Procuring Usable and Work-friendly Software
How to Select IT Systems for a Healthy Work Environment in Public Procurement Processes

Elena Sánchez Sánchez
Abstract

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The introduction of IT systems in workplaces has often been accompanied by a detriment in workers' health and wellbeing. The design of software tools used at work has proved to be one of the risk factors that can increase workers' level of stress and contribute to create an unhealthy work environment.

Previous research in this area has mainly focused on measuring the effects of an existing IT system on workers. Nevertheless, once a software is implemented, it is normally too difficult and expensive to perform the necessary changes in its design to ensure quality and healthy work.

This research studied the possibilities of considering work environment factors when selecting which IT Systems to purchase in public procurement processes. Results include an analysis of the constraints of public procurement framework to set up a work environment evaluation, a list of work environment guidelines to evaluate IT systems and the insights obtained after testing a first evaluation setup with real users. The research also provides some guidance in how to better involve users in assessing the suitability of IT systems for a specific work situation.

The knowledge achieved by this study can be used as a basis for the design of a methodology to evaluate work environment aspects in public procurement processes.
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1. INTRODUCTION

Numerous research studies have demonstrated that the introduction of IT systems in workplaces has been often accompanied by negative effects as an increase of workload, repetitive and monotonous tasks, constraining conditions, static work postures and a decrease of task variability (Åborg et al., 2003).

As a result, health problems reported by workers have risen dramatically in computer supported work environments. The symptoms documented include eye strain, neck and shoulder problems, mouse arm syndrome and stress-related disorders (Sandsjö and Kadefors, 2001), (Bergkvist, 1993), (Aronsson et al., 1994). According to Boivie et al. (2003), some of the risk factors are directly related to the design of the software tools used by workers to perform their job.

Previous research has evaluated the effects of an existing IT system on workers’ health and wellbeing but then it is often too difficult or too expensive to make changes in the software in order to reduce or eliminate risk factors. Therefore, it can be more effective to work from a preventive approach, addressing work environment issues before the software is implemented.

This master thesis studies how to assess work environment factors when selecting IT Systems for a specific work situation in public procurement processes. As a delimitation, the outcome of this research will not be a valid, ready-to-use methodology for setting up a work environment evaluation but some preliminary considerations and insights for its design.

1.1 AIM

The final aim of this study is to contribute to our understanding of how to provide workers with software that supports quality work and contributes to maintain a healthy work environment. One way of achieving this end could be to consider work environment factors when selecting which IT Systems to purchase. My research is focused in understanding how to assess the suitability of IT systems for a specific work situation within public procurement framework. The knowledge and insights achieved by this study could be used as preliminary considerations for the design of a methodology to evaluate work environment aspects in procurement processes.

1.2 RESEARCH QUESTIONS

This master thesis examines the possibilities of assessing work environment factors in public procurement processes to purchase software for work.

Hence, the research questions addressed are:

- Which are the challenges of setting up a work environment evaluation within public procurement framework?
- What aspects should be assessed to identify the software that better supports quality and healthy work?
- How can users be involved in assessing suitability of IT systems for a specific work situation?
2. BACKGROUND AND THEORY

In this section, the background and theory of the master thesis are presented.

2.1 PUBLIC PROCUREMENT

Public procurement is the process whereby public authorities - including all levels of government and public agencies - buy goods and services or commission work. These contracts make up for a significant share of the EU market, accounting for about 16% of its gross domestic product (GDP)(European Union, 2011). According to the law, procurement must be carried out respecting the principles of: transparency, equal treatment, mutual recognition, non-discrimination and proportionality.

Four different processes can be applied: open procedure, restricted procedure, competitive negotiated procedure or competitive dialogue procedure. Depending on the nature of each procurement, the most appropriate approach should be selected. As long as the contract or goods to procure exceed a certain threshold defined by the European Commission, procurement processes are subject to the EU directives: 2004/17/EC and 2004/18/EC.

A typical complex procurement process could be divided in the following three key stages (Office of Government Commerce, 2008):

1. **Pre-procurement**
The pre-procurement stage is dedicated to gather the requirements, plan and decide the characteristics of the process and write the call-for-tenders documentation. The following steps are advisable: consult stakeholders to know what is needed and the budget available, get information from the market to understand the available options and contact with external advisers if necessary. Based on that we will.

2. **The Tender Process**
During the tender process, suppliers that apply to participate in the procurement process are evaluated according to the criteria specified in the tender documentation. The assessment should be pre-defined and consistent with the objectives of the project. The winning tender will be always
the one which offers best value for money (VFM), in other words, the product or service that fits your needs with the lowest whole-life costs.

3. Contract and Supplier Management
The contract and supplier management stage includes signature of the contract with the winning supplier, the formal governance of the contract and possible changes to the contract documents. During this stage is necessary to ensure that goods or services are being delivered as agreed and it is advisable to establish a constructive relationship between the two parties.

According to the principle of transparency, call-for-tenders must be published in the European Union Official Journal (EUOJ). These call-for-tenders could include different kinds of requirements or demands:

- **Must Requirements**
  Must requirements are mandatory characteristics. The suppliers must be able to fulfill all must requirements described in the Call-for-tenders documentation to take part in the tender.

- **Should Requirements**
  Should Requirements are desirable characteristics. Meeting more should requirements increases added value of the product. Thus, the purchaser can pay a little bit more for the product, because it offers a higher value for money. In order to consider this value for money (VFM) in the decision of the winning tender, the fulfillment of each should requirement will contribute to lower the competition price of this product, increasing its opportunities to win the contract.

- **Complementary Evaluations**
  Apart from the must and should requirements, the procurer can establish complementary evaluations, for example, a usability test of the different systems. The result of this evaluation will also give a reduction for the competition price of each tender.

Additionally, it follows from the legislation on public procurement that both suppliers, during elaboration of the tender, and purchasers, during the evaluation of tenders, should preferably be able to objectively and unambiguously verify the extent to which a specific product satisfies each requirement (Thorén, 2004).
2.2 WORK ENVIRONMENT ASPECTS IN PUBLIC PROCUREMENT

To my knowledge, there is not previous research in how to assess software work environment aspects within the framework of public procurement processes. I am also unaware of the existence of real call-for-tenders for procuring software that had already included work environment aspects.

However, the inclusion of usability in public procurement has already received some, even though limited, attention from the research community. Due to the resemblances of work environment and usability, I have considered that these studies could be useful to understand the challenges of assessing work environment in public procurement. A review of some of them is included in the next section.

2.3 USABILITY IN PUBLIC PROCUREMENT

According to the legal framework of public procurement, assessment of tenders should be performed following a pre-defined evaluation. But, preparing valid and verifiable usability requirements for tendering and determining appropriate usability measures and target levels is a challenging task (Jokela, 2010).

A recent study (Lehtonen et al., 2010) that analyzed 38 call-for-tenders issued during a period of three months in Finland, concluded that there is a lot of work to improve quality of usability requirements in call-for-tenders. The number of usability requirements per call-for-tenders typically ranged between 1 and 5, but they were invalid and/or not verifiable. Nine call-for-tenders did not include any usability requirement.

Even though existing literature explicitly on usability requirements in call-for-tenders context is limited, different approaches have been proposed and analyzed:

- Thorén (2004) considered that given the lack of universally recognised usability criteria, it could be envisaged that a product with a certificate issued by a third party and based on a formal standard will get a higher score in the evaluation of tenders. The emergence of suppliers’ declarations offer a possible way of introducing usability requirements in calls-for-tender and that the CIF usability declaration format is a promising approach.

- After exploring different options, Jokela (2010) ended up with two measures:
  - Task completion success rate: 95% confidence that at least a predefined percentage of target population completes a (specific) task correctly.
  - Design solution success rate: 95% confidence that at least a predefined percentage of target population do not have problems with a specific design solution.

Jokela (2010) could not find appropriate ways for defining requirements directly for efficiency and user satisfaction.
Apart from research, we can also find experiences of usability evaluations in real public procurement processes. The following setup was used by a Swedish public authority to assess the usability compliance of an e-commerce service during a public procurement process in 2009:

- **Usability testing**  
  Participants were 8 users, from 4 different roles (job position). The two users of each role worked in pairs to perform two scenarios that corresponded to representative work situations. After the test, each user filled in a satisfaction survey individually.  
  Test measures were:
  
  - Effectiveness (50%): percentage of completeness of each scenario.  
  - Efficiency (20%): time range needed to complete each scenario.  
  - Satisfaction (15%): results of satisfaction survey (SUS).

- **Heuristic evaluation** (15%) an experts’ review based on some guidelines from the ISO-Standard 9241-part 110: Dialog Principles.

  The result of each system in usability evaluation influenced the competition price of each tender. In this concrete procurement process, tenders received a maximum of 15% reduction in their competition price from the usability evaluation.

It is remarkable that the usability evaluation setup used in practice assessed efficiency and user satisfaction while Jokela (2010) could not find appropriate ways to define requirements for these two criteria.
2.4 QUALITY AND HEALTHY WORK

Several frameworks and measures had been proposed by different authors to define and study quality and healthy work. The concept of quality of work used in this master thesis is based on the theoretical framework proposed by Karasek and Theorell (1990). According to Karasek and Theorell’s job model, a quality and healthy work environment is the result of a balance between workers’ subjective experience of demand, decision latitude or control, and social support.

The figure below illustrates the results of different combinations among these factors:

![Figure 2. Relations between demands, control and social support in a work situation (Karasek and Theorell, 1990).]

The combination of high demands and low decision latitude can generate a stressful work atmosphere affecting negatively workers’ wellbeing and health. Social support has a buffering effect reducing stress levels when workers are exposed to high demands and low control. Healthy work combines reasonable demands, strong social support and freedom to decide work pace, methods and routines.

The European Working Conditions Survey (European Foundation for the Improvement of Living and Working Conditions, 2000) revealed that work-related stress was the second most common work health problem across the EU15 only after back pain. Moreover, long term stress can result in permanent physical and psychological health problems among workers such as chronic fatigue, burnout, musculoskeletal problems or cardiovascular disease (European Foundation for the Improvement of Living and Working Conditions, 2007).

As an extension of Karasek and Theorell theoretical framework, Schouteten (2001) proposed the following six characteristics to define quality work:

1. **Work variety**: a job should contain primary tasks, but also preparing and supporting tasks.
2. **Learning opportunities**: a job should contain a variety of difficult and easy tasks.
3. **Workload**: a job should consist of non-monotonous tasks.
4. **Autonomy**: a worker should be able to decide upon work pace, order and methods.
5. **Relation with job environment**: ability to ask direct colleagues, superiors or other departments for help with problems.
6. **Information of work**: a worker should get enough information with respect to the work.
2.5 PROBLEMS ASSOCIATED WITH COMPUTER SUPPORTED WORK

The introduction of IT systems in workplaces has represented a radical change in working life. Unfortunately, this change has not always contributed to enhance workers’ health and wellbeing (Sandblad et al., 2003).

According to Boivie et al. (2003), extensive use of computers at work have been often accompanied by negative effects as increase of workload, repetitive and monotonous tasks, constraining conditions, static work postures and decrease of task variability.

Other significant problems that may arise when using IT systems in work were described by Hardenborg (2007):

- Restraints and lack of freedom. (static monotonous postures, long hours in front of the computer)
- A feeling of being controlled by the IT system.
- Stress and the experience of high work demands (work load, time pressure and poor IT support can exceed workers’ resources)
- Stress-related psychosomatic conditions (i.e. headache, irritation, stomach-ache, lack of sleep.)
- Physical problems (i.e foremost ache in the neck, shoulders, arms and hands)

As a result, stress and health problems have increased dramatically in computer supported work environments (Bergkvist, 1993). Among other risk factors, the design of IT systems for work seems to have an important impact on the quality of work environment (Boivie et al., 2003), (Åborg and Billing, 2003).

A bad-designed computer application can prevent users from working efficiently: making the work problematic, slow, complex and hard to understand. Other negative aspects of IT systems can include bad designed functionality for monitoring, time measurement and distribution of workload (Sandblad et al., 2003).

Previous research in this field includes the development of different methodologies and tools to identify problems and improve IT systems’ design. Some of these methods are briefly described below:

- **ADA-method** (Åborg et al., 2003) consists of a mixture of observations, interviews and questionnaires and was designed to be used by occupational health personnel as part of their investigations of work environment and health in VDU-work. It includes an interview guide with a list of aspects concerning usability and work environment and advices for performing the observations. Moreover, an interpretation guide is provided to support interpreting the results of the observations and interviews.

- **Users’ award** (Walldius et al., 2006) is a user-driven workplace software certification process. The aim of the certification is to give prospective buyers and users an understanding for the overall aspects of the software. The report of the certification is based on what a representative sample of users from at least three workplaces have experience after at least one year of daily use.
The ISO standard 9241: Ergonomic requirements for office work with visual display terminals (retilted as Ergonomics of Human System Interaction) is a multi-part standard from the International Organization for Standardization (ISO). This standard described ergonomics principles for IT systems and provided guidance to ensure optimal working conditions in computer supported work environments. (International Organization for Standardization, 1992-2011)

2.7 IDENTIFYING WORK ENVIRONMENT FACTORS IN COMPUTER SUPPORTED WORK

The aspects of software that can influence the quality of work environment are highly contextual and depend on each concrete situation, the nature of the tasks, work routines and philosophy. Nevertheless, a systematic literature review showed up that some aspects have been repeatedly described by different authors in different contexts.

Thus, I have considered these shared aspects from previous research as a basis for assessing the suitability of IT systems at work and I have organized them in the following 8 key areas:

1. Task steps or workflow
2. Presentation of information
3. Window switching
4. Overview, control and flexibility
5. Mistakes and consequences
6. Monotonous work
7. Input devices
8. Support

The contributions of different authors that explain and support the importance of each of these areas are summarized below:

1. Task steps or workflow

The ISO Standard 9241-2: Guidance on task requirements (International Organization for Standardization, 1992) established that the design of VDT based information processing systems should facilitate task performance.

According to Lif et al. (2001), computer systems must support the user in reaching the appropriate sets of information with minimal time and cognitive effort. In this sense, it is interesting to point out that users are often not aware of high cognitive load, thus, knowledge at this respect is required to be able to capture cognitive work environment problems. (Åborg et al., 2003)

Lif et al. (2001) considered essential to understand that users’ main interest is to perform their work, not to manage a computer. The importance of minimizing users’ actions to manage the computer is also endorsed by the ISO 9241-12: Presentation of Information (International Organization for Standardization, 1997) that includes recommendations as default windows size should be designed to minimize the number of operation the user needs to perform a task. On the other hand, Waal and...
Batengurg (2008) defended that when the order of activities is performed in a logical way a positive effect on information of work and relation with job environment is expected.

Finally, there are also important stressors that are more directly related to the technology itself (Åborg, 2002). IT systems with slow response times can also prevent users to efficiently perform their tasks.

2. Presentation of information

The ISO Standard 9241-12: Presentation of Information (International Organization for Standardization, 1997) established that density of displayed information should be such that it is not perceived as overly cluttered by the user. Moreover, according to ergonomics principles, information should be also located according to user expectations in order to minimize search time.

Lif (1999) also argued that, when possible, all information needed for a decision should be visible simultaneously (this concept will be further explained in next section “Switching windows”). Nevertheless, screen space is usually too limited to hold all needed information at the same time.

At this respect, Gulliksen et al. (1997) proposed to classify all pieces of information or variables for a decision in two different levels. Level 1 would contain all variables needed frequently for the decision, and Level 2, variables used infrequently. If it is not possible to display all information in the same screen, priority 1 should be always visible while level 2 may be hidden. Giving each attribute a priority makes also easier for the user-interface designer to decide which information to put in the foreground and which in the background (Lif, 1999).

Additionally, especially important information for the user can also be highlighted by using a visual cue, e.g. font, shape, colour. Lif et al. (2001) also suggested that using information coding and a careful spatial layout is possible to present more information on the screen.

3. Window switching

According to Tversky and Kahneman (1974), during decision making humans tend to omit information that is not immediately available. Thus, a better judgement for a task can be performed if all information needed for a decision is simultaneously visible in the screen. Unfortunately, Lif et al. (2001) found out that users typically need to use more than one application to accomplish one single task, moreover each application normally includes one main window and accompanying secondary windows.

Information presented on screens that can only be viewed in sequence has proved to be more cognitively demanding than information presented in parallel (Lind, 1991). As a consequence, different presentations of the relevant data may influence how quickly a correct decision is made. According to Lind (1991), simultaneous presentations of information lead to faster decisions and represent a great aid for the user.

Finally, switching between different windows require the user to perform extra mouse clicks which can reduce efficiency to perform the task. At this respect, Gulliksen and Sandblad (1995), observed that interfaces where the users have to spend a lot of time rearranging windows instead of doing their actual work are unfortunately common.
4. Overview, control and flexibility

This area includes different aspects that can influence worker’s subjective feeling of decision latitude: margin to decide among their task order, pace and methods and appropriate overview about their workload, work items and task results. The ISO Standard 9241-2: Guidance on task requirements (International Organization for Standardization, 1992) established that well-designed tasks should provide an appropriate degree of autonomy to the user in deciding priority, pace and procedure.

According to Waal and Batenburg (2009), a certain authorization variance or the possibility to deviate from the workflow is recommended. This flexibility can have a positive effect on learning opportunities for the worker. At this respect, Shen and Gallivan (2004) founded that increasing employees’ level of autonomy over when and how they perform their work is possible to reduce the level of mental strain and enhance their level of job satisfaction.

Additionally, Boivie et al. (2003) founded that one problem in electronic case handling is the possibility that administrators lose the overview and control of their workload, one of the risk factors of Karasek and Theorell’s model (1990). According to Boivie et al. (2003), paper-based documents are tangible and offer rich peripheral information. They can be sorted into piles and the administrator can assess the amount of work by the thickness of the piles. On the contrary, electronic case handling tools, displaying the cases in simple lists or inboxes do not provide the same kind of overview of the workload, i.e., the number of cases and the amount of work each one will require.

The ISO Standard 9241-2 (International Organization for Standardization, 1992) also stated that sufficient feedback on task performance should be provided in terms meaningful to the user. One example of this feedback is detailed in the part 17 of the same ISO 9241: Form filling dialogues (International Organization for Standardization, 1998): the system should provide an acknowledgement to the user that the transmission of the form entries has been accepted by the system.

5. Mistakes and consequences

Even though preventing mistakes is one usability principle, some errors are intrinsically related with the work routines and can affect workers’ feeling of control and support. Thus, some authors have also proposed to study and address errors from a work environment perspective.

For example, identifying and locating errors is one of the aspects included in the ISO Standard 9241-17: Form filling dialogues (International Organization for Standardization, 1998). Boivie et al. (2003) also considered errors and mistakes as stressors at work, especially if these mistakes can have serious consequences, for instance, filling in the wrong social security number when registering a death.

