(Re-) Evaluating User Interface Aspects in ERP Systems
- An Empirical User Study –

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Abstract

In recent years, several user studies have examined specific usability problems in the field of Enterprise Resource Planning (ERP). These studies focused on different branches, various usability aspects, and several user groups. In spite of this diversification, some common and essential usability problems have become apparent, which are related to system complexity and difficulties in finding required information. Although these results revealed essential shortcomings in ERP usability, they date back up to 2005 and comprised only individual ERP systems in specific branches with small user groups. Therefore, this paper first addresses the question of whether the identified usability problems are still present today. Second, it extends the research focus to additional considerations, such as the role of menu type, uncertainty in system usage or the support in problem situations. The results are based upon a broad survey sample of 184 ERP users from small and medium-sized enterprises.

1. Introduction

Research in the field of Enterprise Resource Planning (ERP) has primarily focused on technologies and algorithms to keep up with a steadily increasing complexity of business processes and volatile market needs. [1], [2] In contrast, research concerning the explicit human-computer interaction in ERP is available, but obviously less considered. The few studies available addressed mostly "external user factors" such as the participation of users in the implementation process, top management support, self-efficacy or perceived usefulness of the system (i.e. [3], [4]). In consequence, usability and user aspects have been mostly examined from an abstract point of view. Only few user studies also incorporated the investigation of usability barriers which are immediately located in the graphical user interface (i.e. [5], [6]). Their findings revealed important deficiencies such as the overall system complexity, problems in the

identification of required functionality, and shortcomings in the visual appearance of the UI (see section 2). Due to the insufficient and quite abstract research in ERP over the past years, it is still unclear what constitutes a usable and intuitive ERP interface today.

As some of the UI-related findings date back up to 2005, it seems to be appropriate to re-evaluate their results and to investigate to what extent they are still valid today. In particular, the studies from Topi et al., 2005 [5] and Singh & Wesson, 2009 [6] build an elementary basis for this first main focus in our paper. In addition to re-evaluating general usability problems already identified, the second main focus is set on the investigation of their potential causes related to the UI.

The following four sections discuss these two emphases in more detail. First, our overview of related work presents the findings in the field of usability research in ERP systems within the past years. Second, the research methodology of our user study is presented including the survey techniques used and their limitations with respect to validity. Third, the survey results are discussed, including the involved ERP systems, enterprises, and users. The main focus on usability problems examines the user's ERP system assessment according to complexity, visualization capabilities, the presented level of detail and the amount of information. These ratings are briefly compared to the ratings of the same aspects of supplementary software (e.g. spreadsheet applications), emphasizing the importance of the current usability debate. Furthermore, this section presents an analysis of the user's uncertainty in system usage, comprising knowledge about the process, the ability to identify required functions and the awareness of the resulting consequences. In addition, we investigate how ERP systems support the user in problem situations and in what way this affects the overall system assessment. Fourth, the findings are summarized with regard to the limitations of the present study and an outline of our future work is provided.

2. Related work

User satisfaction is often referred to as one of the main user-centered critical success factors (CSF) of an ERP system [7]. However, the definitions of user satisfaction are manifold and the influencing aspects vary widely from organizational to user aspects [8]–[10]. In this section, several interpretations of the term *user satisfaction* are discussed with a special attention to the phase of ERP selection and the phase of ERP usage.

2.1. User satisfaction in ERP selection

The term *user satisfaction* is often found in ERP market surveys. This type of survey benchmarks available (and mostly commercial) products to support the selection of an ERP system according to several criteria. Whereas "functionality is still the most important selection criterion" for an ERP system [11], user-centered factors are parenthetically summarized in the aspect of *ergonomics*. This ergonomic criterion is ranked fifth in the list of selection criteria, whereas it is not even mentioned in the list of reasons for implementing a new ERP installation [11].

An organizational perspective on the term user satisfaction can be found when it comes to the implementation of an ERP system [9]. Next to user-centered factors, such as self-efficacy, experience, and perceived usefulness [4], also the corporate culture [12], top management support [3], position in organizational hierarchy, and user participation in the implementation process [8] are just as well considered to influence user satisfaction. Conversely, user interface aspects such as the interface complexity are not explicitly declared as a factor that has an impact on user satisfaction.

