THE IMPACT OF USER EXPERIENCE ON HUMAN COMPUTER INTERACTION – RESULTS FROM A USABILITY STUDY

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Abstract –

For a large number of applications, mobile devices offer a manifold variety of potentials to improve business processes. However, most projects still fail to be successful with regard to key performance indicators (KPI). There is a growing understanding that human computer interaction is a key factor for the successful use of mobile devices in practice. However, it is still unclear how interfaces can be designed according to the specific needs of a user applying mobile devices in a business context. In this study we show that user experience has a strong impact on efficient human computer interaction. We present the results of a usability study on a mobile tool for IT-Service technicians. The results show that (a) even low experienced users can achieve sufficient task performance with a usable tool and (b) that participants of all experience groups perform better in the field setting compared to the lab.

Keywords: Usability, Mobile Business Process, Task Performance, IT-Service

1 INTRODUCTION

Mobile devices in information and communication technology have raised great expectations during the past years (Wang et al. 2005, Gumpp & Pousttchi 2005). Following the discussion in academia and industry, expectations go far beyond cost cutting. In particular new business models (and hence new ways of market reach) are inspired by mobile devices. This is grounded by a number of recent studies (cf. Kornak et al. 2004, Basole 2005, Pousttchi & Thurnher, 2006). In more detail, the potentials of mobile devices for business process management include (a) the release of workforce from desktop IT-Systems, (b) replacement of paper-based processes, and (c) access to corporate resources and automated online information request (cf. Basole 2005, Basole & Rouse 2007). In practice, however, the successful implementation of mobile business processes is still a serious problem. Previous research has argued that successful adoption and implementation of any emerging devices, such as mobile devices, often requires fundamental changes of a company's organisation (cf. Taylor & McAdam 2004, Rouse 2006). In fact, although mobile technologies are widely available nowadays, most projects fail in establishing sustainable business processes that are efficiently applied in the business processes of a company. We argue that one possible explanation for this phenomenon lies in a lack of usability mobile tools. Mobile technology can help to integrate field force into value-creating business processes but therefore tool acceptance among field force/users is essential which can be fostered through tool usability. Having a usable mobile tool is a prerequisite for application and user acceptance (Nielsen 2003). Therefore, this paper focuses on the evaluation of a mobile tool for IT-Service technicians by investigating execution of realistic work tasks in a field and lab setting. The mobile tool supports mobile order handling e.g., capturing work-, driving time and number of used spare parts. Moreover, customer data (address, repair history of IT components) is captured and a knowledge-base provides solution suggestions for already occurred problems.

Prior experience of study participants are related to performance values (time and number of clicks). Moreover, we investigate if varying context conditions (lab/field) have an impact on performance. The remainder of this paper is structured as follows: section 2 provides an overview of related work in the areas of mobile business processes and usability of mobile tools. Section 3 presents the research approach and the hypothesis. The experiment description is lined out in section 4 and the results are presented in section 5. The discussion in section 6 and the conclusion and an outlook to future work summarize the paper.

2 RELATED WORK

Evaluating the usability of mobile tools poses a number of challenges due to their nature. Usability is defined as “the effectiveness, efficiency, and satisfaction with which user’s can achieve tasks in a particular environment of a product” (International Standard ISO 9241-11, 1998. p. 5). Moreover, low usability of mobile tools prevents employees from efficient job fulfilment and therefore hinders acceptance and application. Therefore, usability is a vital criterion when integrating mobile technology into former paper-based business processes to achieve improvement of key performance indicators (e.g. time to bill, paper handling time, administrative work-load). Major areas of usability include content layout and classification, structure, user interface, appearance and visual design, intuitiveness, readability, search facilities, and ease of navigation (Nielsen 2003, Kaasinen 2005). Usability is to ensure that interactive products are easy to learn, effective to use and enjoyable from the user’s perspective (Lazar & Preece 2002). Hence, usability is extremely vital for the success of a (mobile) application.