Furthermore, the aspect list developed by the ADA-Method (Åborg et al., 2003) also included error controls and tolerance. The questions proposed in the interview guide (Åborg et al., 2003) were:

- Are the rules automatically verified?
- What kind of feedback is provided in an error situation?
• Is the feedback obvious?
• Is it easy to make corrections?

6. Monotonous work

The ISO Standard 9241-2: Guidance on task requirements (International Organization for Standardization, 1992) established that undue repetitiveness should be avoided as it can lead to sensations of monotony, satiation, boredom, and dissatisfaction.

In the six characteristics to define quality of work proposed by Schouteten (2001) is also stated that job should consist in non-monotonous tasks. Furthermore, the report “Work related stress” (European Foundation for the Improvement of Living and Working Conditions, 2007) also considered monotonous tasks as one of the risk factors for work related stress.

In the study of an enterprise software system (Greenwood and Sommerville, submitted 2011) users considered problematic the fact that the software requires a separate login from the workstation login. Another point that disturbed users was that files could only be uploaded individually. The consequences of these situations were frustration and/or perceptions of wasted time.

Finally, Gulliksen et al. (1997) considered that apart from designing tasks in a efficient way, we should not forget that the movement between the tasks should also be as efficient as possible.

7. Input devices

On one hand, software that requires an extensive use of pointing devices, as mouse, can be harmful for workers. Analyses of risk factors related to computer work showed that for every quartile increase in weekly mouse usage, the risk for acute neck pain increased by 4% and the risk for acute shoulder pain by 10% (Andersen et al., 2008).

Aborg and Billing (2003) also pointed out that one of the major factors behind the increase in musculoskeletal symptoms of their study could have been the introduction of the computer mouse and a computer system that compels a high frequency of mouse clicking. Moreover, Sandsjö and Kadefors (2001) considered that the mouse arm-syndrome is directly related to the implementation of computer systems requiring frequent use of the computer mouse.

On the other hand, switching continuously between input devices can also have negative consequences. At this respect, the ISO Standard 9241-17: Form filling dialogues (International Organization for Standardization, 1998) stated that the need for users to switch between different input devices when filling in a form should be minimized: If a pointing device can be used for input in a form, it should be usable for navigation as well.

Interleaving the use of two input devices can also be unefficient as it requires users to spend time in moving one hand from the keyboard to reach for a pointing device and back (Jastrzembski et al., 2005).
Previous research referred by Jastrzembski et al. (2005) had estimated that 360–400 ms were lost each way in “homing” between the mouse and keyboard.

8. Support

This area includes social support from colleagues and managers but also technical support or maintenance to fix present or potential problems with the IT systems. According to the ISO Standard 9241-2: Guidance on task requirements (International Organization for Standardization, 1992), working alone without opportunities of social contact should be avoided. Andersen et al. (2008) also argued that low social support in the workplace was associated with neck pain.

The ability to ask not only direct colleagues, superiors but also other departments for help with problems was one of the six characteristics proposed by Schouteten (2001) to define quality of work. At this respect, the ISO Standard 9241-2 (1992) stated that users should be encouraged to identify existing and potential problems that can occur during design, implementation and beyond. Effective communication with users should be maintained in order to ensure maintenance and timely and effective organization responses to potential problems.

Additionally, Waal and Batenburg (2009) argued that if users experience a certain degree of influence, this holds a positive relation with the perceived quality of the system, user involvement and attitude towards the system.
3. METHODOLOGY

3.1 DESCRIPTION OF THE RESEARCH PROCESS

I started my work with a literature review of scientific papers regarding quality work, healthy work environment, ergonomics and problems associated to computer supported work, with the intention to get a better understanding of the theory and previous research of my study. I also reviewed articles from other adjacent areas of knowledge that I considered could play an important role in answering my research questions: requirements engineering, software development and procurement processes.

I was especially interested in the intersection of usability with all these fields, due to the closeness of usability and work environment considerations. They are both non-functional requirements, focused in users, in their satisfaction or well-being, and consequently, contextual and difficult to measure. As, up to date usability has received more attention from the research community, I considered that some lessons learned by this field could be used as starting point for work environment.

At this point, I had an introductory interview with an IT procurement officer to get direct knowledge about his work, experiences and main challenges of this framework. He also provided to me with different documentation regarding former procurement processes for IT systems. I also interviewed a HCI researcher and consultant that have participated in the definition and carrying out of a usability evaluation within a public procurement process. The aim was to get some insights about how they decided each aspect of the evaluation procedure and which was his experience in implementing it.

After that, I compiled guidelines about quality and healthy work from different authors, and refined the list selecting those that could applicable for software. The objective was not to elaborate an exhaustive checklist with all possible problems, but a brief list to prevent the most frequent and severe problems and that could have more possibilities to be used in practice. This list of guidelines was meant to serve as a basis or theoretical background for the evaluation of work environment issues.

Then, I elaborated a first proposal for setting up a work environment evaluation that should be performed in combination with the usability evaluation design by the expert interviewed. The idea was to take advantage of same users and same scenarios and just add a section in which users can assess the compliance of work environment guidelines. Not all guidelines will be directly graded by users, in some of them users will provide information and experts will decide the grades based on that information. I also included the possibility of giving extra points if the supplier undertakes the compromise to fulfill the guideline later on based on our instructions, once the contract was signed.

In order to get feedback and keep working iteratively, I presented this proposal to the expert in procurement processes in a second interview. His insights about the possible problems or challenges to carry out the work environment evaluation within the context of different procurement processes were really enriching.

At this point, I judged interesting to get also feedback from users that could participate in this kind of evaluations of work environment factors. The aim was to get a deeper understanding on how can we better involve them in the work environment assessment: which guidelines are more suitable to be assessed by
users, what kind of questions or grading scales are adequate, if is more useful qualitative or quantitative feedback, if the results could be considered significant, if some diagrams o screenshots can help them evaluating some guidelines,...

The ideal situation would have been to test the proposal with real users in a real context of an ongoing procurement process and follow the whole process, from the request for tenders to the implementation. But, as this was out of the scope and deadlines of this master thesis, I just carried out a test with users of one of the software already used by financial staff of Uppsala University.

I am aware that this scenario has some limitations regarding the applicability of results in the procurement stage, because the users have already been working with the software for a long time. Therefore, test results could not be taken as a proof of the validity of the method. But, as the purpose of this master thesis was not to set up a valid and ready to use protocol for work environment evaluation in procurement processes for IT systems, but to provide some insights about the challenges of this kind of evaluation and users’ involvement, I considered the knowledge achieved throughout this test could be meaningful despite this limitation.

The procedure was designed to make users review all the work environment aspects both qualitative and quantitatively, even those that could be more suitable to be reviewed by experts. The test included questionnaires, observations and interviews. Information about the context of use of the program, their tasks and work routines was gathered from two previous interviews with two users of the system. These details were used to define the scenario and questionnaires for the test.

Finally, I tried to organize all the knowledge gathered from articles, users, experts and my own experience, and provide some preliminary considerations for designing a work environment evaluation suitable for public procurement processes.
The following table contains an overview of the process with a brief description of each method:

<table>
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<th>METHOD</th>
<th>DESCRIPTION</th>
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<tbody>
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<td>Literature review</td>
<td>Review previous scientific research about healthy work environment, ergonomics and problems associated to computer supported work, public procurement, usability and requirements engineering.</td>
</tr>
<tr>
<td>First interviews with experts</td>
<td>Interview an expert in public procurement about the challenges of the framework for procuring IT systems.</td>
</tr>
<tr>
<td></td>
<td>Interview an Expert in usability about the challenges of evaluating usability in public procurement.</td>
</tr>
<tr>
<td>List of guidelines about healthy software</td>
<td>Compile of best practices about health and quality work and selection of the ones applicable to software</td>
</tr>
<tr>
<td>Proposal for a work environment evaluation for public procurement</td>
<td>Design a procedure to assess work environment aspects by users and experts</td>
</tr>
<tr>
<td>Second interview with expert</td>
<td>Interview an expert in public procurement about my proposal for a work environment evaluation.</td>
</tr>
<tr>
<td>TEST CASE</td>
<td></td>
</tr>
<tr>
<td>Interview with users</td>
<td>Gather information from users of one specific software about the context of use and their work</td>
</tr>
<tr>
<td>Work environment test with users</td>
<td>Apply the proposal for a work environment evaluation with a real context with real users</td>
</tr>
</tbody>
</table>

Table 1. Overview of the methods used during the research

3.2 QUALITATIVE APPROACH

This research has been conducted from a qualitative approach, since the nature of the goal was to better understand the challenges of assessing work environment issues in public procurement processes of IT systems. Even though some results of this study are contextual and limited, I hope the knowledge acquired could serve as a basis for further research and for designing the final setup of a work environment evaluation for procurement processes with the aim to provide workers with software that enhances quality work and healthy work environments.

During the test case, I have also gathered some quantitative information: the questionnaires filled in by users asked them to grade the compliance of each work environment factors in the software tested from 1 to 5. This method was decided according to the characteristics of procurement processes framework, which requires the work environment evaluations to end up with a figure, at least when selecting the winning tender. Nevertheless, the reduced number of users in the test made valueless any statistical analysis. Consequently, also quantitative information was analyzed qualitatively with the only purpose to find out if users’ grades seemed meaningful and matched with their qualitative comments.
3.3 INTERVIEWS

During this study, I had an introductory interview with one expert in procurement process, who is directly in charge of managing IT procurement processes in a public institution in Sweden, to gather information and insights about procurement processes and his experiences. After one month, I had a second interview with him, this time to get feedback about the first proposal for a work environment evaluation.

I also interviewed one Swedish usability consultant and researcher who took part in the design of a usability evaluation for a public procurement processes to get some insights about the usability evaluation setup, the challenges of the process and his experiences.

Moreover, I interviewed two of the people working as financial administrators in the same public institution. The interviews were aimed at gathering information about their work routines, environment and tasks. Knowledge acquired from these interviews was used for selecting the scenario of the test case and for designing the forms and questions to interview the users.

All interviews were semi-structured and lasted between 1 and 2 hours. Data was gathered through notes on paper or audio recordings. For further details, the questions of each interview are included in the Appendix.

3.4 WORK ENVIRONMENT EVALUATION WITH USERS

The aim of the test case was to get insights about how can we better involve users in a work environment evaluation. As the work environment evaluation procedure was designed to be performed jointly with the usability evaluation, our test case included one part in which the expert asked the user to perform one scenario. The intention was to partially reproduce the atmosphere of the usability test and make the users focus in the given scenario for answering the questionnaire and interview about work environment.

The procedure was designed for making the users assess each work environment aspect qualitatively in a scale from 1 to 5, but also quantitatively and see if the two results match and if they were aligned to our previous considerations.

Figure 3.Users performing different parts of the test

Due to time restrictions, the test just studied one role of users and one scenario: introduce the financial details to pay one invoice and send it to authorization. As it was impossible to introduce a fake invoice in the system, the users did not performed the task with exactly the same invoice but with one real invoice from their inboxes. Even though it can be seen as a restricted condition at the beginning, observing the task
with different invoices has given me the opportunity to observe some variations within the task that have also been enlightening.

Instead of making the users fill in the post-test questionnaire first, and then interview them about the work environment guidelines, I thought that could be interesting to overlap both methods. I considered that after having answered the qualitative questions, the user could be able to grade the work environment aspects with a better understanding and criteria. Nevertheless, there is also the possibility that formulation of the qualitative questions and the expressions of the interviewer could have biased the users’ grades.

Procedure:

1. The facilitator explained the user the details of the test and ask the users to sign the informed consent form.
2. The user filled in the Pre-test questionnaire.
3. The user performed the task with one of the invoices of his/her inbox (think-aloud method).
4. The user answered qualitative questions about one guideline and then was asked to look at the question in the Post-questionnaire and grade it from 1-5. This step was repeated for each of the guidelines.

In order to check if a workflow diagram of the task could help the users answering the questions of the post-test questionnaire/interview, I developed a diagram with the steps and screen of the task to use it during the test. To assess if there was any difference using the diagrams or not, three of the users were provided with these diagrams from the first moment, the other two users answered first the questions without the diagram, and then they were asked to answer some of the questions again after looking the diagram.

Additionally, printed screenshots were used in some questions, with the intention that users could look at the elements of the interface more closely and even make notes on te paper.
**Pilot test:**

In order to test the procedure, I decided to carry out a pilot test. The insights from this pilot test were really useful to refine the formulation of some questions that were not clear, to modify some parts of the pre-test questionnaire and to decide to make the users grade all guidelines even those that I considered that could be better assessed by experts.

Although this changes, I have considered that could be interesting to include the results from the pilot test in the results section, due to the restricted number of participants and the qualitative approach of the study. Anyhow, to remark this difference, this user has been labelled as “Pilot test” and instead of “User 1”.

**Software tested:**

The test was performed with the software “Raindance portalen” used for reception, payment and storage of electronic invoices mainly by administrative and economic staff.

**Test conditions:**

The tests were carried out individually, in the office of each user, with their own computer, and they all lasted between 1 hour and 1.5 hours. The whole test was recorded with audio, and additionally with video during the while in what the user was performing the task in the computer.

**Users’ overview:**

<table>
<thead>
<tr>
<th>USER 1 (PILOT TEST)</th>
<th>USER 2</th>
<th>USER 3</th>
<th>USER 4</th>
<th>USER 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Job position</td>
<td>Financial Administrator</td>
<td>Research Administrator</td>
<td>Economist</td>
<td>Administrative coordinator</td>
</tr>
<tr>
<td>Frequency of use</td>
<td>5 invoices/day</td>
<td>1 invoice/week</td>
<td>3 invoices/week</td>
<td>2 invoices/week</td>
</tr>
<tr>
<td>Permissions</td>
<td>Admin</td>
<td>-</td>
<td>Admin</td>
<td>Admin</td>
</tr>
<tr>
<td>Gender</td>
<td>Female</td>
<td>Female</td>
<td>Male</td>
<td>Female</td>
</tr>
</tbody>
</table>

Table 2. Overview of test participants’ characteristics.

For further details about the test, the following documents are included in the Appendix:

- Informed consent form
- Pre-test questionnaire
- Post-test questionnaire and qualitative questions
- Workflow diagram of the task
- Screenshots
4. RESULTS

4.1 GUIDELINES FOR HEALTHY WORK ENVIRONMENT IN COMPUTER SUPPORTED WORK

The following list of guidelines is based on previous research from different authors about work environment, healthy work and problems associated with computer supported work. The concrete studies and references that support each guideline can be founded in the Background and Theory part of this report (Section 2.7 Identifying work environment factors in computer supported work).

<table>
<thead>
<tr>
<th>SUMMARY</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. TASK STEPS</td>
</tr>
<tr>
<td>Meaningful process aligned with work routines</td>
</tr>
<tr>
<td>Minimum number of steps and minimum cognitive effort</td>
</tr>
<tr>
<td>Quick system responses</td>
</tr>
<tr>
<td>2. DISPLAYING INFORMATION WITHIN THE SCREEN</td>
</tr>
<tr>
<td>Presentation of information</td>
</tr>
<tr>
<td>Simultaneous information</td>
</tr>
<tr>
<td>Prioritization of information</td>
</tr>
<tr>
<td>3. EXTERNAL INFORMATION SOURCES AND OTHER PROGRAMS</td>
</tr>
<tr>
<td>Minimum window switching</td>
</tr>
<tr>
<td>4. CONTROL AND OVERVIEW</td>
</tr>
<tr>
<td>Easy workload overview</td>
</tr>
<tr>
<td>Flexibility to move between tasks</td>
</tr>
<tr>
<td>Space for task variance or exceptional cases</td>
</tr>
<tr>
<td>Clear result of the task</td>
</tr>
<tr>
<td>5. MISTAKES AND ERRORS</td>
</tr>
<tr>
<td>Reducing the number and consequences of mistakes</td>
</tr>
<tr>
<td>6. MONOTONOUS WORK</td>
</tr>
<tr>
<td>Avoiding repetitive Log in/Log out</td>
</tr>
<tr>
<td>Optimized process for repeated tasks</td>
</tr>
<tr>
<td>Perform task jointly for more than one item</td>
</tr>
<tr>
<td>7. INPUT DEVICES</td>
</tr>
<tr>
<td>Avoiding extensive use of mouse</td>
</tr>
<tr>
<td>Minimum switch from keyboard to mouse</td>
</tr>
<tr>
<td>8. SUPPORT AND MAINTENANCE</td>
</tr>
<tr>
<td>Confidence in receiving support in case of problems with the software</td>
</tr>
<tr>
<td>Social communication</td>
</tr>
<tr>
<td>Periodical updates to fix problems reported by users</td>
</tr>
</tbody>
</table>

Table 3. Summary of work environment guidelines and subguidelines.

A further explanation of the best practices for each criteria is provided below:
1. TASK STEPS

The workflow should be intuitive and aligned to the work routines in order to support efficient work and prevent stress.

1.1 Meaningful process for the workers and connected to their work routines

The user should be able to concentrate on his/her main task instead of thinking about what was the next step or how to perform this action with the software. To accomplish that, task steps and order should be meaningful to users and connected to their work routines and organization philosophy.

1.2 Minimum number of steps and minimum cognitive workload of each step

Task workflow should include a minimum number of steps, actions or inputs. The ones to just operate the computer should be minimized. Steps not requiring human judgment should be automated. The system should not ask users to introduce unnecessary data.

Apart from reducing the number of steps, to facilitate working more efficiently, we should reduce the cognitive workload of each step. It could be done by reducing information that should be memorized, calculations, risk of mistakes...

1.3 Quick system responses

In a healthy work environment, workers should feel in control over their own work pace. If workers are forced to use IT systems to work, be constantly waiting for system response to perform next step, could negatively influence their feeling of control over their work pace. Additionally, it will probably increase their level of stress to finish the job on time.

2. DISPLAYING INFORMATION ON THE SCREEN

2.1 Presentation of information

Another aspect that can contribute to increase quality of work is if workers get enough information regarding the work to be done. In terms of interface design, the system should display enough information but also present it in an appropriate way in order to allow the user to perceive it and understand it correctly and efficiently.

2.2 Simultaneous information

Simultaneous presentation of data can be processed more efficiently by humans than data displayed sequentially. Some studies have also revealed that humans tend to omit information that is not currently available when making a decision. Thus, if possible, system should display in the same screen all necessary information for a decision instead of requiring the user to switching between windows or scrolling. It will contribute to reduce cognitive workload, time needed to complete a task and mistakes.
2.3 Prioritization of information

Even though advisable, space limitations of the screen sometimes make not possible to simultaneously display all information needed for one step. As all information is not equally important, the different data should be prioritized according to its importance for the users. Information with high priority should always be visible and have a prominent position, size or layout. Information with low priority can be less prominent or hidden.