2.2. User satisfaction in ERP usage

Concerning the daily system usage, UI-related aspects are also discussed. Additionally to the aspects stated above, the definition of *user satisfaction* is now extended by dimensions such as navigation, user guidance, visual factors, minimal memory load, and learnability [13], [14]. However, most of this research measured "attitudes rather than use of the ERP" [15]. As a consequence, Parks proclaims the need for practical user tests in addition to the well-established, model-based approaches. Furthermore, she highlights the importance of well-designed enterprise interfaces as miskeyed data might decrease the enterprise performance significantly (e.g. unrealized production targets or incorrect orders). Her user study with an exemplary inventory use case with 38 participants investigated the impact of UI complexity on task time and success. The results showed, that "complexity was a significant variable only for time spent working on the task, not success" [15].

In 2005, Topi et al. interviewed ERP users to identify critical deficiencies in their system usage [5]. Although the results originate from an interview session with just ten participants, they revealed concrete UI deficiencies, which hamper the user-system interaction. Major difficulties existed in the identification of and the access to the right functionality, support in transaction execution, system output limitations, terminology, and finally the overall system complexity.

With the aim of identifying heuristics for assessing ERP usability, Singh & Wesson summarized and classified many of the common usability criteria found in research literature. Their findings originate from a heuristic evaluation with three usability experts and comprised the major heuristics: navigation, learnability, task support, presentation, and customization [6]. Examples for potential usability issues assigned to the heuristic of navigation are "Information is not easy to find" and "There is no form of guidance within the system to aid the user when completing a business process." Examples for usability problems assigned to the heuristic of presentation are "Visual layout is too complex", "Output is not easy to understand and interpret" and "The UI of the system is not very intuitive."

The potentials of qualitative studies in usability research on ERP are also part of the work of Scholtz et al. [16] This work is based on the five ERP heuristics as introduced by Singh & Wesson. A complementary, three-part approach was used, including a case study, an interview, and a diary. These techniques were applied to validate the results from Singh & Wesson in a quantitative manner and to obtain comprehensive information about a user's behavior. With a focus on the heuristics of navigation and presentation the results stated major problems in "finding functions in the menu", "struggling to search for […] details" and "information overload". Thus, the results conform to the findings presented above.

2.3. Motivation and limitation

Research on visual interfaces [17] and usability methods [18], [19] in general has examined typical usability problems in ERP. However, this research is often limited to large systems such as SAP [6], [16] and to comparisons with Microsoft Navision [19] or PeopleSoft [20]. In contrast, ERP systems for small and medium-sized enterprises are rarely addressed in

current research, which primarily focuses on methods. New design approaches, the application of different interface technologies, and their impact on the usability of ERP systems have not been sufficiently considered so far.

In particular, the research described in the preceding section stated concrete usability problems found in ERP within the past seven years. Although these four evaluations range from 2005 to 2012 and have been completely different in terms of the scientific approach, the considered ERP system, the number and experience of participants, and the use case, they have identified similar and primary UI-related deficiencies. Nevertheless, the informative value of each single contribution is limited due to the evaluation of a single ERP system in a specific scenario with small user groups (cf. table 1).

As a consequence, our research approach comprises various systems and branches and a larger user group. To gain deeper insights into UI- specific aspects, a survey was conducted to re-evaluate the identified shortcomings and which extends the focus to the user interface in ERP. It investigates selected aspects of the usability issues discussed before (namely *complexity* and *identification*) and examines their presence today on a larger data sample. In particular, this survey also provides a first evaluation of potential approaches to overcome these barriers. The survey methodology, its limitations and the findings are explained in more detail in the following sections 3 and 4.

3. Research objective and methodology

Aiming for a broad survey sample and a variety of research questions, this survey investigates concrete causes of the usability problems discussed in section 2 and is explicitly focused on UI aspects.