Mobile information and communication technologies (ICT) offer a plethora of new value propositions and promise to have a significant transformational impact on business processes, organizations, and supply chains (Kornak et al. 2004; Basole 2005; Pousttchi & Thurnher, 2006a; Thurnher et al. 2005). However, despite its potential contributions, enterprise adoption of mobile ICT has not been as widely spread as initially anticipated. Previous research has argued that successful adoption and implementation of any emerging ICT, such as mobile ICT, often requires fundamental changes across an enterprise and its current business processes, organizational culture, and workflows (Taylor & Adam, 2004; Rouse, 1999; Rouse, 2006). Hence, in order to minimize organizational risks and maximize the potential benefits of mobile ICT, companies have to evaluate the value of mobility to their organization (cf. Hartman et al., 2000; Ward & Peppard, 2002).

For the usability evaluation of a mobile tool a number of methods and approaches is available. There are studies which discuss the question whether the evaluation should be carried out in a laboratory- or field setting (Goodman et al. 2004, Kjeldskov & Stage 2004, Kjeldskov et al. 2005, Po et al. 2004, Pousttchi & Thurnher 2006, Musa 2006). The common message of these papers is that they apply a multi-method approach to usability testing and discuss optimal solutions for efficient data analysis. Goodman et al. (2004) and Po et al. (2004) describe the importance of evaluating the usability of mobile tool in the field. They point out that an evaluation in real context is important in order to consider factors like distraction, noise and lighting. Po et al. (2004) compared results she got from testing a mobile tool in laboratory- and field settings. They applied heuristic evaluation and heuristic walkthrough in the laboratory as well as contextual walkthrough in the field. Testing the application in the field revealed the most severe usability issues. On the other hand Kjeldskov et al. (2005) investigated a mobile guide using different usability evaluation methods. He used a lab and field evaluation, heuristic walkthrough and rapid reflection. The field evaluation revealed the most severe usability problems but still only found 7 out of 11 problems. Kjeldskov et al. (2005) pointed out that the benefit of a multi method approach is analyzing the data from different points of views and thereby achieving confirmation of the results. Baillie and Schatz (2005) investigate mobile tool usability within a lab and field context and observed a slightly better performance in the field.

As a common approach the above mentioned studies applied *scenario-based* usability testing which where captured through different method-sets. Within scenario-based study settings participants execute predefined series of tasks (single steps) which are derived from real work tasks (Nielsen 2003). Likewise, the above mentioned studies mostly apply a background questionnaire in order to capture e.g., mobile device- or computer literacy and experience of participants. Within this study we want to investigate if even low experienced users can operate a mobile tool; assuming general tool usability. Align with the study of Baillie and Schatz (2005) we investigate location impact (e.g. H1: lab/field) on task performance (number of clicks/time). We applied a multi-method approach using a usability questionnaire as well as log-file analysis in a field and lab setting.

3 RESEARCH APPROACH AND HYPOTHESIS

This paper presents basic results of a usability study to evaluate mobile scenario performance (number of clicks and time required for scenario completion) regarding end-user experience and tool application in different settings (laboratory and field setting). Scenarios include typical business tasks applying mobile tool for, e.g., request of available spare parts in stock via a mobile tool. Section 4 describes the three scenarios used in this study in detail. Scenario performance refers to the number of clicks and time (in seconds) to complete a scenario. We collected end-user experience prior to the experiment by using a self-estimation *background questionnaire*. The experiment was conducted in a classroom setting (lab location) and in real-world environment (field) to investigate the impact of different environmental factors, e.g., noise and motion. Based on this setting we identified two *major research* questions:

RQ1) Is there any significant difference on scenario performance regarding different experience levels? Depending on the implementation of the tool, we expect only small benefits for higher experienced participants because of active guidance through the scenario process provided by the tool implementation.

H1.1) Low qualified participants need significantly more time to solve a scenario than higher qualified participants. Nevertheless, also low qualified participants should be in an acceptable time range. We expect a higher effort (more time) for lower qualified participants because they have to get familiar with the mobile tool, i.e. they have to learn (a) the mobile tool/application handling and (b) domain handling. Nevertheless, the mobile tool will support scenario execution. Thus, we expect that all participants are within acceptable execution duration for all scenarios.

H1.2) All participants need a similar number of clicks to solve the scenarios. We don't expect any significant differences regarding the number of clicks because of the tool guidance of the mobile solution to solve each scenario. There should be a clear and predictable process workflow for scenario completion.