3. EXTERNAL INFORMATION SOURCES AND PROGRAMS

3.1 Minimum window switching

Sometimes external information sources or other programs are necessary or helpful to complete one task. Nevertheless, it is not advisable that users are forced to use a large number of windows, programs and processes at the same time.

Window switching could increase short-memory load and make more difficult to get the overview. It will also increase mouse usage. Thus, software should allow users to open different programs or information sources without abandoning the main task, but require a minimum number of external sources and different windows (pop-ups).

4. OVERVIEW AND CONTROL

4.1 Easy workload overview

Computer should not provoke users to lose overview or control about their workload. Software should display enough details of each item or work cases to allow users easily identify each of them. Users should also be able to judge amount of work to be done and complexity without performing any action or within a reasonable number of clics.

4.2 Flexibility to move between tasks

Worker autonomy to decide task pace, order, and methods is one of the principles of healthy work. It is advisable that software offers users the possibility to decide which task they will perform first and which later. Moreover, users should be able to interrupt a task (save even when the task is not finished, and continue later from the same point) and open another task simultaneously.

4.3 Space for task variations or exceptional cases

Workers should not feel constrained by the software when performing their work. Software should be flexible enough to allow workers to perform the task with some variations if necessary: unknown data, data in a different format, free text instead of options, ...
4.4 Result of the task

Workers should receive enough information about task progress and outcome. Uncertainty could contribute to increase the level of stress. Users should not feel doubtful if the task has been finished correctly or not. Even some time after having finished the task, workers should be able to check the task status within the system.

5. MISTAKES AND ERRORS

5.1 Reducing the risks and consequences of mistakes

Mistakes that may have serious consequences could be considered as work stressors. Fear of workers to commit these mistakes could lead to increase their cognitive workload and drive to stressful situations. Thus, would be advisable that software includes some kind of mechanisms to check mistakes, for example, among data entries: automatically or warning users to double check important data.

Although, can be positive that workers receive some support from the system in controlling and checking mistakes and avoiding consequences, if workers think that the system can control everything, they could feel either useless or fearless and pay less attention to perform the task. This could drive in committing other mistakes.

6. MONOTONOUS WORK

Monotonous work is one of the factors that negatively contribute to quality and health work and to workers wellbeing.

6.1 Repetitive Log in/log out

It is common that workers need to use several softwares during their working time. If each of these softwares has a separate login, workers are required not only to remember several logins and passwords, but to repeat the same task several times in the course of the day. This action is often perceived by workers as frustrating and time wasting. If possible, it is advisable that the different software share the same login (i.e. workstation login or intranet login). If not possible, at least each system should minimize the number of times that users need to relogin.

6.2 Optimized process for repeated tasks

If users need to do the same task more than one time in a row, they should be able to skip the maximum number of steps the second time instead of starting again from the beginning.

6.3 Perform the task jointly for more than one item

If users are supposed to repeat exactly the same task with a large number of items, software should contemplate a way to optimize this process. One option could be to be able to select a number of items and perform the task jointly with all of the items at the same time.
7. INPUT DEVICES

7.1 Avoid extensive mouse usage

Software requiring a high frequency of mouse clicking could negatively contribute to increase the risk of musculoskeletal problems among workers.

7.2 Switch from mouse to keyboard

A high frequency of switching between different input devices can also increase users’ risk to suffer health problems. Additionally, it is necessary some time for move and home the hand back to keyboard or mouse every time. Thus, software that requires users to constantly switch between mouse and keyboard can be inefficient and harmful.

8. SUPPORT AND MAINTENANCE

8.1 Confidence in receiving support in case of problems with the software

Feeling lack of control over their work can contribute to increase workers’ stress level. Workers should receive appropriate training to be able to understand, control and feel comfortable using the software.

Users should also feel confident about getting appropriate support to solve any doubt or unexpected problem with the software. If frequently asked questions and contextual support is not enough, they should know how and who to ask for support (telephone number and mail). As long as possible, users’ enquiries should receive a quick and effective response.

8.2 Social communication

Social support is one important factor for a healthy work. If task requires the worker to communicate with colleagues or managers, the system should enhance this communication in an easy way.

8.3 Updates to fix problems reported by users

High decision latitude about work routines and procedures can have a positive effect on reducing workers’ stress level. Unfortunately, is not common to ask workers opinions regarding the softwares they need to use at work. In order to enhance the feeling that users’ opinions are listened, would be advisable that a certain number of problems that users reported each year could be solved.
4.2 INTERVIEW WITH A USABILITY CONSULTANT AND RESEARCHER WITH EXPERIENCE IN PUBLIC PROCUREMENT

The expert is a usability consultant and researcher that participated in the design of a usability evaluation used for the procurement process of an E-commerce service for a Swedish public authority in 2009. The setup of this evaluation is detailed in the Background and Theory Section of this report (2.4). The interview was about the usability evaluation setup and challenges and constraints of designing and performing this evaluation.

Below are explained some of the ideas and insights extracted from his interview:

According to the informant, the usability evaluation setup was not an optimal usability evaluation. Public procurement framework requires a summative and quantitative approach. Thus, the test was aimed at grading the systems according to its usability. This number was then used to calculate a reduction in the competition price of each system. Anyhow, the evaluation did not contribute at improving the usability of any of the systems. In fact, the informant explained that after performing the evaluation, they offered the suppliers to send them a list of usability problems founded within their software by free, but nobody asked for it.

The first part of the evaluation were tests with users, based on the three metrics of usability described in the ISO Standard 9241-11: Guidance on usability (International Organization for Standardization, 1998b) effectiveness, efficiency and satisfaction.

However, the interviewed explained that the usability tests were not able to assess all tasks within the system, but just two scenarios per role. Therefore, they decided to perform a heuristic evaluation as a complement to users’ tests. This expert review will take into consideration the whole system. The heuristics evaluation was based on the ISO Standard 9241-110: Dialogue principles requirements (International Organization for Standardization, 2006). The interviewed explained they could have used other usability guidelines, as the famous 10 guidelines from Nielsen (1994), but they preferred to use the ISO Standard as it was a neutral source.

The usability procedure evaluated “the first impression of the system” and consequently one of the requirements for the users was that participants could not know any of the systems in advance. According to him, this was one of the limitations of the setup, because what the usability evaluation really should evaluate is the “the experienced use of the system” but was impossible to let the users use the system for several months before the evaluation. The scenarios and tasks of the usability test were designed jointly with the project leader that knew the work domain, and checked with users if the chosen scenarios were representative of their work.

The interviewed explained that they defined objective scales for each of the measures of the test, concreting the conditions that should be met to receive each score. For example, if the user successfully completed just some part of a task, the task effectiveness should be scored with i.e. 80%. The documents specifying the scales were not public, but it was considered important to have them in case any of the tenders blamed the process was subjective or unfair.

According to the expert, establishing the measures for some these scales was complicated. For example, one of the challenges was defining the time intervals to evaluate efficiency. Due to framework restrictions,
it was not possible to carry out a pilot test with the different systems to see what time durations were reasonable for each task. Thus, they tried to get some insights looking at commercial websites and the duration of their processes for similar tasks. However, the informant stated that the usefulness of this guidance was limited because commercial sites were much more optimized than the softwares participating in the procurement.

Additionally, the different measures from the users’ tests (effectiveness, efficiency, satisfaction) had different weights in the final calculation. This balance was also a consequence of some conditions of the public procurement framework. The interviewed considered that efficiency should have had a prominent weight in the final result as it is very important for software that will be used to work to be efficient. Nevertheless, as they were not sure if the time intervals they defined in the grading scales were correct or applicable, efficiency was only a 20% of the final score while effectiveness was a 50%.

Regarding the number of users participating in the evaluation, the expert stated they could have had 16 users instead of 8 for evaluating each system, but it would have made the whole procedure more complicated and expensive. For this concrete procurement, the participants were workers from several public authorities and they came from different parts of Sweden.

Furthermore, the expert considered that it was hard and risky to decide all the details of the evaluation before knowing how many tenders will participate and how many systems they will have to evaluate. The investment of time and resources is completely different if you need to evaluate 2 systems or 15 systems, thus, a simplified evaluation procedure would be more suitable for the second context. Nevertheless, public procurement framework requires the procurer to specify the procedure in advance.

Finally, as a curiosity, he commented that the final scores about the usability of each system, after carrying out the whole usability evaluation, matched with the first impression when the project group saw the systems.
4.3 FIRST PROPOSAL FOR A WORK ENVIRONMENT EVALUATION

In order to be able to gather users’ feedback about the guidelines for a healthy work environment (See Section 4.1), I drafted a first proposal for a work environment evaluation setup that could be suitable for the restrictions of public procurement.

The evaluation setup proposed follows the overall structure of the usability evaluation explained in section 1.3 that have already been used in, at least, one real procurement process. The intention was that both evaluations were performed complementarily, sharing the same users and the same scenarios in order to optimize time and resources. I considered that a more complicated or demanding methodology will be more difficult to be used in a real context.

However, I was aware that one of the limitations of the usability evaluation seemed to be that it only helps to decide the winning tender but not to improve the usability of the final software. Therefore, I decided to grade in the work environment evaluation not only the actual compliance of the guidelines, but the compromise of the supplier to give us the opportunity to perform changes after signing the contract.

On one hand, I thought future compromises can be positive because it is difficult that systems can perfectly fit work routines of each organization by default. On the other hand, it would give us the opportunity to make further research with users later, once the supplier is chosen, and define the necessary changes within a less rigid framework.

The work environment evaluation would include 3 parts:

<table>
<thead>
<tr>
<th>USERS REVIEW</th>
<th>EXPERTS REVIEW</th>
<th>COMPROMISES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Users should answer some qualitative questions and grade degree of compliance of some criteria within a questionnaire (after having performed the usability test)</td>
<td>Experts should grade degree of compliance of some criteria (after having received qualitative information from users).</td>
<td>If the supplier undertakes the compromise to do the necessary changes to meet some criteria later on, they will get extra points.</td>
</tr>
<tr>
<td>Scale 1-5</td>
<td>Scale 1-5</td>
<td>YES (5)/ NO (0)</td>
</tr>
</tbody>
</table>

Table 4. Overall description of the work environment evaluation parts.

Example of users’ questionnaire question:

Do you consider that the system shows clearly enough if the task have been accomplished successfully or failed?

1---------------------------------------------3--------------------------------------------5

No information about it or confusing  Easy and clear information
Example of expert’s review checkpoint:

Does the system allow users to freely decide their work pace and task order?

1---------------------------------------------------------------3---------------------------------------------------------------5

Grading scale:

1- User is not allowed to do any of these things: decide order of tasks, save without finishing a task, and open a new one at the same time.

3- User is allowed to do some of these things but not all.

5- User is allowed to do all these things.

Example of compromise:

We will be able to tailor system messages for success and failed task, and check the status of the task before, during and after having finished it.

The integration with usability evaluation could be done in the following terms:

1. Pre-test questionnaire about the scenario and the task
   The purpose was to get an overview of the task before users look any system.

2. Usability test
   Two users of the same role would work in pairs to perform 2 scenarios within one system.

3. Satisfaction survey (SUS)
   A satisfaction survey about this system would be filled in by each user individually.

4. Work environment evaluation – User’s interview and questionnaire
   The evaluation would be performed individually for each person and for each scenario. Users should answer some qualitative questions and grade in a questionnaire the compliance of some work environment aspects from 1 to 5.

5. Usability heuristic evaluation
   Each expert would explore the whole system and grade (1-5) the compliance of some principles for computer dialogue.

6. Work environment evaluation- Expert’s review
   The evaluation should be done individually by each of the two experts after having explored the whole interface, the pre-test questionnaire, the information and diagrams provided by the user. They should base their scores on a guide that define the grading scales (1-5) they should use for each checkpoint.
Additionally, based on the information and knowledge achieved, I suggested the following distribution of weight between users, experts and compromises:

<table>
<thead>
<tr>
<th>QUALITY WORK ENVIRONMENT EVALUATION</th>
<th>TOTAL: 15% price reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>USERS’ REVIEW</td>
</tr>
<tr>
<td>1. TASK STEPS</td>
<td></td>
</tr>
<tr>
<td>Meaningful process aligned with work routines</td>
<td>60%</td>
</tr>
<tr>
<td>Minimum number of steps and minimum cognitive effort</td>
<td>60%</td>
</tr>
<tr>
<td>Quick system responses</td>
<td>60%</td>
</tr>
<tr>
<td>2. DISPLAYING INFORMATION WITHIN THE SCREEN</td>
<td></td>
</tr>
<tr>
<td>Presentation of information</td>
<td>30%</td>
</tr>
<tr>
<td>Simultaneous information</td>
<td>info</td>
</tr>
<tr>
<td>Prioritization of information</td>
<td>info</td>
</tr>
<tr>
<td>3. EXTERNAL INFORMATION SOURCES AND OTHER PROGRAMS</td>
<td></td>
</tr>
<tr>
<td>Minimum window switching</td>
<td>info</td>
</tr>
<tr>
<td>4. CONTROL AND OVERVIEW</td>
<td></td>
</tr>
<tr>
<td>Easy workload overview</td>
<td>60%</td>
</tr>
<tr>
<td>Flexibility to move between tasks</td>
<td>info</td>
</tr>
<tr>
<td>Space for task variance or exceptional cases</td>
<td>info</td>
</tr>
<tr>
<td>Clear result of the task</td>
<td>30%</td>
</tr>
<tr>
<td>5. MISTAKES AND ERRORS</td>
<td></td>
</tr>
<tr>
<td>Reducing the number and consequences of mistakes</td>
<td>info</td>
</tr>
<tr>
<td>6. MONOTONOUS WORK</td>
<td></td>
</tr>
<tr>
<td>Log in/Log out</td>
<td>NO</td>
</tr>
<tr>
<td>Optimized process for repeated tasks</td>
<td>info</td>
</tr>
<tr>
<td>Perform task jointly for more than one item</td>
<td>info</td>
</tr>
<tr>
<td>7. INPUT DEVICES</td>
<td></td>
</tr>
<tr>
<td>Avoiding extensive use of mouse</td>
<td>60%</td>
</tr>
<tr>
<td>Minimum switch from keyboard to mouse</td>
<td>60%</td>
</tr>
<tr>
<td>8. SUPPORT AND MAINTENANCE</td>
<td></td>
</tr>
<tr>
<td>Confidence in receiving support in case of problems with the software</td>
<td>NO</td>
</tr>
<tr>
<td>Social communication</td>
<td>60%</td>
</tr>
<tr>
<td>Updates to fix problems reported by users</td>
<td>NO</td>
</tr>
</tbody>
</table>

Table 5: Overall distribution of weight among users’, experts and compromises for each guideline.

The distribution of weight is only general and should be adjusted according to the nature of the systems, its main requirements and the characteristics of the procurement process.
In order to illustrate how weights should be used to calculate the final score for each guideline, the following scenario is provided as an example:

<table>
<thead>
<tr>
<th>Guideline “4.4 Clear result of the task”</th>
<th>USERS’ REVIEW AVERAGE GRADE</th>
<th>EXPERTS’ REVIEW GRADE</th>
<th>COMPROMISES’ GRADE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grades 1-5</td>
<td>4 points</td>
<td>3 points</td>
<td>Yes (5 points)</td>
</tr>
</tbody>
</table>

Table 6. User’s, expert’s and compromises grades in a fictitious scenario.

In this scenario, users’s average grade for this guideline was 3 points, experts’ grade was 3 points and the supplier got 5 points for undertaking the compromise of allowing us to tailor system messages for success and failed task, and check the status of the task before, during and after having finished it.

The first step is to ponder each grade according to its relative weight:

<table>
<thead>
<tr>
<th>Guideline “4.4 Clear result of the task”</th>
<th>USERS’ REVIEW AVERAGE GRADE</th>
<th>EXPERTS’ REVIEW GRADE</th>
<th>COMPROMISES’ GRADE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grades 1-5</td>
<td>4 points</td>
<td>3 points</td>
<td>Yes (5 points)</td>
</tr>
<tr>
<td>Weight</td>
<td>30%</td>
<td>30%</td>
<td>40%</td>
</tr>
<tr>
<td>Pondered grades</td>
<td>$4 \times 30/100 = 1,2$</td>
<td>$3 \times 30/100 = 0,9$</td>
<td>$5 \times 40/100 = 2$</td>
</tr>
</tbody>
</table>

Table 7. Grades, weights and pondered grades in a fictitious scenario

In a second step pondered grades of users (1,2), experts (0,9) and compromise (2) should be added to obtain the final score for this guideline.

Thus, the score for the guideline “clear result of the task” in this scenario would have been 4,1 points out of 5.
4.4 INTERVIEW WITH A PROCUREMENT OFFICER

The first introductory interview with the procurement officer of a Swedish public institution was about framework and challenges of public procurement process of IT systems. In a second and more in-depth interview I explained the first proposal for a work environment evaluation and requested his advices as an expert.

Below are explained some of the ideas and insights extracted from these two interviews with the procurement officer:

According to the informant, one of the difficult points of public procurement is that, the law establishes that the tenders could only be graded according to aspects that have been described as important in the call-for-tenders. This point goes in favour of transparency and fairness, but represents a real limitation for procurers. They cannot adjust, modify or iterate over the requirements during the process.

If an important characteristic of the future system is identified after the call-for-tenders was published, this characteristic could not be taken into consideration for selecting or discarding any participant. In extreme cases, the procurer could decide to cancel the process because the requirements were incorrect or incomplete. However, since procurement processes are expensive and time-consuming, cancelling and starting another process is not a desirable situation.

The procurement officer explained that they do not start from zero when they write the requirements for each procurement process. Some requirements are the same for every IT system, thus, they have lists of requirements to use as a basis. Additionally, if the same institution has procured a similar system before, they can also consider as a starting point the list of requirements used in this processes. Then, they review these lists to select the requirements that are applicable to the actual procurement process and disregard the ones that are not. After that, they also add some specific requirements for this concrete IT system that are based on the information received from stakeholders, managers and users.

According to the informant, one of the challenges of this stage is to decide the weight of each requirement for this IT system: if it should be considered “must requirement” or “should requirement” and how many points they should be worth. Apart from the specific value of each requirement, the procurer could change the weight between sections (i.e. usability, security, etc.) depending on the characteristics of the system to be bought. For example, if the system will be used by all employees, the usability should be more important than if the system will be used just by three experts. In the second case, the three experts can learn and remember how to use the system, thus, the procurer could give more value to the functional aspects of the system.

The balance between the requirements should also be aligned with available IT solutions in the market. If the call-for-tender establishes some “must requirements” that no tenders could fulfill, the process would end up without any available system to be purchased. If this happen, the procurer would have lost time, efforts and money, and must start again from the beginning.