The survey was conceived as an online questionnaire, comprising small and medium- sized enterprises across Germany in a period of ten weeks (from March to May 2013). The initial data acquisition for the identification and contacting of potential participants was based on an official enterprise information database service. The companies have been selected on the basis of the company size (micro, small, and medium-sized enterprises), branch (manufacturing; wholesale and retail trade; transportation and storage; information and communication; financial and insurance activities; professional, scientific and technical activities; administrative and support service activities; other

Table 1. User studies focusing on user interface aspects in ERP usability

Author(s)	Year	Data sample	Methodology	System	Main aspects
Topi et al. [5]	2005	9 users 1 non-user	in-depth interviews; semi-structured	unknown ERP (confidential)	• identification and access to information • transaction execution • system output • error support • terminology • system complexity
Singh & Wesson [6]	2009	3 experts	literature review; heuristic evaluation	SAP Business One	• navigation • presentation • task support • learnability • customization
Scholtz et al. [16]	2010	21 users (students)	user study with questionnaires and diaries	SAP R/3	• navigation • presentation • task support • learnability • customization
Parks [15]	2012	38 users	user study with talk-aloud and measurements	PeopleSoft	• UI complexity • task success • task time

Table 2. Overview of the sections in the questionnaire and the extract presented in this paper

Company	ERP system	Usability	Participant
• number of employees • branch • regional activities	• *availability of ERP* • vendor and name • *year of implementation* • customizations • *supplementary software* • reasons for not using an ERP • supported divisions	• *menu types* • *process knowledge* [5] • *consequence awareness* [5] • *identification of functionality* [5] • *ERP assessment* [6] • *supplementary SW assessment* [6] • *approach evaluation* [6] • transaction execution • search functionality • system access • mobile devices and (enterprise) usage	• *position* • age • gender • years in company • years of ERP experience • private use of (mobile) devices

[5] five-point ordinal Likert scale   [6] six-point decentralized ordinal Likert scale   *italic*: presented in this paper

service activities), country, and availability of a contact option. Due to the resulting high number of 523,095 enterprises, a random sample of 5,000 companies was selected for each group of company size. Based on this subset, we conducted 2,500 phone calls during the period requesting participation and asking for a valid mail address, leading to 1,080 invitations via the online service. This procedure was complemented by invitations via newsletters and newsgroups of the target audience. A reminder was sent one week after the initial invitation. Finally, 277 responses could be used for the subsequent analysis.

The structure of the questionnaire comprised four sections to gather information about the company, the ERP system, the usability, and finally the participant (cf. table 2). The user's path through the online survey got adapted according to the position in the company, the availability of an ERP system, and the use of supplementary software. User paths ranged from 14 questions (no ERP system and no additional software present, employee user) to 24 questions (ERP system and additional software present, CEO/CIO user) with an average execution time of 11 minutes.

This broad scope of research questions implies several methodological shortcomings, by nature. For instance, the length of the questionnaire constitutes a limiting factor as users should not have to spend more than 15 minutes on answering the questions to minimize the abortion rate. As a consequence, the authors decided to rely on only one item per construct. This certainly poses a risk for the reliability of the results, but allows for the investigation of several aspects simultaneously.

Most of the assessment questions are using a five-point Likert scale. For the evaluation of statements which require a clear positioning of the user in means of agreement or denial, a six-point Likert scale was used. All questions also contained a "I don't know" option to avoid incorrect answers (i.e. misuse of the mid-value in five-point scales). Table 2 lists the aspects addressed in each section of the survey and their corresponding assessment scales.

4. Results

This section presents our findings to answer the questions about potential causes of current usability problems. The results comprise the assessment of the used ERP systems, the users' uncertainty in system usage, the support in problem situations and finally the evaluation of potential solutions to overcome the deficiencies. The following results include all participants, who had the specific question in their questionnaire and did not skip nor answer it with "I don't know".

4.1. Companies, ERP systems and users

From the total set of 277 companies providing answers, 66.43% are using an ERP system (184), which is the basis for subsequent analysis. 70.86% of them are medium-sized enterprises (50-250 employees), 24.57% are small enterprises (10-49 employees) and only 4.57% are micro-sized enterprises (less than 10 employees). The most frequently stated branches are production (52.30%), wholesale and retail

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trade (16.67%) and information and communication services (10.92%). The average age of the ERP systems is 8.6 years and varies between one and 23 years. A broad range of ERP vendors can be found, whereas SAP is the most prevalent system with 28.26%. ERP systems are used by participants holding different positions in their companies ranging from employees (38.51%) to department managers (42.53%) and CEOs or CIOs (18.97%).