RQ2) Can we observe differences on scenario performance regarding execution location, i.e., lab and field?

H2.1) The time for scenario completion will be higher within the field environment. We expect advantages regarding lab environments because there should be less distraction of the participants (e.g., noise and motion).

H2.2) The number of clicks in laboratory setting is lower than the number of clicks in the field. Following the previous hypothesis, we expect a higher number of clicks of the participants in the field because of environmental reasons (e.g., noise and motion).

The next section introduces the experiment setting to find answers to the research questions and to investigate the results according to the defined hypothesis.

4 EXPERIMENT DESCRIPTION

4.1 Methodology

This section provides an overview of the experiment setting and procedure, the study material, and threats to validity. Figure 1 gives on overview of the study procedure. At first the study participants filed in a background questionnaire (duration: 5min). After that the actual usability study was executed. Assignment of participants to lab and field settings was randomly and study execution lasted about 1 hour. The gathered data (questionnaire and log-files) was than analysed.

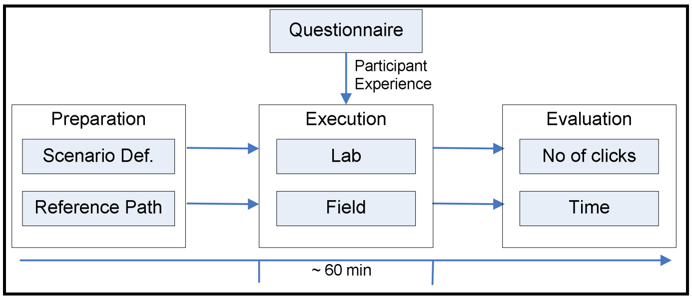

Figure 1: Experiment Procedure

Background Questionnaire: The participants have been asked to fill in a background questionnaire, which contains several items testing e.g. their experience and the frequency of use of computers and mobile devices. Based on the questionnaire, we identified 4 major factors for measuring user experience: (a) Frequency of Mobile Device Usage (E3), (b) MS Windows Experience (E5), (c) Mobile Device Experience (E6), and (d) Pocket PC Experience (E7), which are summarized (and classified) to one experience value. See Pousttchi & Thurnher (2006) for a detailed description. The experience part of the questionnaire had to be filled in prior to test execution. The entire questionnaire was realized as a stand-alone application directly on the PDA. The participants were identified at the login screen with their user-ID. For efficient data preparation the questionnaire application realized a replication mechanism, which transferred the data to a database on the desktop. This process reduced the time and effort for data analysis considerably. We used *log-files* (Hilbert & Redmiles, 2000; Partanen, 2003; Thurnher et al., 2005a) for quantitative data like: number of clicks per task and time and errors. The artificial test situation during a study can influence process performance (Wohlin et al., 2000); to avoid this we applied non-intrusive methods of observation and on purpose did not use a camera to lower this risk. Instead we used an automated video capturing tool which recorded the interactions of the participants with the mobile tool. In order to test the predefined hypothesis (see section 3) we conducted statistical analysis using SPSS and applied non-parametric tests (Mann-Withney-U-Test, 2-sided) at a confidence level of 95%.

4.2 Variables

In the context of the experiment we define dependent and independent variables. *Dependent variables* are described as the *time* and *click* rate for scenario solution. The time was measured in seconds/minutes and the click rate was counted via the implemented logging mechanism. Furthermore, *efficiency* was chosen as an independent variable. According to Preece (2002) efficiency refers to the way a system supports users in carrying out their tasks. We define a task as a sequence of actions (clicks), required to reach a predefined goal of a job activity. In this paper each job is described by a defined minimal number of clicks, which are defined by the reference path. The reference path is the most efficient/shortest way for task completion (least amount of clicks). Thus, *efficiency is the time required to solve a scenario,* i.e. average time per click. *Independent Variables* are end-user experience and reference path. The *experience* with mobile device usage of a subject was measured with several questions of a questionnaire (e.g. frequency of mobile device usage, experience with Pocket PCs, etc.). We applied a five point Likert-Scale (1 = low; 5 = very high). In order to compare the time and click values of the subject we applied a *reference path.* The reference path is the shortest/most efficient way to solve a task, using the least numbers of clicks. Baillie and Schatz (2005) categorized the results of their study concerning the time needed to solve the tasks according to reference values. These values were gathered in a pre-testing phase by two expert users.