Additionally, the procurer should take into consideration that if they give too much reduction for “Should requirements” (i.e. usability) the institution will have to pay a higher price for the system.
According to the procurer officer, some guidance for deciding how to set the balance of usability and work environment depending on the situation would be interesting: “when should we have what kind of figures? What circumstances should we look at for deciding how much reduction we give for usability or work environment aspects?”

Concerning the work environment evaluation, he explained that they cannot expect the suppliers to develop and customize their systems according to the specifications just to participate in this evaluation. The most probable situation is that we should carry out the work environment evaluation with a preliminary setup of the systems. Sometimes it could be only a toolbox, a mockup, or the system setup for a previous client.

At this point, he expressed some doubts regarding if the work environment suitability of the preliminary setup will be representative enough of the work environment suitability of the final setup of the system. We agreed that the final setup is the one that matters for work environment aspects, because it is the one that users will work with, but it is not possible to be assessed during the evaluation of tenders.

Moreover, the informant considered that combining users and experts review within the work environment evaluation was positive. According to him, would be desirable to involve the users as much as possible because they are the ones that will need to use the system but some aspects can be better assessed by experts. Additionally, he considered that the distribution of guidelines to be assessed by users or expert could be decided depending on the characteristics and fidelity of the system to evaluate: mockup, prototype or system setup for another company.

The procurement officer also formulated some interesting questions about the evaluation details: “Should we have the same users all the time? Should we have different persons? Does the order influence the result?”

Concerning the compromises of the suppliers to give us flexibility to customize some aspects later on, he suggested to put these compromises as “should requirements” and formulated them this way: “Can we change the fields in the screen and adapt it according to our needs?” Additionally, the procurer can decide which questions can be answered by suppliers with just a yes or no, and which ones require a further explanation. Thus, if the question can be misunderstood or tricky, the supplier could be required to “Explain how”. Then, an expert should review the explanation and grade from 1-5, for example, if he thinks it is possible to change the fields in the screen.

The procurer also pointed out that for these requirements about flexibility is also important to take into consideration if this customization can be done by the procurer (the users or some internal personal) or if it will need a consultant from the supplier and which is its rate per hour. The second option could be more expensive, but if the changes will be punctual and just last few hours, maybe it is not worth it to have someone in the company that know how to do that and you prefer to pay a consultant.

The informant said that they can also ask these customizations to be included in the final price, but he did not recommend it because as it is hard for the supplier to calculate the cost of these customizations without further details, they will give you an overpriced estimation not to assume too much risk.

He also commented that all work environment requirements could be gathered in a specific section of the call-for-tender, and that this section could be labeled as “Work environment”. This section should include
the list of “should requirements” and the detailed explanation regarding how the work environment evaluation will be performed. He pointed out that we should be aware of not including the same aspect both in the evaluation and as a “should requirement”. Finally, the procurement officer expressed his interest in how they should involve the users during the customization stage in order to adapt the system to their needs: “How should we work with users so the users feel involved and asked? Which is the best way to get feedback from them?”
4.5 WORK ENVIRONMENT EVALUATION WITH USERS

4.5.1 Context of use

The information about the context of use was gathered from two interviews performed with users of Raindance Portalen before the test performance. Since the test will be focused on the role of economic staff, the two persons interviewed were financial administrators. Therefor, the context described below corresponds to their specific role and work environment:

The main tasks of financial administrators are: elaborate budgets, manage invoices, payments and reimbursements, follow-up project funding, and prepare annual or project reports. The two users interviewed had financial studies, no technical background, but they spend almost 100% of their time working with computers. They work in their own office, with a desktop computer and a roller mouse as a pointing input device.

The interviewed persons stated that they use several softwares to perform their daily work:

- KONTRACTDATABASEN (for contracts for Project funding, periods of payments...)
- W3C3 (for get a number for the recruiting process)
- EDGAR (for specify the conditions and requirements for a job opening)
- PRIMULA (for contracts and salaries management)
- UU+ (for prepare estimated budgets, and to close the final budget of the year)
- RAINDANCE CLASSIC (for consult suppliers or invoices details, prepare economic reports, ...)
- RAINDANCE PORTALEN (For review and authorize electronic or scanned invoices)

The work environment evaluation will be carried out with the software “Raindance Portalen”. Financial staff of Uppsala University has been working with this software since 2007. Before Raindance Portalen they used another program, but in the old times they received the invoices in paper, walked with the invoice to the Head of the Department to sign it and send it for payment.

They use Raindance Portalen daily, according to one of the users, 40% of the working time on average. But the percentage of usage fluctuates depending on the period of the year and if they have to close the books or not. Raindance Portalen is an on-line software. To access you need to open a internet browser, go to an URL and introduce your login and password, but you cannot log in from home nor from the wireless at work.

The program is used by financial staff to manage the economic details of invoices, but also by researchers or professors to check if the invoices are correct, and by managers or Heads of Department to review and authorize the payments.
### 4.5.2 Data gathered during the test

The following tables summarize the information gathered from the users during the test (including questionnaires, interviews and task performance):

<table>
<thead>
<tr>
<th>PRE-TEST QUESTIONNAIRE</th>
<th>PILOT TEST</th>
<th>USER 2</th>
<th>USER 3</th>
<th>USER 4</th>
<th>USER 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency of this task</td>
<td>5/day</td>
<td>1/week</td>
<td>3/week</td>
<td>2/week</td>
<td>5/day</td>
</tr>
<tr>
<td>Easy</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Reasonable duration</td>
<td>Couple of minutes</td>
<td>2 minutes</td>
<td>1-5 minutes</td>
<td>1.5 minutes</td>
<td>1.5 minutes</td>
</tr>
<tr>
<td>Logical Steps</td>
<td>1. Check</td>
<td>2. Send to the owner</td>
<td>3. Find the right account to use</td>
<td>4. send the Head of Department</td>
<td>5. Head authorizes payment</td>
</tr>
<tr>
<td></td>
<td>1. Get the invoice paper</td>
<td>2. Send it for scanning</td>
<td>3. See invoice in portal, introduce account and send it to the person to sign</td>
<td>1. Collect information on what project should be debited</td>
<td>2. Make the accounting</td>
</tr>
<tr>
<td></td>
<td>1. Register</td>
<td>2. Circulate for the Head of the Department</td>
<td>3. He will sign it</td>
<td>4. Wait for payment</td>
<td>1. Check the invoice</td>
</tr>
<tr>
<td>Successful end</td>
<td>Invoice paid in time (right account)</td>
<td>If the invoice disappears, and do not return to my inbox</td>
<td>If I have received information on what project should be debited</td>
<td>If the head has signed it</td>
<td>When I do not see the invoices</td>
</tr>
<tr>
<td>Unsuccessful end</td>
<td>Invoice not paid in time</td>
<td>If somebody has to send it back</td>
<td>If I do not have the information, I cannot finish the task</td>
<td>If something was wrong or the travelling was not allowed</td>
<td>When they send it back to me</td>
</tr>
<tr>
<td>Mistakes</td>
<td>A. Wrong account: Pretty severe.</td>
<td>B. Wrong project: Not so severe.</td>
<td>C. Wrong department (easy to change it during the same budget period, but not changeable between budget years)</td>
<td>A. Wrong account number (we will always find out later, it will be corrected 99%) severity 4</td>
<td>A. Wrong project (severity 2)</td>
</tr>
<tr>
<td></td>
<td>A. Delay (extra cost for late payment) severity 2</td>
<td>B. Wrong account (Extra work to fix it. If we notice it too late, project closed, the Department will have to pay it) severity 4</td>
<td>B. Sent to the wrong person to attest (they will not be allowed to sign it, so we have to get it back) severity 2</td>
<td>A. Not counted all the amount (the head cannot sign it) severity 2</td>
<td>A. I have not taken care of the total amount, some SEK left (the head cannot sign it and must send it back) Severity 3</td>
</tr>
<tr>
<td>Need to communicate with</td>
<td>Owner of the invoice, owner of the money to use, and/or the head of the department</td>
<td>Colleagues, FAQ</td>
<td>The person who bought it about what project should pay and the person in charge to authorize the payment</td>
<td>Head of department</td>
<td>Talk or mail about what they have bought and what project to pay</td>
</tr>
<tr>
<td>Information to judge amount of work</td>
<td>I need to open the invoices to judge the amount of time, because it depends on the information I have got</td>
<td>If they buy computers, we need to do 3 steps. Then, if I know the invoice is about computers I know it is longer.</td>
<td>Depending on if I can do it by myself, it is easier, or need someone else’s feedback. For evaluate this, I just look at the name of the supplier.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other comments</td>
<td>The time to get the right information is difficult to estimate (30 minutes or several days)</td>
<td>The hard or long part of the task is to get the proper information, because sometimes “granskars” do not remember how to give this information within the system</td>
<td>Small department: not many invoices but I help with other Departments.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 8. Summary of the data gathered from the pre-test questionnaire.
<table>
<thead>
<tr>
<th>1. TASK STEPS</th>
<th>PILOT TEST</th>
<th>USER 2</th>
<th>USER 3</th>
<th>USER 4</th>
<th>USER 5</th>
<th>MEAN</th>
<th>STAND.DEV.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1 Meaningful process aligned with work routines</td>
<td>1</td>
<td>4</td>
<td>2</td>
<td>4</td>
<td>4</td>
<td>3,0</td>
<td>1,41</td>
</tr>
<tr>
<td>1.2 Minimum number of steps and cognitive effort</td>
<td>3</td>
<td>4</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td>3,0</td>
<td>1,00</td>
</tr>
<tr>
<td>1.3 Quick system responses</td>
<td>5</td>
<td>4</td>
<td>4</td>
<td>3</td>
<td>4</td>
<td>4,0</td>
<td>0,71</td>
</tr>
</tbody>
</table>

**Other comments**

Delete step: Clic the trash icon next to your name.

Change step: instead of clic “Next invoice” to send invoice, you should clic “Send”.

Entry fields: All needed.

“FIN”: I can put a number if I want to search this invoice later in Raindance Classic. We do not normally use it.

“AKT”: For some accounts I need to put this additional information, is about who gave the money.

Complex steps: “9. Introduce financial details”. Sometimes you need to recalculate the VAT and change it in “Change invoice”.

“Basically the process is logical but I do not like certain steps.”

Delete step: throw yourself to dust bin.

Change step: instead of pressing “Next invoice” you should press “Submit” and then clic “Next invoice”.

Entry fields: Some entry fields are seldom used but they are necessary, you make a choice by not using them.

Complex steps: Introduce financial information.

Before looking at the diagram:

“Before looking at the diagram: It is not a logical system but it make sense for me now.”

The steps are ok but the problem is the complexity of the view of the system, too much information. It is impossible for the people not used to it: “granskar”, heads of department, etc.

After looking at the diagram:

Delete steps: Yes, the circulation part is very silly, “throw yourself to the trash” can be eliminated.

Change step: when you finish, it does not say “finish” it says “next invoice”. People usually get stuck there because when they are done they do not know how to send it, they do not recognize the button “next invoice” as “finish”.

“Before looking at the diagram: It is not totally logical, you need to press “Next invoice” twice for send it to the boss.”

Delete/Change step: I do not know.

After looking at the diagram:

Delete step: Maybe “Throw your name to trash” should be avoided. And “Cirkulation” could come automatically, when you have accounted the whole amount.

Complex steps: None, but when you need to split the amount in two rows you need to calculate and I have this stupid old machine, so, I have needed to move from the computer to the other part or the table.

“After looking at the diagram: After looking at the diagram: Delete step: trash step could be avoided.

System response is quick enough, but for me it is not working so well (technical problems).

“Complex steps: None, but when you need to split the amount in two rows you need to calculate and I have this stupid old machine, so, I have needed to move from the computer to the other part or the table.

“Take less time to do it now, than before we use Raindance Portalen”

After looking at the diagram:

Delete step: trash step could be avoided.

System response is quick enough, but for me it is not working so well (technical problems).

“Complex steps: None, but when you need to split the amount in two rows you need to calculate and I have this stupid old machine, so, I have needed to move from the computer to the other part or the table.

“Take less time to do it now, than before we use Raindance Portalen”

“Take less time to do it now, than before we use Raindance Portalen”

Notes made by the users in the diagrams

11. Clic the trash button next to your name.

14. Clic “Next invoice” or press ENTER

15. Clic “Next invoice” or press ENTER again

12. Clic the trash button next to your name.

16. Clic “Next invoice” or press ENTER again

13. Clic the magnifying glass to look for the person that needs to authorize the invoice

18. Clic “Next invoice” or press ENTER again

1. Open internet browser

2. Go to the bookmark of the program

12. Clic the trash button next to your name.

Table 9. Summary of the data gathered during the test regarding guideline 1: Task steps.
<table>
<thead>
<tr>
<th>2. DISPLAYING INFORMATION</th>
<th>PILOT TEST</th>
<th>USER 2</th>
<th>USER 3</th>
<th>USER 4</th>
<th>USER 5</th>
<th>MEAN</th>
<th>STAN. DEV.</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1 Presentation of information</td>
<td>4</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td>5</td>
<td>3.40</td>
<td>1.34</td>
</tr>
<tr>
<td>2.2 Simultaneous information</td>
<td>3</td>
<td>4</td>
<td>2</td>
<td>4</td>
<td>3</td>
<td>3.20</td>
<td>0.84</td>
</tr>
<tr>
<td>2.3 Prioritization of information</td>
<td>4</td>
<td>3</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>3.80</td>
<td>0.45</td>
</tr>
</tbody>
</table>

**Other comments**

**Decision:** Choose one account or another if the head of the department says I should choose.

**Information needed:** Outside Raindance Portalen.

**Prioritization of information:** The most important information is the PDF of the invoice: who bought what, when...

It takes the biggest part of the screen, but the window is too small and you need to scroll down. Thus, not all information is displayed simultaneously.

It is also important the right column to check the VAT and the amount, you need to check if this is correct if it matches with the PDF and sometimes you need to change the information in this column. In fact this is the data that matters for the system.

**Missing information:** It would be useful if the number of the supplier could be displayed in the screen, to search for this supplier in the other Raindance (Classic).

"I really do not like the design, because some very important data is far away in the corner."

**Prioritization of information:** The grey section on the right is very important, you need to compare it with the information inside the PDF of the invoice. It is very easy to accept the PDF as being correct because is more prominent but what really go further is the data in the grey square. If it was bigger you would feel that it is more important and look at it in more detail.

I would like to have the whole PDF visible. The window is too small.

The "circulation" tab is hidden, it could be more visible.

To read the comments you need to notice the pencil icon is red and click on it to open it.

"No, I don’t feel the key information is highlighted."

**Too many buttons:** The button “Eskalera” is not used (it means that you ask a higher level to take care of the invoice)

What the system does is good, but the presentation is not good: confusing, too much information. I would like to restrict the view for some users, for example, “granskar” do not need some parts.

**Decision:** What account to use

**Information needed:** What kind of cost is it, financial rules, what the “granskar” said and if it is ok or allowed...

**Prioritization of information:** The invoice is the most important because even though the “granskar” had said it is ok, I need to check it from a financial viewpoint.

Also the “kontera”, because my work is to ensure that the different items are paid by the correct projects.

It is possible to minimize the grey area on the right, but it should be minimized by default. I can open if I need it.

And it is difficult because sometimes you have to use buttons and sometimes you need to change tabs.

**Decision:** You take decisions at every step, when you choose the account, the pretation, etc.

**Information needed:** You have enough information but not in the screen, also in your papers, in your head, etc.

**Prioritization of information:** It is important the last date of payment (within the grey square), the number of the department and the PDF of the invoice.

The grey part contains the same information than the PDF. If you need to change this information you can press the button “Change invoice” and modify VAT or amount.

It is not highlighted, nothing is highlighted, only if there are comments and documents attached, then, you can see that the pencil icon is red.

Even though it is not highlighted, I think the information is correctly prioritized or displayed. At least I am used to it like that.

**Information missing:** If my workmate get an invoice, and the “granskar” have written her a message saying which project or account to use, when she sends the invoice to me, I cannot see the message.

**Prioritization of information:** You always should check the department in the PDF. Also the amount and the messages in the grey square.

I would like to have more information there (grey square) for example the supplier have a number in the system. I would like to have it there, just in case I need to search another invoice of the same kind, and check what account was used previously.

In some invoices you can look at paper (not in the screen) that said more.

I do not like the design (the PDF is quite zoomed) I think I can fold this part, but even with that I need to scroll down to see the whole invoice.

---

Table 10. Summary of the data gathered during the test regarding guideline 2: Presentation of information.
<table>
<thead>
<tr>
<th>PILOT TEST</th>
<th>ANOTATIONS MADE BY THE USERS ON THE PRINTED SCREENSHOTS</th>
<th>Transcription of some annotations</th>
</tr>
</thead>
<tbody>
<tr>
<td>USER 2</td>
<td>(No screenshot was used during the pilot test)</td>
<td>The grey zone on the right upper corner is the most important information.</td>
</tr>
<tr>
<td>USER 3</td>
<td>The user have marked the following prioritization:</td>
<td>The user have marked the following prioritization:</td>
</tr>
<tr>
<td></td>
<td>1. PDF</td>
<td>1. PDF</td>
</tr>
<tr>
<td></td>
<td>2. Section to introduce financial information</td>
<td>2. Section to introduce financial information</td>
</tr>
<tr>
<td></td>
<td>3. Grey square on the right</td>
<td>3. Grey square on the right</td>
</tr>
</tbody>
</table>
The user marked as the most important information the grey square and the PDF.

The PDF was marked by the user as the most important information for the task (especially the number of the department). The second most important information for the user was the “Comments” displayed in the grey square. The rest of the information in the grey square was not considered so important.

The user have also pointed out that the amount of the invoice is important, however is displayed with a small size.

Table 11. Annotations made by users on the printed screenshots used in guideline 2: Presentation of information.
### Table 12. Summary of the data gathered during the test regarding guideline 3: External information sources and other programs.