4.2. ERP system assessment results

A first emphasis of our survey is derived from the usability problems identified in recent literature (cf. section 2.2). It is dedicated to the user's evaluation of the ERP system according to the statements presented in table 3. These items cover the support in error situations (1), the overall system complexity (2), the amount and level of detail of information (3), the availability of visualizations (4) and the confusion caused by simultaneously opened windows (5).

The participants were asked to evaluate the five statements shown in table 3 on a six-point, decentralized Likert scale ranging from "1 – I totally agree" to "6 – I totally disagree". The results indicate that users are facing only medium to minor problems in all of the criteria considered (see table 3). In contrast to our prediction derived from the related work, overall system complexity (see table 3, no.2) seems not to be a major concern as it is rated with 4.01 on average. However, system complexity is significantly related to the perceived abundance of information and its level of detail (table 3, no. 3) ($r = .632$, $p < .001$). Moreover,

the availability of numerous and useful visualizations (table3, no. 4) improves the user rating of system complexity ($r = -.312$, $p < .001$). The presence of multiple application windows, which are simultaneously opened (item no. 5), is not a serious barrier for most users, as it is rated with 4.42 on average. However, it positively correlates with the users' assessment of ERP system complexity ($r = .300$, $p < .001$). The availability of useful and numerous visualizations (table 3, no. 4) is rated with 3.86 and requires further improvements – especially as this item has an impact on system complexity.

For the purpose of a better interpretation of these results, a comparison with supplementary applications might be helpful. As the utilization of additional software has been observed in all participating enterprises, we compared their results with those from ERP systems and on the same evaluation basis (cf. table 3). Supplementary software, i.e. spreadsheet applications, is employed for reasons such as increasing flexibility or extending the ERP system by specific functionality. The participants reported to use two additional applications on average. Spreadsheet software (e.g., Microsoft Excel) is the most commonly used (N = 174, 95.83 %), followed by self-developed applications (N = 174, 55.95%).

The ERP system and the supplementary software correlate highly significantly in their ratings of items 2, 3, and 5 (all $r > .36$ and $p < .001$, 136 < N < 140). In addition, an analysis of variance (ANOVA) exposed differences in the rating of ERP and supplementary application in items 2, 3, and 4 ($F(4,448) = 21.53$, $p < .001$). On the one hand, users are facing a higher level

Table 3. ERP system and supplementary application (SA) assessment, N = 123

	item (statement)	polarity	ERP		SA	
			M	SD	M	SD
1	My ERP system offers a wide range of support functionality to deal with problems (e.g., explain causes, offer solutions and assistance).	+	3.40	1.35	3.35	1.39
2	My ERP system is very complex, which often makes me feel lost.	-	4.01	1.35	4.55	1.02
3	The amount of information and given details is way too high for my needs.	-	4.19	1.31	4.61	1.05
4	My ERP system offers numerous and useful visualizations, which I can choose myself (e.g., tables, diagrams, dashboards, organigrams...).	+	3.68	1.46	2.59	1.20
5	When having opened many application windows simultaneously, I feel hindered or overstrained.	-	4.42	1.26	4.50	1.19

Mean values based on a six-point decentralized ordinal Likert scale from "1 – I totally agree" to "6 –I totally disagree"

of complexity as well as a higher amount and detail of information in their ERP system (items no. 2 and 3, $p <$ .001). On the other hand, supplementary applications provide more useful visualizations compared to ERP systems (item no. 4, $p <$ .001). The aspect of support in problem situations and the aspect of simultaneously opened windows (items no. 1 and 5) are rated similarly in ERP and supplementary system (both $p >$ .5).

Finally, these results indicate that ERP systems still have some deficiencies, which should be addressed in future work to keep up with additionally used software in terms of an easy-to-use interface.