4.2.1 Scenario Description

During the study the participants executed the following scenarios:

- S1: Data capturing (e.g., work on a service job and job closure)
- S2: Search and update the Knowledgebase (e.g., solution for a certain technical problem)
- S3: Change certain details (e.g. personal details) and search for an already occurred problem in the KnowledgeBase.

These scenarios where selected as they comprise realistic IT-Service technician's work task. The *first scenario* served as an "introductory" scenario to the application in order to familiarize the study participants with the application. The participants had to accept a job, work on the job and finish the job. The *second scenario* contained searching and updating of the KnowledgeBase, which contained technical solution suggestions for already occurred problems or the repair history of a customer. The *third scenario* was a combination of scenario one and two. The participants had to change certain details of a customer e.g., address, phone number and update the knowledge base. All executed user actions were logged in order to analyse the needed time and clicks for scenario solution. First we analysed the time needed to solve the scenarios during the evaluation. In order to compare the time and click values of the subject we applied a *reference path.* The reference path is the shortest/most efficient way to solve a task, using the least numbers of clicks. We applied the procedure suggested by Baillie and Schatz (2005) and used the values from two expert users to gather values for the reference path. According to the reference path we classified execution time ranges in: excellent, acceptable and unacceptable. Table 1 provides an overview of the classified ranges:

	Categorisation of Time Intervals [sec]				Categorization of Clicks			
	Ref	Excellent	Accept.	Unaccept.	Ref	Excellent	Accept.	Unaccept.
S1	171s	< 420s	420 - 600s	> 600s	9	< 10	10-14	> 14
S2	186s	< 600s	600 - 900s	> 900s	12	< 13	13-16	> 16
S3	137s	< 360s	360 - 600s	> 600s	11	< 12	12-14	> 14

Table 1: Time and Number of Clicks to Solve the scenarios: Reference-Path, Classification.

4.2.2 Participant Description

In the study we had 30 participants to avoid anecdotal evidence and had a wider range of participants; participants differed in age, educational background and computer literacy. The study lasted about one hour. 11 participants executed the usability test within a laboratory and 19 in a field setting. The participants have been asked to fill in a background questionnaire prior to study execution, which contained several items testing their experience and the frequency of use of computers and mobile devices. According to these experience values the participants have been classified into low, medium and high experienced. Table 2 provides an overview of the experience distribution of participants in the lab and field environment.

	Low		Medium		High		Total	
	No	%	No	%	No	%	No	%
Lab	4	13,3%	2	6,7%	5	16,7%	11	36,7%
Field	4	13,3%	10	33,3%	5	16,7%	19	63,3%
Total	8	26,7%	12	40,0%	10	33,3%	30	100%

Table 2. Distribution of Participant Experience and Execution Location

4.3 Threats to Validity and Limitations

In order to increase internal and external validity we consider a set of threats to validity and established appropriate countermeasures (see also Wohlin et al., 2000; Winkler, 2006). To address internal validity the level of prior experience in mobile device usage of the participants was collected at the beginning of the study by gathering experience data via questionnaire. We applied a feedback cycle of the transcripted interview questionnaires to reduce errors and misunderstandings. Additionally, we performed intensive reviews of the study questionnaire to verify the correctness and understandability of questions. In order to avoid learning effects we did not provide feedback, neither during case study interviews nor during usability study execution. The duration of the usability study has been limited to a maximum of 1.5 hours. Participants could finish earlier but always within the given time frame. In order to foster external validity we used a well-known application domain (IT-Service application) to avoid domain-specific interpretation problems. Additionally, the tested mobile tool describes a real world application to enable comparability to industrial settings. Regarding the selection of participants we used test persons with varying educational backgrounds, age and mobile device literacy for the usability study and domain experts for the industry case studies. We provided a pre study tutorial to explain the application, its purpose, task and terms. This has been done to guarantee that test persons with a non IT-Service background understood the tasks and terms of the application (e.g., the knowledge base). As study layout for the usability study we had a lab and a field setting to increase generalizability of the results and investigate performance differences (e.g., time, number of clicks) in those specific contexts. For all tests different participants are used whereas the tasks remain the same. To avoid position effects the order for the different situations was random.