<table>
<thead>
<tr>
<th>3. EXTERNAL INFORMATION SOURCES AND OTHER PROGRAMS</th>
<th>PILOT TEST</th>
<th>USER 2</th>
<th>USER 3</th>
<th>USER 4</th>
<th>USER 5</th>
<th>MEAN</th>
<th>STAN. DEV.</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1 Window switching</td>
<td>4</td>
<td>2</td>
<td>4</td>
<td>3</td>
<td>4</td>
<td>3.40</td>
<td>0.89</td>
</tr>
<tr>
<td>Other comments</td>
<td>Papers:</td>
<td>- For the account I look at a paper: Kontoplan. - For the project number I look at a paper: Projektplan. - For the prestation I need the Projektplan or oral/written information from the head of department (comments/mail). Other windows: - For the financier I can go to Raindance Classic to search for the financier code but I have it also in paper (sorted out in alphabetical order and numbers order). &quot;You can search inside Raindance portalen aswell but I usually go to Raindance Classic to see how I did the last time with similar invoices.” Other Windows: - Raindance classic - Mail - Comments inside Raindance portalen (another window) Papers: - Kontoplan - ProjektPlan</td>
<td>The invoices of travelling have a reference number that I can introduce in another portal to see details. Other windows: - Travelling portal - Emails with information about the next invoices - PDF files (attached to the invoice or mails) Papers: Not specified. There is a lack with the electronic invoices (not the scanned invoices): if I send an invoice to other universities, I cannot attach PDF to the electronic invoice, and if I need to send additional information (tickets, delivery notes, etc.) I have to send it by mail to the person that will get the invoice. Other Windows: - Mail Papers: - List of accounts. (quicker to use than the search inside the system,...) - Contracts for the projects or financial rules. Papers: Not specified. I remember the “prestation” in my head, for the account I need to look at the papers. Other Windows: - Mail Papers: - List of accounts</td>
<td>Other windows: - Mail “Sometimes I have to check mails, but not so many windows.”</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other comments</td>
<td>PILOT TEST</td>
<td>USER 2</td>
<td>USER 3</td>
<td>USER 4</td>
<td>USER 5</td>
<td>MEAN</td>
<td>STAN. DEV.</td>
</tr>
<tr>
<td>----------------</td>
<td>------------</td>
<td>--------</td>
<td>--------</td>
<td>--------</td>
<td>--------</td>
<td>-------</td>
<td>------------</td>
</tr>
<tr>
<td>Workload depends on the number of invoices but also depends on if I can find the information I need on them. I can recognize some invoices in the inbox, others I have never looked at them, so I cannot recognize them.</td>
<td>4</td>
<td>5</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>3,40</td>
<td>1,14</td>
</tr>
<tr>
<td>Most important information:</td>
<td>Name of the supplier (if it is an invoice from SJ, for example, could be either easy or difficult: if more people was travelling it would take more time to get info or confirmation from all)</td>
<td>“This (the inbox design) is perhaps the best part”. If I have no time to do all invoices, I can select them for how far is the deadline.</td>
<td>“I need to open each information invoice to see which information is missing.” Does not really matter if the invoice is from one supplier or other, it depends more on who is the “granskar”.</td>
<td>“I am not sure what means På cirkulation, it does not really say anything, just that it is not finished, but this is obvious, otherwise it should not be in the inbox.”</td>
<td>“I can take the most important first, or I just take all of them, it depends... if I you have a lot of other things to do”</td>
<td>Most important information:</td>
<td>Days until payment ( very useful for prioritization)</td>
</tr>
<tr>
<td>Useful information:</td>
<td>- Name of the supplier (1)</td>
<td>- Days until payment (2)</td>
<td>- Comments (3) seldom used but important.</td>
<td>- Closest date of payment</td>
<td>- Days left to payment.</td>
<td>Usefull information:</td>
<td>- Department ( because I work for two departments)</td>
</tr>
<tr>
<td>Not useful information:</td>
<td>- “Amount” (to recognize it)</td>
<td>- “Förfaller” (how many days you have to pay it)</td>
<td>- “Väntat” (how many days it has been in the system waiting)</td>
<td>- “Status ”</td>
<td>- “Currency” (all are in SEK)</td>
<td>- “Väntat” (how many days it has been in the system waiting)</td>
<td>- “Currency” (all are in SEK)</td>
</tr>
<tr>
<td>Missing information:</td>
<td>Invoice number</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Most important information:</td>
<td></td>
</tr>
</tbody>
</table>

Table 13: Summary of the data gathered during the test regarding guideline 4: Control and overview (Part1).
4. CONTROL AND OVERVIEW

<table>
<thead>
<tr>
<th>PILOT TEST</th>
<th>ANOTATIONS MADE BY THE USERS ON THE PRINTED SCREENSHOT</th>
<th>Transcription of some annotations</th>
</tr>
</thead>
<tbody>
<tr>
<td>USER 2</td>
<td>(No screenshot was used during the pilot test)</td>
<td>The user prioritized the useful information as follows: 1. Name of the supplier 2. Days until payment 3. Messages</td>
</tr>
<tr>
<td>USER 3</td>
<td></td>
<td>The columns for amount, currency (SEK) and status were both marked as not necessary.</td>
</tr>
</tbody>
</table>
The number of days until payment and the number of the department were both marked as important.

The user considered the name of the supplier as the most important information and the number of days until payment as useful to prioritize the invoices. The amount and the number of the department were also marked as necessary. Number of days until payment, currency and messages were marked as not important for the inbox. The user did not know what was the meaning of Status.

Table 14. Annotations made by users on the printed screenshots used in guideline 4: Control and overview.
<table>
<thead>
<tr>
<th>4. CONTROL AND OVERVIEW (CONT.)</th>
<th>PILOT TEST</th>
<th>USER 2</th>
<th>USER 3</th>
<th>USER 4</th>
<th>USER 5</th>
<th>MEAN</th>
<th>STAN. DEV.</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.2 Flexibility to decide about work</td>
<td>-</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4,00</td>
<td>0,00</td>
</tr>
<tr>
<td>4.3 Admitting task variance or exceptional cases</td>
<td>3</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>3,80</td>
<td>0,45</td>
</tr>
<tr>
<td>4.4 Clear result of the task</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td>4</td>
<td>3,00</td>
<td>1,00</td>
</tr>
</tbody>
</table>

**Other comments**

**Flexibility:**
It is flexible, but I cannot open more than one invoice at the same time, maybe I can open 2 Raindance Portalen, I have not tried that. But it is not useful for me, when I need to work with another invoice I can always go back and open the other invoice.

I can save a task even without finishing it, and until I send it out, it will be in my inbox. If the project does not exist, then I cannot save until I write the correct project number or one possible project. (We discovered during the task that: If you choose one person in circulation, and instead of clicking “Next invoice” you click “Go Back” the system will send it away anyway, it disappears from your inbox)

**Exceptional cases:**
- Other currencies (managed with Raindance Classic)
- If the Supplier is not registered in the system (I need to contact Raindance Support – 1 extra day)
- Information missing in the invoice, maybe supplier need to send it again.

**Success:**
I know it has been sent away when it disappears from my inbox.

**Flexibility:**
"Freedom about the order of the tasks? yes, sure!"

**Exceptional cases:**
- Some of the university invoices are not done through Raindance Portalen. Everything else could be managed.
- Even late invoices will be paid through Raindance Portalen. If the invoice is incorrect, I will ask the supplier to make another, and I will delete the first one in the system with a note saying it was incorrect.
- If we receive an invoice that we should not receive, I contact the help desk to remove it or send it to the correct person.

**Success:**
It is ok for me, I already know that if it disappears, it is ok. But for other people is confusing.

I can pick the invoice up again (special permissions) but most people cannot.

---

Table 15: Summary of the data gathered during the test regarding guideline 4: Control and overview (Part 2).
5. MISTAKES AND ERRORS

### 5.1 Reducing the number and consequences of mistakes

<table>
<thead>
<tr>
<th>PILOT TEST</th>
<th>USER 2</th>
<th>USER 3</th>
<th>USER 4</th>
<th>USER 5</th>
<th>MEAN</th>
<th>STAN. DEV.</th>
</tr>
</thead>
<tbody>
<tr>
<td>-</td>
<td>4</td>
<td>4</td>
<td>3</td>
<td>3</td>
<td>3,50</td>
<td>0,58</td>
</tr>
</tbody>
</table>

#### Risky steps:
- Introduce account, project and prestation.
  
  “I can easily use the wrong account just switching a couple of numbers.”

(During the user test, the participant almost made a mistake with the number of the Department, as she is in charge of the invoices of two departments.)

#### Prevention:

- The system helps just if the project or account number does not exist.

The prestation is almost always the same number for the same project, but you can have two prestation for the same project.

#### Risky steps:
- Check if the VAT is ok
- Introduce financial information (where I actually make the decision)

#### Prevention:

- In the highest level the system prevent mistakes, because before Raindance you could always lose the paper and there were just one copy.

If you have not counted for the total amount, it should warn you: “Do you really like to send it even though it is not all amount considered?” because sometimes I can want to.”

The system allows you to prefabricate the strip for projects/prestation/account.

#### Risky steps:
- Not really any part. It is always the possibility to put the wrong project because typing you can slip some numbers but... yes, maybe this step (introducing project).

#### Prevention:

- Do you think could be useful if when you type the number of the project the system show you the name? Sure!!

It is better than the old system because paper easily got lost, thus, from my point of view helps. But for the “granskar” is more difficult now and I think they commit more mistakes. I need to teach them how to do it every time. And difficulty takes away focus from the actual task of the “granskar” (review the invoice): they are so happy that they do it right that maybe they forgot to look at the invoice.

#### Risky steps:
- Introduce project and prestation.

  “When you did it with paper, it was more easy to do it right, you always look at it and write on it... but here it goes so fast, you don’t think about it.”

#### Prevention:

- The program tells if you cannot use this account number with this prestation. I get an error message if I have not fill in correctly the project field, but I need to check the amount by myself. At the beginning, it was very difficult, you never looked at that before sending it, but then, the boss was not able to sign it and he did not know why... It would be nice if the system could tell me that it is zero or you have more cost to take care of.

#### Solving mistakes:

- If I realize after sending the invoice that it was wrong, I cannot take it back, I should ask E., she can go into the program and take it back for me. But, I would like to take it by myself.

### Other comments

- Risky steps:
  - Check if the VAT is ok
  - Introduce financial information (where I actually make the decision)

#### Prevention:

- In the highest level the system prevent mistakes, because before Raindance you could always lose the paper and there were just one copy.

If you have not counted for the total amount, it should warn you: “Do you really like to send it even though it is not all amount considered?” because sometimes I can want to.”

The system allows you to prefabricate the strip for projects/prestation/account.

#### Risky steps:
- Not really any part. It is always the possibility to put the wrong project because typing you can slip some numbers but... yes, maybe this step (introducing project).

#### Prevention:

- Do you think could be useful if when you type the number of the project the system show you the name? Sure!!

It is better than the old system because paper easily got lost, thus, from my point of view helps. But for the “granskar” is more difficult now and I think they commit more mistakes. I need to teach them how to do it every time. And difficulty takes away focus from the actual task of the “granskar” (review the invoice): they are so happy that they do it right that maybe they forgot to look at the invoice.

#### Risky steps:
- Introduce project and prestation.

  “When you did it with paper, it was more easy to do it right, you always look at it and write on it... but here it goes so fast, you don’t think about it.”

#### Prevention:

- The program tells if you cannot use this account number with this prestation. I get an error message if I have not fill in correctly the project field, but I need to check the amount by myself. At the beginning, it was very difficult, you never looked at that before sending it, but then, the boss was not able to sign it and he did not know why... It would be nice if the system could tell me that it is zero or you have more cost to take care of.

#### Solving mistakes:

- If I realize after sending the invoice that it was wrong, I cannot take it back, I should ask E., she can go into the program and take it back for me. But, I would like to take it by myself.

### Notes made by the users in the diagrams

- 8.1 Type the account
- 8.2 Type the project
- 8.3 Type the amount
- 8.4 Type the prestation
- 10.1 Type the account
- 10.2 Type the prestation
- 10.3 Type the project
- 10.4 Type FIN
- 10.5 Type AKT
- 10.6 Type the amount
- 10.7 Type keywords
- 10.8 Press Enter
- 11. Open Circulation tab
- 12. Close the program
- 13. Open Circulation tab
- 10.9 Type AKT
- 10.6 Press Enter
- 10.7 Type keywords
- 10.3 Type the project
- 10.4 Type FIN

Table 16. Summary of the data gathered during the test regarding guideline 5: Mistakes and errors.
### 6. MONOTONOUS WORK

<table>
<thead>
<tr>
<th>Frequency of Login</th>
<th>PILOT TEST</th>
<th>USER 2</th>
<th>USER 3</th>
<th>USER 4</th>
<th>USER 5</th>
<th>MEAN</th>
<th>STAN. DEV.</th>
</tr>
</thead>
<tbody>
<tr>
<td>-</td>
<td>-</td>
<td>1/week</td>
<td>3/day</td>
<td>3/day</td>
<td>6/ day</td>
<td>3</td>
<td>1,29</td>
</tr>
<tr>
<td>6.1 Satisfaction about Log in/Log out</td>
<td>-</td>
<td>5</td>
<td>2</td>
<td>4</td>
<td>3</td>
<td>3,50</td>
<td>1,29</td>
</tr>
<tr>
<td>6.2 Optimized process for repeated tasks</td>
<td>-</td>
<td>4</td>
<td>4</td>
<td>3</td>
<td>4</td>
<td>3,75</td>
<td>0,50</td>
</tr>
<tr>
<td>6.3 Perform task jointly for more than one item</td>
<td>-</td>
<td>2</td>
<td>4</td>
<td>1</td>
<td>4</td>
<td>2,75</td>
<td>1,50</td>
</tr>
</tbody>
</table>

### Other comments

- **When you click “next invoice” you will go to next invoice or back to the inbox in case it was the last invoice in the list.**
- I would like to go back to the inbox and choose which invoice I want to work with because perhaps I do not have enough information about some of them.
- Normally invoices have 30 days to payment, so I enter once a week and usually manage 2 or 3 invoices in a row. Then, I prefer to go to the next invoice than to the inbox, because most of my invoices have the same accounting.
- Jointly tasks:
  - If I had an invoice for flights for 10 people, the same amount, the same date,... I would like to do it jointly but it is so seldom.
- It is sometimes a bit frustrating because the system throws you out (log out) a little bit fast. Not when I am actually working on it, but if I need to check something on my papers, and I get interrupted, then when I go back I am out of Raindance Portalen.
- Jointly tasks:
  - When finish one invoice I would prefer to go to the next invoice directly. The task is quite repetitive, but it is in the nature of the work.
  - I log in many times a day, because after some while (I do not know if it is half an hour) the system takes you off.
  - Maybe they could have a button saying “log in again”.
- After pressing “Next invoice”, I would like to go to the inbox because I need to choose myself the next invoice. But it could be useful also to go directly to the one that has less number of days left to payment.
- Jointly tasks:
  - I get all the invoices of the department, and I am supposed to just circulate them all. Would be really useful if I could circulate them jointly if they are for the same person but I need to open each of them and send it separately. That is not possible today.
- Jointly tasks:
  - I think it makes no sense.
  - They have made changes recently, now you can send jointly several invoices to the same person without opening them.
- I normally log in and do one invoice, and close the window because I need to do something else, and later I need to open it again and relgin, etc.
- I have problems to go on browser and then look for the link to the Raindance portalen each time. I would like to open it throughout an icon: shortcut, instead of clicking around... I have one icon in my desktop, but they change it all the time, so I cannot use it anyway.

Table 17: Summary of the data gathered during the test regarding guideline 6: Monotonous work.
<table>
<thead>
<tr>
<th>7. INPUT DEVICES</th>
<th>PILOT TEST</th>
<th>USER 2</th>
<th>USER 3</th>
<th>USER 4</th>
<th>USER 5</th>
<th>MEAN</th>
<th>STAN. DEV.</th>
</tr>
</thead>
<tbody>
<tr>
<td>pointing device</td>
<td>ROLLER MOUSE</td>
<td>CLASSIC MOUSE</td>
<td>CLASSIC MOUSE</td>
<td>ROLLER MOUSE</td>
<td>ROLLER MOUSE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>% mouse</td>
<td>-</td>
<td>20%</td>
<td>70%</td>
<td>5%</td>
<td>30%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>% keyboard</td>
<td>-</td>
<td>80%</td>
<td>30%</td>
<td>95%</td>
<td>70%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.1 Satisfaction using the mouse</td>
<td>-</td>
<td>5</td>
<td>4</td>
<td>4</td>
<td>5</td>
<td>4,50</td>
<td>0,50</td>
</tr>
<tr>
<td>7.2 Switch from keyboard to mouse</td>
<td>-</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>5</td>
<td>4,25</td>
<td>0,96</td>
</tr>
<tr>
<td>Other comments</td>
<td>I use the mouse most of the time, I could use the tab to go to the next form field but I use the roller mouse, I think it is easier. But I do use the enter key. You need to do double clic to open the invoice from the inbox.</td>
<td>When you enter the right number of numbers for a field, the cursor automatically goes to the next field. I have never tried to use Raindance Portalen just with the keyboard.</td>
<td>I have no problems, maybe in a couple of years but… I tab to pass to the next field, but I do not press the enter key because there are so many options that I am not sure what will be activated pressing enter. I have never tried to use Raindance just with the keyboard but I do not think it will be useful.</td>
<td>I use the mouse to go to the next field in the form, not the tab key. I use the mouse to go to the next field. I have never tried to manage the program just with the keyboard. Switching: I am so use to it, I do not even think about it.</td>
<td>I use the mouse to go to the next field once in the first row but all times in the second row of financial information. She pressed enter to accept the row of financial details, but clicked “next invoice” twice to accept the person to send and to actually send the invoice. Between the two clics in the same button, she clics “OK” to an error message. Also with the mouse.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Observations from the task performance</td>
<td>The user introduced the project by selecting one from the list (with the mouse) She used the mouse to go to the next field. She pressed enter to accept the row of financial details, and pressed enter to accept the person to send. Then, she clicked “next invoice” with the mouse. She used the mouse at least as long as the keyboard.</td>
<td>The user press tab to go to the next field of the form, but half of the times he needed to look at something in the PDF, or search for a number in the search functions, then, he used the mouse to put again the pointer to the text field. He clicked on the button “Next invoice” instead of pressing enter.</td>
<td>The user just used the mouse to go to the next field once in the first row but all times in the second row of financial information. She pressed enter to accept the row of financial details, but clicked “next invoice” twice to accept the person to send and to send the invoice. Between the two clics in the same button, she needed to move the mouse to clic “OK” to skip an error message.</td>
<td>The user used the mouse to move to next field of the form, and press enter to accept each row, but clicked “next invoice” twice to accept the person to send and to actually send the invoice. Between the two clics in the same button, she clics “OK” to an error message, also with the mouse.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 18.Summary of the data gathered during the test regarding guideline 7: Input devices.
### 8. SUPPORT AND MAINTENANCE