5 RESULTS

This section describes the findings for the predefined research questions with focus on the defined hypothesis.

5.1 Participant Experience and Scenario Execution Performance

This section provides the results of hypothesis H1.1 (low qualified participants require more time to complete a scenario) and H1.2 (comparable number of clicks for all experience levels to complete a scenario). Scenario execution performance refers to (a) the required time for scenario completion, (b) the number of clicks to finish the task, and (c) the average time per click, i.e. the efficiency.

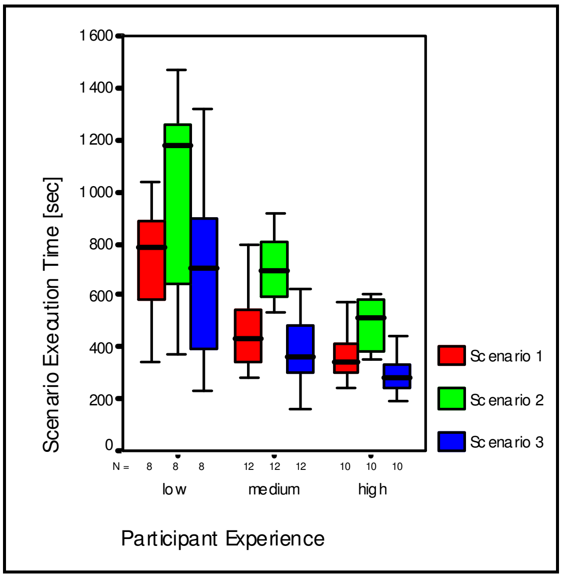

Figure 2: Scenario Completion Time per Scenario and Participant Experience.

Regarding the reference path, the results show that all participant groups require more time than the experts. Low experienced participants needed 4.5-5.1x more time than needed for the reference path and are in an unacceptable range of scenario execution duration. Medium experienced participants required 2.6-3x more time but they are in an acceptable time-frame and high experienced participants are in an excellent time-frame. Applying the Mann-Whitney-U-Test at a significance level of 95%, we observed significant differences between high and low qualified participants for all scenarios (p-value: <0.020). Additionally, we found significant differences for low/medium qualified participants in scenario 1 (p-value: 0.007) and for medium/high experience participants in scenario 2 (p-value: 0.001).

We assume that low qualified participants require additional time in the first scenario to get familiar with the basic functionality and the User Interface (UI) of the mobile tool. Scenario 2 and 3 shows no significant differences between low/medium experienced participants.

Execution Time [sec]	Ref. Path	Low		Medium		High	
		Mean	Std.Dev	Mean	Std.Dev.	Mean	Std.Dev
Scenario 1	171	733.0	223.24	456.8	150.58	368.3	99.90
Scenario 2	286	998.9	393.28	742.0	229.53	487.7	96.77
Scenario 3	137	693.6	351.72	411.4	185.85	308.0	104.85

Table 3: Scenario Completion Time per Scenario and Participant Experience.

The number of required clicks to complete the scenarios is a second important measure to identify the mobile tool performance. The number of click refers to the guidance of scenario completion by the mobile solution. The results show that all low experienced participants need on average more clicks than medium qualified participants, and all medium qualified participants require more clicks than high qualified participants. Considering scenario 1 all participant groups are in an acceptable click range. Low qualified participants are in an acceptable range in scenario 2 and 3. Furthermore, all medium and high qualified participants are classified in the range “excellent” in S2 and S3. Regarding the Mann-Whitney-U-Test, we observed significant differences in scenario 3 between low/medium qualified participants (p-value: 0.020) and in scenario 2 and 3 between low/high qualified participants (p-value: < 0.018). We did not observe significant differences in S1 between the experience groups. One reason might be that there are advantages for higher qualified participants in more complex scenarios, i.e., S2 and S3.