<table>
<thead>
<tr>
<th>Other comments</th>
<th>PILOT TEST</th>
<th>USER 2</th>
<th>USER 3</th>
<th>USER 4</th>
<th>USER 5</th>
<th>MEAN</th>
<th>STAN. DEV.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>8.1 Confident about receiving support if any problem</strong></td>
<td>Training: Yes, inside the Raindance training we had one introduction to Raindance Portalen. (Was it enough?) I guess so...</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4,00</td>
<td>0,00</td>
</tr>
<tr>
<td></td>
<td>Incidences and support: I have contacted Raindance support by mail or have asked my colleagues. I have never called them. The mail address of Raindance support is on the directory of the mail.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>8.2 Enhances communication with colleagues and managers</strong></td>
<td></td>
<td>-</td>
<td>2</td>
<td>4</td>
<td>3</td>
<td>3</td>
<td>3,00</td>
</tr>
<tr>
<td></td>
<td>Some colleagues maybe need some guidance because they are not so familiar with the program. I have been sending them messages and also going to their office to show them how to use it.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>I feel there might be a problem, not for me, but lots of people mostly professors, they do not feel that this is any fun and they do not want to perform the tasks. When people should be users they get help or the administrator makes a PDF so they can look at it out the system, and send an email or something. So, they get the information by another ways and attach the mail to the invoice.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Yes, you need to communicate with others, it is in the nature of the task. (Does the system support it?) It is possible to do it within the system, but it is hard to know how...</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>The only thing is that before, when you received an invoice, you walked and asked to the person and now everything have to be inside the program, well you can print it out, or send it by mail but...</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>I do not think so, I want to be able to see the messages that my colleague has (when a invoice is forwarded to a third person).</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 19: Summary of the data gathered during the test regarding guideline 8: Support and maintenance.
<table>
<thead>
<tr>
<th>ABOUT THE TEST PROCEDURE</th>
<th>PILOT TEST</th>
<th>USER 2</th>
<th>USER 3</th>
<th>USER 4</th>
<th>USER 5</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Opinion:</strong> We have discussed the system but it was in our own, it was not with the purpose to change anything. (Will you feel more involved in the company or satisfied in the workplace if you could give your opinion about the software you are going to use?) Yes, that would be great</td>
<td><strong>Test:</strong> It is difficult because sometimes it depends on how you read the question, what thoughts you get when reading the question. I need to balance my first idea and my second idea, do I always feel that? Because some things are really good with the system, for example, not losing invoices, and be able to look at them easily. <strong>Opinion:</strong> We have sent some proposals for improving the system. <strong>Other comments:</strong> I have just a few of invoices, and most of the things I have ordered myself, thus there are a few unexpected things. I feel that when I have answered these questions mostly with a 4, and it could seem that I am pretty satisfied but it is not my feeling. I think that whatever is needed is there, it perform the task, but not in the most intuitive way.</td>
<td><strong>Test:</strong> Some questions are difficult to apply to this task. I think for me it is easier to look at the screen than to look at the diagrams. <strong>Opinion:</strong> I have never been asked about the program. They bought the system and we are supposed to use it. We have given suggestions, but often the answer is that will be very expensive to change that. (If they ask us before purchasing one system or another?) That would be nice. <strong>Participation:</strong> Yes, I would like to participate if Uppsala University asks me to participate. In fact, I have been in a depth interview last week. <strong>Other comments:</strong> The thing with the systems is that there are a lot of different kinds of users, and people that only see the invoice to check if the amount is correct, they should have another view, just with the info they need.</td>
<td><strong>Test:</strong> It is difficult to answer some questions. When you work in this you are so used to use it, you do not think about what you do. <strong>Opinion:</strong> I have never been asked about my satisfaction. And I have not reported any feature to be redesign, no. <strong>Participation:</strong> (Would you like to participate if Uppsala University asks you to?) Yes. (Would you feel satisfied if Uppsala University ask you before purchasing one program?) Yes, but, they have had test groups for everything but I do not know if it helps.</td>
<td><strong>Test:</strong> Ohh, how many questions! It was difficult to answer English! You start to think very much about the program and if there is something you can change or do better. <strong>Opinion:</strong> I have never been asked about my satisfaction. I complained, in the beginning you try to ask for more, but nothing changed. <strong>Participation:</strong> (Would you like to participate if Uppsala University asks you to?) Yes, but they do not listen to me, I think.</td>
<td></td>
</tr>
</tbody>
</table>

Table 20. Summary of the data gathered regarding the test procedure.
4.5.3 Analysis of the test results

Considerations about the test results regarding each guideline are provided below:

1. TASK STEPS

The general opinion was that the workflow of the task is not completely logic, but they are used to it. Some on them even pointed out that the workflow makes sense for them now. This seems to indicate that, at least in this case, we can consider that the logic of the process is important but not critical if the system is addressed to frequent users. They can adapt to it. On the contrary, several users emphasized that the lack of logic of the process represents a problem for seldom users (“granskar”, head of the department) for which the system is very difficult to understand and consequently to use.

Besides that, all users reported that the step “throw your name in the trash can” is absurd and should be deleted, as expected. Most of them also would like to have a button labeled as “Send or Submit” for sending the invoice, instead of having to press “Next invoice” twice, both to send the invoice and go to the next invoice.

In general, users were quite satisfied with system response. Even though in this case the system response was not problematic, one of the comments of the users indicates that a slow system response could be an important factor for stress and discomfort:

“I don’t need to wait, not in this program, we have another program... it is terrible!”

According to the users, most complex part of the task are the steps in which they have to introduced the financial details: it requires more attention for typing the numbers correctly, sometimes they even need to make calculations to split the amount in two percentages if the invoice is shared by two departments...

2. DISPLAYING INFORMATION

The users commented that the only decision they need to take during the task is related to “what account to use”. Most of the times the account is suggested by the owner of the invoice but the financial administrators should checks if it is possible to pay this item with this account according to economic rules.

It is remarkable that they have rather different opinions about which is the most important information of the screen. Some of them pointed out that the grey section on the right upper corner is the key part because it contains the details of the invoice within the system and the ones that will be used to pay the invoice. They should check if they are correct and match the PDF.

Others thought that the PDF of the invoice is more important, because it normally contains more information about the items bought and it can be useful to decide the account or project. Most of the users agreed that the window that contains the PDF of the invoice is rather small, and they just can see a small section of it at the same time. They can change the view options, but if they zoom out, the letters are too small to read them.
The comments and messages from colleagues, or the owner of the invoice, seem also essential to make the decision. The problem is that there are different places in which you can write a text: as a message when you send it, as a comment attached to the invoice... making it confusing. The first ones would be displayed in the inbox before opening the invoice, and in the grey area. On the contrary, if there is any comment attached to the invoice the icon of a pencil will be red, and after clicking the icon, a pop-up window would show you the comment. This information is normally essential, but you need to open a pop-up to be able to read it. Furthermore, you need to notice that the pencil icon is red, which is not so prominent, and remember to open it.

Some of the users had the impression that the screen contains too much information and is not easy to decide where to start reading. There are also too many buttons and options without a clear prioritization. The participants of the test claimed that this is especially confusing for seldom users, for example, the owners of the invoice that have to review it or the managers that have to authorize it. They do not know where to press when they are finished, as none of the options is highlighted or clearly labeled as “OK/SUBMIT/FINISH”.

One of the users suggested that “granskar” and head of department could have a simplified view or interface, as they do not need most of the information and options displayed on the screen. They just need to look at the PDF, confirm that it is correct, and send it back to the financial staff.

Two users also reported that would be really useful for them if the screen displays the number that the supplier have in Raindance Classic to be able to search former invoices of this company and check how they were paid.

3. SWITCHING WINDOWS

Inside the program users could need to open the following windows: main window, comments pop-up, attachments pop-up, search options for account, search options for project and search options for recipients.

Outside the program users could need to check the following sources: printed papers in a plastic displayer (for project, prestation and accounts), mail, Raindance Classic and documents attached to mails. However they are a large number, users usually need to open just some of them when dealing with one invoice, and not simultaneously. They can open one, check one data and close it.

It is also remarkable that they have created a way outside the system to reduce the number of windows, and instead of using the search options in the program they look at papers (perfectly organized and handy) to checks the codes of projects and accounts. Some of the users do not even know that you can search the project numbers inside Raindance Portalen, but the ones who knew said it is easier to look at the papers outside the system.

If the system of comments and messages inside the system was more effective, it would be unnecessary to send normal emails with information about invoices and users will not need to switch between this window and their mail.
4. CONTROL AND OVERVIEW

When looking at the inbox, users agreed that the name of the supplier and the number of days left for payment are important information in order to identify each invoice and prioritize them. For those users that manage invoices from two departments, it is also important that the number of the Department was display next to each invoice.

However, one of the users pointed out that he cannot calculate his workload only looking at the inbox screen. He needs to open the invoices and see what information is provided by the owner of the invoice and what is missing to predict the workload that each invoice will entail.

The number of days that the invoice has been in the system and the status, was judged as unnecessary and avoidable information for the users. Some of them do not even know what the “status” column means exactly.

The comments about the flexibility of the system were rather positive. Users feel that they can freely decide about the task order and pace. The users also pointed out that the system admits a wide range of variance and exceptional cases, it also allow some options that were not possible when using paper invoices (to split payment between two departments, one of them had to pay the whole invoice and the send an invoice for half amount to the other department). The only exceptions that cannot be managed with Raindance Portalen are foreign invoices but it does not seem a real problem, they manage them with Raindance Classic. However, it would be advisable that they can be included in the same system in the future.

About the clear result of the task, users have learnt that as long as the invoice disappears from the screen and from the inbox, it has been correctly sent. I would not consider this as a clear way to communicate that the task has been finished successfully. Nevertheless, users’ opinions could indicate that frequent users can adapt to this circumstance and perform their work even though they do not receive appropriate feedback. In any case, they can search for the invoice afterwards and check its status or the information they introduced.

On the contrary, this could be a more severe problem for seldom users as they could be more doubtful about having performed the task correctly. They could be unaware of why the invoice had disappeared, especially if they have clicked something by mistake, and they will probably ignore how to find this invoice again and look at its status to see what happened.

5. MISTAKES

The users agreed that the steps to introduce financial information were the ones in which they can commit more errors, but none of them seemed to have dramatic consequences. The information provided by the users in this section was in tune with the main mistakes described in the pre-test questionnaire: wrong project and wrong account.

Apart from introducing the wrong project or account, two of the users also remaked “not taking care of the whole amount” as one of the most common mistakes. This was directly related to the work routines of these two users, as the invoices they manage are usually shared by two departments, thus, they should split the amount in two rows. If they discard some decimals when calculating the percentage corresponding to each of them, they could
end up with a discrepancy in the amount. The proposal of one of the users was to add an error message saying “the total amount was not considered, do you want to continue anyway?” because in some exceptional cases, the invoice should be sent anyway, without considering the total amount.

The “prestation” (Research, Education…) is almost always the same number for the same project, but some projects have two different “prestations”.

In case of detecting a mistake once the invoice has been sent, only the users that have admin permissions within the system can take the invoice back. Some of the participants commented that, as they do not have these permissions, they need to go to a colleague with admin permissions and ask him/her to send the invoice back to them.

Additionally, one of the users considered that the system could have contributed to lower the general awareness about the task:

“When you did it with paper, it was more easy to do it right, you always look at it and write on it,… but here it goes so fast, you don’t think about it.”

6. MONOTONOUS WORK

Most of the users reported that they need to login several times during the same day. The period of inactivity allowed before automatic logout is considered too short by the users and the need to relogin several times is perceived as a little bit annoying or frustrating.

Users had different preferences about where they would like to be driven after finishing managing one invoice. Some of them would like to go back to the inbox and select themselves the next invoice they want to work with, depending on if they have already received the correct information about each invoice or not.

On the contrary, for users that manage invoices with always the same financial details or things that have bought themselves it is not so important to choose which invoice to work with, and they prefer to go directly to the next in the list. This could be one of the characteristics of the system that could be customized.

The possibility of performing the same task jointly for several invoices was not considered really useful in this context because each invoice normally need to be filled in with different financial data, and the possibility of having a list of invoices with the same details is remote.

However, one of the users reported that the option of circulating several invoices at the same time without opening each of them, could be really useful for him but that it is not possible. Nevertheless, another user explained that the option of circulating several invoices at the same time was implemented last year but that it was not really useful. This fact could indicate some lack in communication between users and system administrators. It is not enough to implement new options or features, it is necessary to inform the users. Otherwise, they will not use this option even though they need to.

Besides, during the task performance I observed that between the first and second time users press “enter” or “next factura” to finish the task, there is an error message. As the users are
used to it, they press “OK” instinctively. I asked them what the error said and they did not even know, thus, the error message is not fulfilling its purpose but it represents an unnecessary extra step to perform the task.

7. INPUT DEVICES

The users seemed confused about the questions in this section. They were not really conscious about their usage of the input devices, and some of them commented that they have never thought about that. They all use the mouse for performing most of the steps in the task, but as they need to introduce a lot of numbers and eventually some texts, they also spend some time of the task using the keyboard.

Even though they have the possibility to move the cursor to the next field of the form pressing the Tab key, most of them used the mouse to. Moreover, they do not feel uncomfortable with this situation, one of the users even commented:

“I have no pain, and no problem to use it. I think I like it!”

On the other hand, they mostly pressed “enter” key with the keyboard to accept each row with financial information, instead of clicking the button with the mouse. They reported that they have never tried to use the system just with the keyboard, they do not even know if it is possible, but they seem not interested in this possibility.

8. SUPPORT AND MAINTENANCE

Most of the users have received training about the system, but at least one of them said that it was only introductory. About the help section, some of the user did not even notice that there was a “Help section” inside the program. Anyhow, they seemed all rather satisfied with the support received when they have had any problem with the system. They reported to feel confident and supported enough.

Besides that, several of them commented that when the system is not working because of “technical problems” they have to wait. The elevated number of references to this situation could indicate that these technical problems are quite usual within Raindance Portalen. Furthermore, one of the users commented that she had problems with the system that the help desk is not able to fix, the program does not work properly in her computer.

All users agreed that the task often requires communicating with colleagues and managers to get the proper information. This communication is not successfully supported by the system. Even though Raindance Portalen allows the users to write and read messages attached to the invoices, it is not always easy for seldom users to use this functionality.

Thus, the users explained that they often need to teach seldom users how they have to do the task. They could even go to their office to do it with them, or print the invoice so they can look at it out of the system.
### 4.5.4 Opportunities for improvements

According to the test results, the following changes or improvements are proposed:

- **Delete the step “Throw your name to the trash can”**

  As the normal situation is that you do not want to send the invoice to yourself, the system should not display your name as a recipient, by default. This way, the user will not be forced to delete his/her own name every time.

  ![Screenshot of Raindance Portalen to illustrate the step “Throw your name to the trash can”](image)

- **Clearly identify the button to finish the task**

  The user should be able to identify what button to press to finish the task. This button should be more prominent than the surrounding options (or isolated) and with a clear label as: “Submit”, “Ok” or “Send”.

- **Automatic suggestion of recipients when sending the invoice to authorize**

  Depending of the characteristics of the invoice, the project, and the department, the invoice could only be authorized by a certain person. I understand that the system include some type of rules about authorization, because if you send the invoice to the wrong person he cannot certify it. In this case, the system should suggest this recipient automatically (giving the user the possibility to change it) instead of making the user to look each time for the name of the person. This suggestion is not applicable to send the invoice to “granskar” as they have no fixed rules for who has to check each invoice.

- **Simplified interface for “granskar”**

  The person that ordered the items in the invoice only needs to look at the PDF and check that all details are correct (“granskar” in Swedish). Consequently, they just need to have in the interface: the PDF, the checkpoint to say that it is correct, and one button to submit. All the other information and options could be avoided. Once finished, the invoice could be send back automatically to the financial administrator that sent it previously.

- **Optimizing error messages**

  On one hand, the error message that appears after clicking the first time “Next invoice” should be avoided. It is mechanically skipped by the users without reading it, represents an extra step and could contribute to subtract credibility to other important error messages. On the other hand, would be advisable to add an error message warning the users that they are sending an invoice without having assigned the whole amount (i.e. 1 SEK left) as it seems to be a common mistake which is easily avoidable by an error message.
- **Show the name of the project once accepted one row**
  Even though the user needs to introduce the project by its numerical code, once the user has saved the row, the interface could show the name of the project instead of code numbers. Making evident the name of the project could help the users to detect if they have introduced the wrong project as it is easier to identify that it was mistaken looking at the name of the project. If there is a mistake, the users should be able to click again to edit the field and correct the numbers.

- **Restrict the “prestation” to the options allowed in the project selected (pull-down menu)**
  Actually, the system checks if the “prestation” introduced matches with the project possibilities. Instead of doing this check after introducing the number of the prestation, it could be done in advance: just letting the user to choose between prestation that are contemplated in the selected project. Moreover, as some projects have only one prestation, the user will not even need to select between several options in these cases. Additionally, it is advisable to change the order of the fields for selecting the project before the prestation.

![Figure 6. Screenshot of Raindance Portalen to illustrate the actual view of the “Prestation field.](image)

**Proposed changes:**

![Figure 7. Screenshot of Raindance Portalen to illustrate the improvement of creating a pull-down menu for “Prestation” field.](image)
- **Show also the number of the supplier in the grey section**
  Some users have pointed out that they often look at previous invoices of the same supplier to check what financial details were used previously for similar items. It will be easier for them to find these former invoices if the grey area displays not only the name but the number of the supplier within the system Raindance Classic.

- **Add the possibility to split the invoice by percentages**
  Instead of making the user calculate outside the system how much is the 30% of this invoice (that should be paid this Department) it could be advisable to add a field for introducing the percentage directly. This way, the user could choose between assigning one concrete amount to each payer or one percentage over the total. When introducing or modifying one of these fields, the other could be recalculated automatically. It would be easier for users and reduce the possibilities of mistakes.

**Actual view:**

![Actual view screenshot](image)

**Figure 8.** Screenshot of Raindance Portalen to illustrate the actual view of the financial information form.

**Proposed changes:**

![Proposed changes screenshot](image)

**Figure 9.** Screenshot of Raindance Portalen to illustrate the improvement of add a field to split invoices by percentages.

- **Show the whole word instead of 3 letters (AKT- )**
  As long as there is space, it would be better to display the word completely accompanying to each entry field. The frequent users probably know what each 3 letters means, but it could be confusing for seldom users. Anyhow, both users will probably need less cognitive effort to identify the word when written complete than with only three letters.

![Show the whole word screenshot](image)

**Figure 10.** Screenshot of Raindance Portalen to illustrate that actual view only displays 3 letters of the fields titles.

- **Allow the possibility of modifying or correcting invoices after sending them**
  If the user finds out that has sent an invoice by mistake, he/she should be able to take it back and without asking some colleague with admin permissions to take it back for him. It does not mean that everyone will have admin permissions (for example to be able to see other people’s invoices) but they will be allowed only to take back the invoices that they have sent.
- Review the system of comments and messages

If the system of comments and messages inside the system was easier to use, it would be unnecessary to send normal emails with information about invoices and users will not need to switch between this window and their mail. Now there are different kinds of messages or comments, displayed in different places:

![Figure 11. Screenshot of Raindance Portalen to illustrate where comments and messages are displayed in the invoice screen.](image1.png)

![Figure 12. Screenshot of Raindance Portalen to illustrate where comments and messages are displayed in the inbox screen.](image2.png)
- **Two options once finished the task**
  Due to the discrepancies between the test participants about if they prefer to be driven to the inbox or directly to the next invoice after finishing one task, this setting could be customized depending on the user. Another alternative is that the interface could offer two options to the users throughout two buttons or links: “Back to inbox” or “Next invoice”.

- **Inbox should be redesigned**
  Some information of the inbox does not help users neither to get an overview of their workload nor to identify the different invoices. The unnecessary columns can be deleted. On the contrary, some users considered that “if the granskar has provided enough information about the invoice or not” is a key criteria for prioritizing the invoices, thus, this information should be somehow available in the inbox.
4.5.5 Reflections about the test procedure

Based on the results obtained from the test and users’ opinions, the following considerations about the test procedure are provided:

Pre-test questionnaire

The pre-test questionnaire has the aim to gather information about the scenario and the task routines. It should be filled in by the users before seeing any of the systems. This information could be used by experts for evaluating some of the guidelines about work environment later on. For example, comparing the possible mistakes of the task that the users reported before seeing any system (pre-test questionnaire) and once using the systems (user tests) could help to identify new mistakes, consequences of the system design.

Due to the circumstances of the test case (the users are already working with system) I cannot assess its appropriateness or usefulness to gather neutral data. In this case, the information was undoubtedly biased by users’ knowledge of the system. Further research is needed to check if previous questionnaires are useful to get previous information about task routines and if this previous information is useful to assess the systems. Even this way, I consider that some answers from the pre-test questionnaire were useful to contextualize and analyze the results.

About the setup of the questionnaire the following problems were detected:

I am not sure if all of the users understood the first question in the same way: some of them could have answered how many times they manage an invoice whereas other users could have answered how many times they manage travelling invoices because the scenario described one travelling invoice. Some asked me what they should answer, but I cannot ensure what answered the ones who did not ask.

The question about the successful scenario of the task was confusing for some of the users, but I do not know if it was because the question formulation was not clear, because they have already used the system or both. Anyhow, only one of the users described the successful scenario as “invoice paid in time”, the rest defined the successful end as “when the invoice disappears”. Besides, the next question about the unsuccessful scenario of the task seemed to be unnecessary as it was commonly answered as “the opposite of the successful scenario” and perceived as repetitive.

The question about the overview was difficult to answer for some of them in abstract. The idea of this question is to understand what information they need to get an overview of their workload. The expert could check then, looking at the systems, if this information is displayed in the inbox of the system or not. Further research is needed to see if is feasible to make this question in a context where the users have not used the system and if it should be done in abstract or in a given situation.

Even though the scenario described in the pre-test questionnaire started when the invoice was already been “granskar” and only referred to “introduce financial information and send the invoice for payment” the users considered additional or previous steps as part of the same task when answering some questions (i.e. send the invoice for scanning). When designing the
test, I decided to start the scenario after the owner of the invoice has reviewed it to make it simpler and more concrete. But, the results indicate that this delimitation was not aligned to users’ mental model that do not considered the scenario as a task in itself but just a part of a more global task.

I would also say that could be advisable to consider the substitution of the questionnaire by an interview because was easier for users to explain the qualitative considerations than to write them down.

**Post-test questionnaire + interview**

One of the most difficult parts of the test was to make the users verbalize some tacit knowledge about their job, they just know it but they are not aware of it. At this respect, one of the users commented:

“It is difficult to answer some questions. When you work in this you are so used to use it, you do not think about what you do.”

For example, the question about what information they use to identify the different cases or to calculate their workload was hard to be answered on abstract. But when they have to perform the task, they selected themselves one invoice from their inbox. Then, I asked them why they have chosen this invoice. This question forced them to reflect about what they have done and to verbalize some unconscious reasons for selecting one or another. These reflections were more enlightening than the general explanations.

I think one of the advantages of defining one scenario for the test and perform the whole test according to this scenario is that the user could apply the questions to something concrete. In our case, nevertheless, the scenario described in the pre-test questionnaire did not match with the invoice they perform the task with.

As expected, the contribution of users to some of the guidelines or aspects was more important than to others. For example, experts could have judged that the step “Throw your name to the trash” was absurd. But it would have been harder for experts to predict that even though the entry field “FIN” or “AKT is seldom used, it is necessary in some occasions. Also, the potential usefulness of splitting invoices by percentage is a direct consequence of the work routines of the users and consequently difficult to have been predict by experts.

Users’ quantitative feedback seems more meaningful when the guideline is evaluating the subjective feeling of the user about the system. For example, about the system flexibility and decision latitude, what matters is “if the users feel that the system is flexible enough for them to decide task order, pace, etc.” and not “if it is actually flexible according to objective measures”.

On the contrary, I would say that for the guideline about the prioritization of information, it is more convenient users’ qualitative feedback: “what is the most important information for performing the task correctly, which is the second one, and the third one”. Then, the experts are more prepared to evaluate if this hierarchy is reflected in the screen. In this sense, some of the users were quite unsure about how to grade this guideline.
Another of my impressions about the quantitative information is that a scale from 1 to 5 could be too limited. Consequently, it was difficult to see significant differences in the level of compliance of the different guidelines, because most of the aspects were graded with a 3 or 4. Maybe establishing the scale from 1 to 10 could give us the possibility to increase the range of answers. On the other hand, if some guidelines were yet a little bit hard to grade, more options could make the users even be more doubtful.

Due to the hybrid procedure of the test, half usability and work environment, and the natural closeness between both disciplines, most of the problems detected could be classified in any of the two areas, or in both at the same time. This could be seen as a handicap in a research context to evaluate the effectiveness of the method for detecting ones or the other ones. But it is not significant for performing the tests in a real context where the important is to detect and correct the larger number of problems, not if they are usability or work environment problems.

For the assessment of the test procedure, it is necessary to also take into consideration the limitation of the language. All tests were performed in English, which is neither the mother tongue of the users nor the facilitator. This could have prevented users to express themselves in a easier and more accurate way. In this case, this difficulty was accentuated by the fact that the program Raindance Portalen was also in Swedish. Thus, during the test, the users were unsure about how to correctly translate to English a certain concept or a certain word of the interface. In these situations, in order to avoid misunderstandings in translations, I encouraged them to use the Swedish word.

Diagrams

One of my hypothesis was that offering the users a diagram of the workflow of the task could support them in better answering some of the questions. This idea was based on the following usability heuristic for interface design: (Nielsen, 1994):

“Recognition rather than recall

Minimize the user’s memory load by making objects, actions, and options visible. The user should not have to remember information from one part of the dialogue to another. Instructions for use of the system should be visible or easily retrievable whenever appropriate. “

Thus, it seemed feasible that could be easier for the participants to recognize the problematic steps looking at the diagram than recall those steps from memory. The diagram could also help to provide an abstract overview of the task and workflow. As limitations, I can say that looking at diagrams has also a lower accuracy that looking at actual interface, because not all possible paths or actions can be included in the diagram. Consequently, during the tests some users look back to the interface to make some comments about some additional steps or options that were missing in the diagram.

In order to experience, if there were any difference in the answers of users with or without the diagrams, I used two different procedures. I showed the diagrams to some of the users when reading the first question. To the rest, I waited until they have answered the question, and
then I showed them the diagram and ask them if they can add something looking at the diagram. I also asked to all of them, at the end of the test, if they consider that the diagrams were useful to answer some of the questions. At this respect, users provided different opinions. One of them described it as helpful because it gave her a new point of view about the task. On the contrary, another user commented that they were not really useful for him, and that he prefers to look at the screen.

However, if we look at their behavior, the diagrams seemed to support them in giving more complete answers, at least in some sections. Even the user that said he did not find them useful, was able to give more information and suggestions after looking at the diagram to review the steps, than when he answered the question without diagram.

Even though the results of this test were not statistically significant, it could indicate that the diagram could be useful in some of the sections, for example, when asking the users to think if they would delete or change any of the steps of the task. On the contrary, the diagram was less significant in other sections as social support or control and overview, and could be avoided to make the test quicker.

**Screenshots**

One screenshot of the interface was used in section “2. Information displayed in the screen” to make the user mark the most important information of the task within the screen. Another screenshot was used in section “4. Overview and control” to make the user review and assess its usefulness of the different information displayed in the inbox.

My impression is that having a printed paper in which the users could write on was useful. The notes in the paper were an indication of which columns have been reviewed and which have not yet been commented. The users also seemed to reflect another time about what they have said, before writing it on the paper, therefore, their opinions could be considered as more consistently grounded. Nevertheless, the screenshots could not be analyzed independently, because the meaning of some handwritings or marks was not easy to understand without the support of the audio recordings.

**Users’ involvement**

About the users’ predisposition to take part in tests to select or improve the system, all of them stated that they would be glad to participate, and it would help them feel more involved. One of them has already participated in some interviews about a new program, and another commented that some colleagues had participated in test groups.

However, according to their comments, they have never been asked about their satisfaction with Raindance Portalen, but some of them have sent a list of complaints or proposals for improvement. They have the impression that their suggestions did not have any effect, but the fact that one of the features that this user claimed as important (circulate jointly more than one invoice from the inbox) was recently implemented could indicate that they did consider some suggestions.
If this was the case, the problem is not about they do not listen to users, but they do not effectively communicate with them. I think that to better involve users is not enough to get knowledge from them, asking them or making test with them, we need to give them also some feedback. For example, if the results of the test have identified 5 opportunities for improvement, it would be positive to explain them that we understand these problems, that because of technical or budget limitations the first two are impossible to fix, but we will try to solve the other 3 problems. If we do not build a fluent communication, and they do not trust that their opinions are taken into consideration, they will probably not explain us their problems next time.
4.6 DISCUSSION

The test results indicate that the evaluation procedure proposed could be helpful to identify work environment problems and to propose a list of improvements. Nevertheless, a list of improvements cannot be considered a valuable outcome during the evaluation for tenders. Additionally, as participants had already used the system, the applicability of the results to procurement context is limited. The results are indeed relevant for periodic work environment evaluations once the system is in use.

On the other hand, most of the work environment problems identified within the software can also be considered usability problems. Thus, further research should be carried out to check if the same list of improvements could have been obtained with a regular usability test.

The test results were anyhow interesting to value users’ contribution in the assessment of each guideline:

1. **Task steps**: The logic of the workflow seems to be more important for seldom users than frequent users. Low system response can be considered an important problem. Users can identify the complex steps, but an expert should review if this complexity is avoidable.

2. **Information**: Users can assess if the information in the screen is clear or if it is inconvenient to read (small windows) by a subjective punctuation. Users can identify the most important information for a decision, but an expert should evaluate if the screen follows this prioritization.

3. **Switching windows**: It is difficult to judge, both for users and experts, in what cases the system requires you to switch between “too many windows”. More concrete measures are needed. They can be general or contextual measures.

4. **Overview and control**: It is difficult to know if the screen displays proper information to judge the workload or if the users have got used to the information available. Users seem to ignore the unnecessary extra information without being bothered. Receive proper feedback about the results of the task seems more important for seldom users. Users find difficult to think in exceptional cases of the task, maybe the question could be formulated differently or indirectly.

5. **Mistakes**: Error messages are valuable as a warning, but users should have the possibility to perform the action anyway. Users should be able to correct their mistakes by themselves without depending on colleagues or managers. Quick and easy task performance and confidence in the system could contribute to lower users’ awareness.

6. **Monotonous work**: Users’ preference of what screen to go after finishing the task seem to depend on personal routines, thus, it could be an aspect for customization. The question about the usefulness of performing the task jointly for several items should be refined.
7. **Input devices**: Users perceived comfort about input devices could not be enough to assess this guideline. Further research is needed to define concrete measures and best practices and to evaluate ergonomics of different new pointing devices. Additionally to answer the following question: what should we do if users prefer to use the mouse even when they can use tab key?

8. **Support and maintenance**: I am not sure about how this guideline should be judged. Should the communication with managers and colleagues be managed inside the system? Or will this reduce social support face-to-face? Further research is needed to define how social support should be addressed in software design.

The above mentioned considerations are just preliminary and should be review by future research.

Additionally, the test results also indicate that the use of diagrams and screenshots could be helpful for users, at least, in the assessment of some of the guidelines: the workflow diagram was more meaningful for reviewing the task steps (guideline 1) and the screenshots for grading the importance of the information displayed in the screen (guideline 2 and 4).

My general impression is that the qualitative information was more important or significant than the quantitative grades. One of the users commented at the end of the test that she had a strange feeling, because looking at the grades of her questionnaire it could seem that she was really glad with the software, but she was not.

It could indicate that the quantitative grading questions are not a suitable method to get reliable work environment feedback from users. But it could be also that the software was acceptable from a work environment perspective but the user was considering other factors. Finally, there is the possibility that the questions were not appropriately formulated to gather an accurate users’ opinion. Further research is needed to investigate it and to find a good way to gather reliable quantitative information from users.

On the other hand, experiences during the test case suggest that an interview could be more appropriate than a pre-test questionnaire to get extended information from users as they only wrote down in the questionnaire part of the information they provided verbally.

The results of the test also point out that some guidelines or aspects could be more important for seldom users while others are more essential for frequent users. For example, if the send button is not remarked, frequent users can still learn where it is, if they use it every day, but that could be a problem for seldom users. On the other side, if one process cannot be done jointly for more than one item is not so important for seldom users, they can spend more time on it punctually, but it could be really frustrating for frequent users.

Finally, I consider that list of guidelines have also been a good base for setting a work environment evaluation. Anyhow, the validity and completeness of this list need to be confirmed by further research. Even though guidelines always entail the risk to be taken as general truth, I think they can also be a good tool for disseminating work environment considerations amoung procurers in an easy way. Nevertheless, it is necessary to complement the guidelines with some instructions or examples to apply them to concrete cases.
5. CONCLUSIONS

5.1 ABOUT CHALLENGES OF PUBLIC PROCUREMENT FRAMEWORK

Public procurement represents a constrained framework. The main challenges of considering work environment issues when procuring IT systems are summarized below:

- **Many decisions should be taken at the beginning with all information available**
  All requirements should be considered in the call-for-tender, there is no space for improvements or iterations. The evaluation procedure and measures should be defined before having seen or used any of the systems and without knowing how many systems will be necessary to evaluate.

- **Quantitative approach**
  Work environment is not an exact field but the procurement framework requires it to be addressed quantitatively. The evaluation aim is not to improve the quality of the systems, but just to grade them.

- **Doubtful relevance of the results**
  To judge work environment factors the system should be evaluated after an extended use, but during procurement it is only possible to assess users “first impression”.
  The work environment evaluation should be carried out with the final setup of the system (interface, workflows and functionality customized for the needs of this organization) but normally it is only possible to evaluate a preliminary setup of the systems. The degree of completeness could vary.

- **Fear of failure**
  The requirements should be balanced: you want the best system but if your requirements are too high, as you cannot refine them later, you can discard all systems. Due to the time and money spent in each procurement process, it is crucial that the process finishes with the purchase of one system.

- **Difficult to develop a general procedure:**
  The importance of contextual information in the evaluation of work environment aspects makes difficult to design a general setup for work environment evaluation.

According to these limitations, a work environment evaluation within public procurement framework will not be optimal. Nevertheless, I would say these limitations could be minimized by not focusing all the work environment activities within the procurement or the evaluation of tenders. It would be advisable to include work environment aspects during the pre-procurement research activities. This preliminary information could serve as a basis to decide the most suitable evaluation setup. Additionally, would be recommendable to contemplate the possibility to fix some work environment problems after the procurement: both in the customization stage before implementation and as a maintenance activity.
5.2 ABOUT WHAT ASPECTS SHOULD BE EVALUATED

The aspects that could be part of a work environment evaluation are detailed in the list of guidelines for a healthy work environment presented in section 5.1. Moreover, based on the knowledge acquired during this research, I would like to propose three alternative approaches to assess these aspects:

- **Evaluate the systems based on its present compliance of the guidelines**
  
  *Advantages:* No need to invest time and money in customization. If the system we evaluate is close to the final setup, we can be sure that the system will have these characteristics.
  
  *Disadvantages:* It is difficult to set the correct and accurate measures. It will only be relevant if the preliminary setup is close to the final setup, or if we can evaluate the final setup (i.e. Software as a service that admits not customization). Extended use of the system cannot be assessed.

- **Evaluate the systems based on its flexibility (future compliance of the guidelines)**
  
  Sometimes could be more interesting to select a flexible system that could be customized according to work routines and users’ needs after signing the contract.
  
  *Advantages:* We can better tailor the system after the procurement, without the procurement restrictive framework, and when more research could have been carried out. We can also make some customizations later, once it is deployed and the workers can judge its extensive use. Moreover, in case work routines change with the time, the system will be flexible to be modified.
  
  *Disadvantages:* Some changes can seem feasible in theory but not be possible in reality. You normally pay each customization apart from the cost of the system, but you could save part of the budget for customization.

- **Hybrid approach**
  
  We can mix both approaches and evaluate the ergonomics of those aspects that do not admit customization, and grade the flexibility of the ones that could be adapted or changed later.
5.3 ABOUT USERS’ INVOLVEMENT

It is essential to involve users in the work environment evaluation because they can provide key information about the work routines, context of use and task details. The results of this research indicate that users’ quantitative feedback could be more appropriate for guidelines judging users subjective feeling. On the contrary, users’ qualitative feedback could be more useful as a base for guidelines requiring experts’ judgement. Further research is needed to confirm these preliminary insights.

The following insights about how to better involve users have been obtained from the test case and the interviews performed:

- **Long-term collaboration with users**
  One of the advantages of software for work is that we should not recruit or pay the users to participate in tests or other methods. Instead of a punctual collaboration, we can create a long-term relationship with the users. Seems positive that workers could feel involved in the selection and customization of the software and co-responsables of its maintenance or improvement.

- **Double-edged weapon**
  On the other hand, a lasting relationship with the users’ needs a trusting atmosphere and fluent communication. If they participate in the work environment activities but their opinions or proposals are not considered or implemented, they could feel deceived or cheated. In order to avoid that, we should inform them both about the improvements that will be developed and the proposals that have been listened but cannot be implemented and why.

- **Encouraging immediate and pro-active feedback**
  Maybe if the users feel confident that their opinions will be listened, they could send a mail every time they find a problem, just when they experience it. Maybe these mails could be reviewed once a year, assess the importance of the different problems and decide which ones could be fixed this year.
6. RESEARCH EVALUATION

I consider the outcome of this master thesis have been positive: the research process has been enriching and even though the results are not conclusive I think they provide insights and draw interesting lines of research for advance towards the aim of procuring work-friendly software.