Number of clicks	Ref. Path	Low		Medium		High	
		Mean	Std.Dev	Mean	Std.Dev	Mean	Std.Dev
Scenario 1	9	12.6	2.39	11.0	1.21	10.5	0.97
Scenario 2	12	15.4	2.93	12.8	1.27	12.2	0.42
Scenario 3	11	13.9	2.30	11.7	1.16	11.4	0.70

Table 4: Number of Clicks per Scenario and Participant Experience.

Efficiency enables comparability between different scenarios because of different minimum clicks to solve the individual scenarios. Note that the reference path of the individual scenarios varies in the minimum number of clicks (S1: 9, S2: 12, and S3: 11). In the context of this paper we define efficiency as the time per click to complete a scenario. The results show an improvement of efficiency for higher experienced participants, i.e., they need less time per click to complete a scenario. Table 5 presents mean values and standard deviation for efficiency and the individual scenarios and the individual experience classes. Applying the Mann-Whitney-U-Test we observe significant differences between low and high experienced participants for all scenarios and significant differences between medium and high experienced participants in scenario 2.

Efficiency		Low		Medium		High	
	Ref. Path	Mean	Std.Dev	Mean	Std.Dev	Mean	Std.Dev
Scenario 1	19	58.6	18.02	41.5	12.50	35.2	9.27
Scenario 2	15.5	63.1	18.36	57.3	13.25	39.4	7.70
Scenario 3	12.5	48.2	19.20	35.3	16.22	27.2	9.86

Table 5: Efficiency per Scenario and Participant Experience.

5.2 Scenario Execution Location (Lab/Field) and Performance

This subsection provides the results of hypothesis H2.1 (higher scenario completion time within a field setting) and H2.2 (higher qualified participants will need less time and clicks in the field). An essential question in the area of usability studies focuses on the location of study execution. Is it necessary to evaluate a tools/user interfaces in the field, i.e., a real world setting, or is it possible to evaluate the tool/user interface in a classroom setting, i.e., in laboratory environment (e.g., Po et al, 2004, Pousttchi & Thurnher 2006). This section provides a comparison of performance measures (time, click, and efficiency) in different locations (lab/field). As reported in the previous section, we evaluated (a) the required time for scenario completion, (b) the number of clicks to finish the task, and (c) the average time per click, i.e. the efficiency. Table 6 presents mean value and standard deviation of the scenario execution time. We observed advantages regarding the field setting for scenario 1 and 2, but not for scenario 3. Nevertheless, we did not observe any significant differences between both groups (lab and field) for all scenarios.

No of clicks		Lab		Field	
	Ref. Path	Mean	Std.Dev	Mean	Std.Dev.
Scenario 1	171	572.7	257.68	459.8	177.77
Scenario 2	286	752.2	386.32	710.4	279.73
Scenario 3	137	450.6	353.96	453.6	208.97

Table 6: Scenario Execution Time per Scenario and Execution Location.

Regarding the number of clicks for scenario completion we observe a similar behavior compared to the time evaluation. We observe advantages regarding the number of clicks for all scenarios in the field, i.e., they require less clicks to complete the scenario successfully. Table 7 presents the details of this evaluation. Additionally, we did not observe any significant differences between lab and field setting.

No of clicks		Lab		Field	
	Ref. Path	Mean	Std.Dev	Mean	Std.Dev.
Scenario 1	9	11.6	1.21	11.1	1.41
Scenario 2	12	13.9	2.98	13.0	1.35
Scenario 3	11	12.5	2.02	12.0	1.60

Table 7: Number of Clicks per Scenario and Execution Location.

Regarding efficiency, we observed advantages for the field setting (S1) and for the laboratory setting in S2 and S3. Addtionally, we did not observe any significant differences (95% Mann-Whitney Test) between lab and field setting. Table 8 provides mean and standard deviation of this evaluation.

Efficiency		Lab		Field	
	Ref. Path	Mean	Std.Dev	Mean	Std.Dev.
Scenario 1	19	49.3	19.74	40.9	12.79
Scenario 2	15.5	51.8	16.98	53.8	16.08
Scenario 3	12.5	33.7	19.30	37.4	15.81

Table 8: Efficiency per Scenario and Execution Location.

6 DISCUSSION

This paper focuses on the empirical evaluation of scenarios for a mobile tool with respect to (a) different participant experience levels (low, medium and higher experienced participants) and (b) scenario execution location (lab and field setting). *Table 9* summarizes the results of the hypothesis.