Regarding the research questions, I consider that they have been all addressed during the research but they have been answered in different degrees:

- Which are the challenges of setting up a work environment evaluation within public procurement framework?

  Even though the list of challenges of public procurement could be always extended, I think this research have identified the most important limitations, giving the overall picture of which constrains should be considered for the development of a work environment evaluation.

- What aspects should be assessed to identify the software that better supports quality and healthy work?

  I have proposed a list of guidelines to be used as a theoretical basis for a work environment evaluation. Nevertheless, my answer to this question is “depending on the circumstances and the system to be purchased”. Further research is needed to define the best setup for addressing work environment aspects in each situation.

- How can users be involved in assessing suitability of IT systems for a specific work situation?

  The results of the work environment evaluation carried out with users have provided some insights regarding which guidelines could be better assess directly by users and which by experts. I have also proposed to establish a long-term and fluent relationship with the users, requiring their active participation before, during and after the procurement. However, future research should define the appropriate terms of this relationship and measure its costs and benefits.

However, some limitations of this research should also be pointed out. Due to the complexity of the public procurement and my limited knowledge about the legal aspects, my insights of the framework and its possibilities for a work environment evaluation could include some inaccuracies.

In my opinion, language has also represented a limitation for the literature review and the work environment evaluation with users. In the first case, my basic level of Swedish has prevented me to properly review the documents from former procurement processes of Uppsala University. In the second one, I think the results of the test case could have been more relevant if the questionnaires have been written in Swedish and users could have had the opportunity to express in Swedish.
Additionally, I am aware that some conditions of the test (users have been working with the system for years) could have influenced and biased the results, limiting the applicability of the results for the procurement context, but they are applicable for maintenance. However, I consider carrying out the work environment evaluation with users has been especially useful to drive the research to something concrete.

In that respect, I think one of the weaknesses of this study has been to work from a general approach instead of restricting the research to some specific conditions. Due to the differences of each procurement process, it is difficult to analyze the limitations for a work environment evaluation in any possible case. Focus on the challenges of considering work environment aspects in a concrete procurement process could have been more suitable. Also, focus on one concrete guideline and study how to evaluate it in different procurement processes and situations. Nevertheless, I have the impression that I have needed to get the general picture to be able to understand how the research scope could have been restricted in a meaningful way.

Additionally, I think that not defining the methodology from the beginning could have also been a limitation for the research. On one hand, it allowed me to work in a more flexible way and refine the scope of my research iteratively according to my findings. On the other hand, it has represented to invest time in different directions instead of focusing in one concrete and restricted part of the problem.

In any case, an increased awareness about limiting the scope of the research and defining a flexible but clear methodology from an early stage could be considered as other positive outcomes of this master thesis.
7. FUTURE WORK

Future research in this area can include:

- Review the completeness and validity of the list of guidelines for a healthy work environment. For example, real data collected from a large number of workplaces about their IT work environment problems could be used to validate if the list of guidelines includes the most important and frequent problems software problems.

- Investigate the applicability of the guidelines proposed to different types of software. The guidelines proposed have been applied to software for financial management, future studies could use the guidelines to evaluate software for other work sectors or tasks (for example, healthcare, music, laboratories, etc.) and check if the guidelines are applicable to each of these softwares.

- Define examples, measures and further explanations to make easier the appliance of the work environment guidelines to concrete cases. Future research could work on answering questions as: What are the alternatives to avoid extensive use of mouse? Which kind of error messages are positive and which could contribute to lower users’ awareness? Should the communication with managers and colleagues be managed inside the system or this will reduce social support face-to-face?

- Confirm the suitability of users or experts to assess each criteria. Using the same software, complementary evaluations for the same criteria could be performed with users and experts. Results could be compared with scientific evidences.

- Design and perform a work environment evaluation for a real case: public procurement process of a software that will be used to work. The study could provide some insights about the obstacles founded during the process and the results obtained.

- Study the costs and benefits of different work environment evaluations approaches. For example, economic studies could calculate the time and money necessary for evaluate and customize a system, on one hand, using the approach of measuring guidelines compliance and, on the other hand, using the approach of measuring flexibility during evaluation of tenders.

- Measure the effects of the changes derived from a work environment evaluation. Studies at this respect could consist of performing a work environment evaluation of an existing software, implementing necessary corrections and controlling the effects throughout a second work environment evaluation.

- Investigate if using the same users to evaluate all systems or different users to evaluate each system has any effect in the evaluation results. For example, parallel evaluations of same three systems could be performed with same and different users.

- Investigate if the order in which users evaluate the different systems can have an effect in the evaluation results (in case same users evaluate all systems) In this case, different groups of users could evaluate the same three systems but in a different order.
8. REFERENCES


International Organization for Standardization (1998) ISO 9241-17: Ergonomic requirements for office work with visual display terminals (VDTs) Part 17: Form filling dialogues (Geneva, Switzerland)

International Organization for Standardization. (1998b) ISO 9241-11: Ergonomic requirements for office work with visual display terminals (VDTs) Part 11: Guidance in usability (Geneva, Switzerland)

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APPENDIX
INTERVIEWS QUESTIONS

First interview with Procurement Officer

- Which is exactly the procedure when your institution needs to purchase a new software?
- How does the requirements for this new system are described or written?
- Which information does software suppliers provide to explain their software solution? Does it include any workflow diagrams?
- Do you have any documents that explains the conditions of the purchasing and selection process?
- Do you have any documentation from former procurement processes that I could review?

Interview with Usability consultant

- Which was the setup of the usability evaluation you used in a public procurement?
- How many users did you involve?
- Did you perform the tests with prototypes or beta version of the systems?
- Did you ask the users to perform some tasks?
- Did the users compare different systems or just test one system?
- What outcomes or results did you get?
- How did you translate them in price reduction for the procurement process?
- In which stage was the usability evaluation carried out? (just before deciding which system to purchase?)

Second interview with Procurement Officer

(Before any question, I explained him the first proposal for a work environment evaluation)

- Can we establish that some criteria will be assessed by users, other by experts, and even others by both?
- Is it possible to establish the compromises? Do you think the companies will accept them?
- Should the compromises be formulated in a more specific way “If we can decide three changes about the colours”?
- Do you already include some requirements about: system response time, trainning and help desk and updates?
- Did you include any other usability requirements apart from the usability evaluation?
- Is it ok if we establish a grading scale from 1 to 5, but we only specify the value of 1, 3 and 5?
• Would be feasible to customize some settings during the implementation?

• Would you have resources or time to do more research (user tests and interviews)?

• Once implemented, can you reserve some money to do some user tests each year? And solve the problems reported by the users?

Interviews with financial staff for designing the test about Raindance

• What is your job position

• How long have you been working in this position?

• What are your main tasks?

• Do you have any technical background?

• How many hours do you work with a computer?

• Which softwares do you use to perform your work?

• Which tasks do you perform with Raindance?

• How long have you used Raindance?

• How often do you use it?

• How long do you use it daily, for example?

• Did you get any training to start using Raindance?

• Do you feel you are more efficient with Raindance than before its implementation?

• Which can be your most frequent tasks with Raindance?

• Which would you say are the most problematic tasks with Raindance?
INFORMED CONSENT FORM TO PARTICIPATE IN THE TEST

Test description and procedure

The purpose of the research is to gather information from users about how it is working with the software Raindance Portalen, if it contributes to a healthy work environment or not and how it could be improved.

I understand the test is aimed at evaluating the technology, not me or my skills using the system.

During the test, I will fill in a previous questionnaire, I will perform some tasks using the system. After finishing the tasks, I will fill in a second questionnaire and be interviewed by one of the researchers.

All data gathered during the test will be anonymous, and will not be associated with any particular individual. The test will be recorded with audio and video, for further analysis but these materials are confidential and will not be used out of the context of this research.

I can exercise my right to access, change or delete my personal data anytime by sending a mail to: luciasilencioroto@gmail.com.

My participation is voluntary and I will not get paid for it.

My signature below indicates that:

- I have read the above description of this research, and I have had the opportunity to make further questions to the researchers and got a satisfactory answer.

- I agree to participate in this research and I give my authorization to be recorded with video and audio during the test.

- I understand my rights as a participant and that I can withdraw at any time, even after having signed this form. In this case, all recordings will be destroyed.

Name: ____________________________
Surname: _________________________

Uppsala, May _____ 2011                      Signature_____________________________
PRE-TEST QUESTIONNAIRE

Role: Financial administrator

Scenario: You are in charge of the economic issues of the IT Department in Uppsala University. One of the researchers of this department, John Travis, travelled last week to Los Angeles, USA, to attend an IT Conference there. Two days ago you received the invoice from the travelling company including flight and accommodation within the new system for electronic invoices Raindance Portalen. John Travis has already reviewed the invoice and confirmed that it is correct. Thus, now you need to arrange the payment of the invoice.

1. How often could you perform this task?
   _____ times a year / ___ times a month / ___ times a week / ___ times a day / ___ times an hour

2. The logical steps to perform this task are: (Your work and others)
   - Check that the invoice have been “granskar” by John Travis
   -
   -
   -
   -

3. You will consider that the task is finished successfully if:

4. You will consider that the task is finished unsuccessfully if:

5. How would you describe your part of the task as: easy, medium, difficult?

1-----------------2------------------3-------------------4-------------------5
Very easy

Very difficult
6. How much time could be reasonable for you to spend working on this task?

_____ hours / ____ minutes / ____ seconds

7. What are the potential mistakes that could happen in your part of the task?

Mistake:
Consequences:

1-----------------------2-----------------------3-----------------------4-----------------------5
(Not very important) (Really Severe)

Mistake:
Consequences:

1-----------------------2-----------------------3-----------------------4-----------------------5
(Not very important) (Really Severe)

Mistake:
Consequences:

1-----------------------2-----------------------3-----------------------4-----------------------5
(Not very important) (Really Severe)

8. To finish the task, would you need to communicate with colleagues or managers?

YES / NO Who?__________________________________________

9. Which information do you need to identify each invoice and to estimate the amount of work that will entail?
POST-TEST QUESTIONNAIRE + INTERVIEW QUESTIONS

(The questions inside the boxes were not written in the printed questionnaire provided to the users, they were formulated orally by the interviewer)

**PART 1 : TASK STEPS**

1.1 Do you think the process to perform this task with the system makes sense? Is it logical?

1-2-3-4-5
Completely illogical The actions and order are totally logical

A. If you could tailor it, how would you organize it?

1.2 Do you think the process to perform this task has a reasonable number of steps with a reasonable complexity?

1-2-3-4-5
Too many and complicated steps Just few and simple steps

A. Are all data that you need to entry really essential to perform the task?

B. Which steps or actions do you think that are more complex, require more mental effort or in which you need to pay more attention?

1.3 When you click or type something, do you think the system response is quickly enough?

1-2-3-4-5
I need to wait for the system constantly System response is immediate
PART 2: PRESENTATION OF INFORMATION

2.1 Would you consider that the information displayed on the screen during the task is clear and concise?

1---------------------------------2-----------------------------------3--------------------------------------4------------------------------------------5
Confusing, too long                                        Easy, clear, concise

2.2 Decision making

A. Which steps require you to make a decision?

B. Which information should you take into account in each of these decisions?

C. Which is the most important information for the task performance?

Priority 1 (essential):
Priority 2 (useful):
Priority 3 (complementary):

Is all this information simultaneously in the screen?

1-------------------------2---------------------------3------------------------4--------------------------5
There is key information missing or hidden         All useful information is displayed

2.3 Do you think the most important information has a prominent space in the screen or is highlighted?

1-------------------------2---------------------------3------------------------4--------------------------5
All information similarly displayed/Wrongly prioritized       Key information highlighted
PART 3: EXTERNAL INFORMATION SOURCES OR PROGRAMS

3.1 Minimal windows switching

A. Which steps do require you to look up information that is placed outside the software (papers, mails, e-documents, databases, ...)?

B. Which are each of these sources and what type? (i.e. Project code (paper)

C. How many windows could you use to complete the task? (other programs, pop-ups)

Do you think the program require you to open too many windows at the same time (other programs, e-documents, pop-ups...)?

1-----------------------------2----------------------------------3------------------------------------------4---------------------------5
I need to manage too many windows Minimum number of windows( essential)
PART 4. OVERVIEW AND CONTROL

4.1 Overview of workload

A. What is the key information that you would use in the inbox to identify each case and to estimate the amount of work to be done?

B. Which information displayed is necessary and which totally unnecessary?

Do you think the actual list displays enough and appropriate information about each case to identify them and judge the amount of work?

1-------------------------2-------------------------3-------------------------4-------------------------5
Too much info/ Confusing/Missing information Appropriate and clear information

4.2 Flexibility to decide task order, save without finishing and open simultaneous tasks

A. Can you choose in which order you want to do the tasks?

B. Can you open more than one task at the same time?

C. Can you save even though the task is not finished? And continue later from this point?

Do you feel that the software let you enough freedom to decide about your work: order of tasks, pace, simultaneous tasks, save one task without finishing it, etc.?

1-------------------------2-------------------------3-------------------------4-------------------------5
The software controls my work I feel completely free to decide about my work
4.3 Space for task variation

A. Based on your experience, what exceptional cases could you expect on this task?

(For example, shared invoice of two different departments, more than one concept in the same invoice, more than one project...)

How many of these cases could be managed using Raindance Portalen?

1-------------------------2--------------------------3--------------------------4--------------------------5
Any case with little variation is excluded All cases could be managed

4.4 Task results

A. How have you known if the task has been finished successfully or failed?

B. Can you check it again afterwards if you have doubts?

Do you consider that the system communicate clearly enough if the task has been finished successfully or failed?

1-------------------------2--------------------------3--------------------------4--------------------------5
No information about it or confusing Really easy to see what happened
PART 5: MISTAKES

5.1 Preventing mistakes and consequences

A. Which are the risky steps of this task?

B. Do you think some of them can be prevented or reduced? How?

Do you consider that the system actually supports you in doing a good job and preventing mistakes?

1-------------------------2-------------------------3-------------------------4-------------------------5
Instead of helping, it induce to some mistakes It helps reducing mistakes or consequences
PART 6: MONOTONOUS WORK

6.1 Log in/out

How many times a day do you need to log in Raindance portalen normally?

How do you feel about it?

1-------------------------2--------------------------3--------------------------4--------------------------5
Totally time-consuming and frustrating It is ok, not that important

6.2 Optimized process for repeated tasks

A. Do you normally perform this same task several times in a row? How many times?
B. Where does the system make you start the second time?
C. Where would you like to be driven in the system after finishing the task?

Do you feel that you need to repeat steps unnecessarily the second time?

1-------------------------2--------------------------3--------------------------4--------------------------5
Yes, more steps could be skipped the second time No, all the steps are essential

6.3 Would you consider useful if you could perform the same task jointly for several invoices at the same time?

1-------------------------2--------------------------3--------------------------4--------------------------5
Not necessary /No sense Extremely useful
PART 7. INPUT DEVICES

7.1 What percentage of the task have you used the mouse or trackball and which the keyboard?

<table>
<thead>
<tr>
<th>Mouse: %</th>
<th>Keyboard: %</th>
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<tbody>
<tr>
<td>Do you feel comfortable using the mouse that much?</td>
<td></td>
</tr>
<tr>
<td>1-----------------2-------------------3-------------------4-------------------5</td>
<td></td>
</tr>
<tr>
<td>It is uncomfortable but I have no option</td>
<td>Yes, no problem at all</td>
</tr>
</tbody>
</table>

7.2 Mouse and keyboard

A. When you fill in a form, do you use the keyboard to go to the next field?
B. Have you ever tried to use Raindance Portalen just with the keyboard? Do you feel it is comfortable?

| Do you feel comfortable switching from mouse to keyboard? |
| 1-----------------2-------------------3-------------------4-------------------5 |
| It is uncomfortable but I have no option | Yes, no problem at all |
### PART 8: SUPPORT AND MAINTENANCE

A. Have you received training about Raindance Portalen?

B. What do you do if you have a problem with Raindance Portalen?

C. Does the system have a Help section? Have you ever look up this section when you have had a doubt?

D. Have you ever contacted support desk (mail or telephone)? Did they respond you and solve the incidence?

E. Have you ever been asked about your satisfaction with the program?

F. Have you report some feature to be redesigned?

#### 8.1 Do you feel confident that you will receive appropriate support to solve any possible incidence with the system? (Contacting Raindance, Help section, FAQ...)

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<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>No, I feel alone dealing with the system, vulnerable</td>
<td>Yes, I feel 100% supported</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

A. Do you need feedback from managers or other colleagues to be able to finish the task?

B. When do you have a doubt, do you ask them directly? By phone? By mail? or use the system to communicate?

#### 8.2 Do you think the system supports the communication/relatıon with managers or other colleagues?

<p>| | | | | | |</p>
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</tr>
<tr>
<td>No at all, it reduces communication</td>
<td>Yes, the system enhances communication</td>
<td></td>
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</table>

#### 8.3 Periodical updates to fix problems reported by users

A. Have you ever been asked about your satisfaction with the program?

B. Have you report some feature to be redesigned?
10. ADDITIONAL COMMENTS

Is there anything more that you think would be good for me to know?

PART 11. ABOUT THE TEST

How have you felt during the test?
Were some questions too abstract or difficult to answer?
Do you think the printed diagrams were useful for you to answer some questions? And the printed screenshots?
If your institution would ask you to participate in tests like that for choosing or improving the software for financial work, would you like to participate?
WORK ENVIRONMENT EVALUATION

TASK: Send invoice to the Head of the Department to authorize payment

USER: Financial administrator

SYSTEM: Raindance portalen

1. Open internet browser
2. Go to the bookmark of the program
3. Login
   3.1 Type Username
   3.2 Type password
   3.3 Type company
   3.4 Clic OK or press ENTER
4. Check your inbox
5. Clic at one invoice to work with it
6. Look at the PDF of the invoice for the details.
7. (If necessary scroll down or clic next page)
8. Check if someone have said the invoice is correct
9. (If necessary clic the icon to see comments)
10. Introduce financial information
    10.1 Type the account
    10.2 Type the prestaton
    10.3 Type the project
    10.4 Type FIN
    10.5 Type AKT
    10.6 Type the amount
    10.7 Type keywords
    10.8 Press Enter
11. Open Cirkulation tab
12. Clic the trash button next to your name.
13. Clic the magnifying glass to look for the person that needs to authorize the invoice
14. (If necessary) Type some observations adressed to that person
15. Clic “Next invoice” or press ENTER
16. Clic “Next invoice” or press ENTER again

NEW WINDOW
A. Look at the list of persons (sorted by surname or codenumber)
B. (If necessary) reorder the list or scroll down
C. Clic on the name of the person

NEW WINDOW
A. Read the comments
B. Close the window
2. Presentation of information
4. Overview: Inbox