Hypothesis	Confirmed	Partly confirmed	Not confirmed
H1.1: Low experiences participants need more time	X		
H1.2: Similar click rates for all experience classes		X	
H2.1: Completion time (Field) > completion time (Lab)			X
H2.2: Clicks (Field) > Clicks (Lab)		X	

Table 9: Overview of Hypothesis Results

H1.1) Low qualified participants needs significantly more time to solve a scenario than higher qualified participants. We expected that low qualified participants require significantly more time to solve a scenario, because they had to learn (a) how to handle the mobile tool and (b) how to solve the given scenarios within the application domain. On the other hand, higher experienced participants can focus on the solution of the scenarios (not on the mobile solution handling). Thus, we expect advantages for higher experienced participants. The results confirmed our expectations. We observed significant differences between low and high experienced participants in all scenarios. Therefore, the results confirmed H1.1. The second expectation, that all participants are within an acceptable execution time range, (see *Table 1*) was not fulfilled. Low experienced participants were in unacceptable time ranges; medium and higher experienced participants were in an acceptable/excellent time range. These findings indicate that mobile tools require basic experiences and are not applicable out of the box by inexperienced end-users.

H1.2) All participants need a similar number of clicks to solve the scenarios. We did not expect any significant differences regarding the number of clicks (process of scenario completion) for all experience classes. The main reason for this expectation is the active guidance through the mobile tool implementation including a clearly and well-defined sequence of steps through the scenario execution and simple track-back mechanisms (for end users) in case of errors. The results showed that all experience classes are at least in an acceptable click range in all scenarios. Furthermore, we observed significant differences between low and high experienced participants in more complex scenarios (S2 and S3). Following these results, our expectation that all participants require similar number of clicks was fulfilled for simple scenarios but not for more complex scenarios.

H2.1) The time for scenario completion will be higher within the field environment. We expected advantages regarding the lab environments because of less distraction of participants through e.g., noise and motion. Thus, participants should require significantly less time in a laboratory setting. However, the results showed advantages for the field setting in scenario 1 and 2, i.e., participants needed less time to complete the scenarios in the field; additionally, we observed similar execution duration for scenario 3. Furthermore, we did not observe any significant differences between the field and lab setting. The results do not support our assumption. One possible explanation might be that the participants are more concentrated on scenario completion, trying to finish faster (because of the disturbing environment), while the lab participants are more relaxed and grant themselves more time (see also Baillie & Schatz 2005).

H2.2) The number of clicks in laboratory setting is lower than the number of clicks in the field. Following the previous hypothesis, we expect a higher number of clicks of the participants in the field because of environmental reasons (e.g., noise and motion). We observed advantages (i.e., less clicks) in the field but we did not observe any significant differences between lab and field. The reason might be similar to H2.1.

7 CONCLUSION AND FURTHER WORK

The aim of the paper was to investigate (a) the impact of different experience levels (RQ1) and (b) the impact of scenario execution location (RQ2) with respect to scenario execution performance (time, number of clicks and efficiency). Focussing on different experience levels, the results showed that all participants need more time in comparison with the reference path (i.e., scenario completion time provided by experts). Nevertheless, low qualified participants required significantly more time to solve the given scenarios and completed the scenarios in an unacceptable time frame. Concerning the number of clicks all participants are within an acceptable range. These findings indicate that there are two time-consuming problems in handling mobile tools/devices: (a) the participants (mostly lower experienced participants) have to get familiar with the tool/device itself (and the interaction elements) and (b) all participants have to understand and proceed with the given scenarios. There are similar results on the number of clicks; thus, there seems to be no problem concerning the workflow of the mobile tool. A second interesting finding of this experiment addresses the location of scenario execution as there are no significant differences between the laboratory and field setting. Despite this, the results indicate that scenario execution within a field setting provide advantages concerning the number of clicks. As a consequence, application and introduction of mobile tools requires a minimum set of experience (training) with these techniques to achieve business process improvement by introducing mobile tools in business process workflows. Part of our future work will be to investigate training methods for different experience groups and validate the findings of this experiment in varying industry contexts.

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