4.3. Uncertainty in system usage

Identification of required ERP functionality and subsequent access to it is an essential task in ERP system usage, but remains a major challenge. [5], [6] To be able to execute a transaction appropriately, users need to possess the knowledge about the business process itself, need to identify and access the required functionality in the user interface, and also have to be aware of the consequences when committing a transaction. These three aspects form our definition of *certainty in system usage*. The participants were asked to evaluate, how often they experience difficulties in these three aspects on a five-point Likert scale from "1 – never" to "5 – always" (figure 1). The findings revealed that users do not primarily suffer from a lack of process knowledge (N = 150, M = 1.93, SD = .95) or an insufficient awareness of their action's consequences (N = 147, M = 1.99, SD = .91).
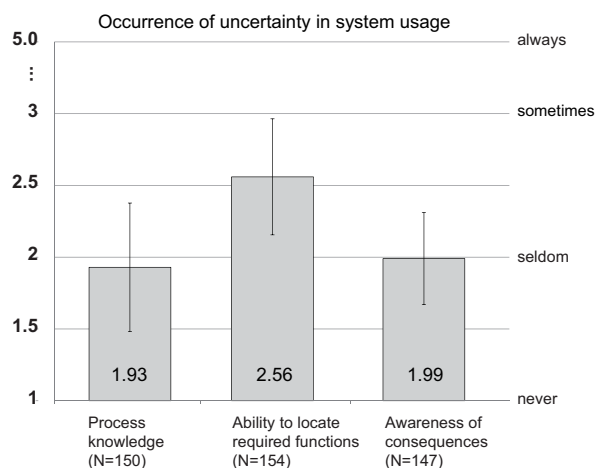

Figure 1. Mean values and standard deviations of uncertainty in system usage on a five-point Likert scale (1 - "never" to 5 – "always")

Hence, it can be concluded that users basically know what to do, but not necessarily where to find it. Surprisingly, this observation is not related to the

user's years of employment in the company or to his or her general experience with ERP systems in years (N = 135, all $|r| <$ .12, all p > .18). Therefore, the ability to locate desired enterprise functionality remains a general usability problem across different levels of experience.

An unhampered access to business functionality and the subsequent navigation through the system are fundamental requirements for working with ERP systems [20]. However, navigation and finding information are well-known problems especially in ERP [5], [13]. Bishu et al. pointed out that "from a user viewpoint [...] the system itself is a maze of screens navigable through a series of hierarchical menus" [21].

As menus are the most commonly used interface element to structure and access functionality, we hypothesize that the menu type has an impact on the assessment of ERP system complexity and especially the ability to locate functions. Due to the diversity of menu types, we further assume that some menus are more appropriate to locate required functions than others.

To investigate a menu's impact on the ability to locate desired functions, we analyzed particular menu types and the subjective experience of difficulties in accessing relevant functionality. For that purpose, we presented six commonly used menu types to the participants and asked them to identify those types available in their ERP system. The choices are illustrated in figure 2 and seem to be almost exhaustive, as only four users stated to work with a different menu type. Although standard ERP UIs might provide a variety of menus in general, the survey revealed that users are limited to two or three different menu types per system on average.

For the analysis of differences in the menu types with regards to the ability to locate functions, we computed t-tests comparing the mean ratings of users and non-users of each menu type.

The user group with tree menus (cf. figure 2, no. 4) rates the location ability quite worse with just 2.66 on average (N = 107, SD = .82) in contrast to non-users with 2.28 (N = 40, SD = .68). The t-test revealed that this observation is a significant difference ($t(145) = -2.66, p = .009$). The user group with context menus (cf. figure 2, no. 5), evaluates its identification ability quite good with 2.33 on average (N = 51, SD = .84), whereas non-users of context menus rate this aspect with just 2.68 on average (N = 96, SD = .76). This finding is also significant in the t-test ($t(145) = 2.51, p = .013$). For the remaining menu types, the results of the t-test revealed no significant difference between the ratings of users and non-users (all $|t| <$ 1.6, all $p >$ .1). Hence, it can be concluded, that the better rated context menu
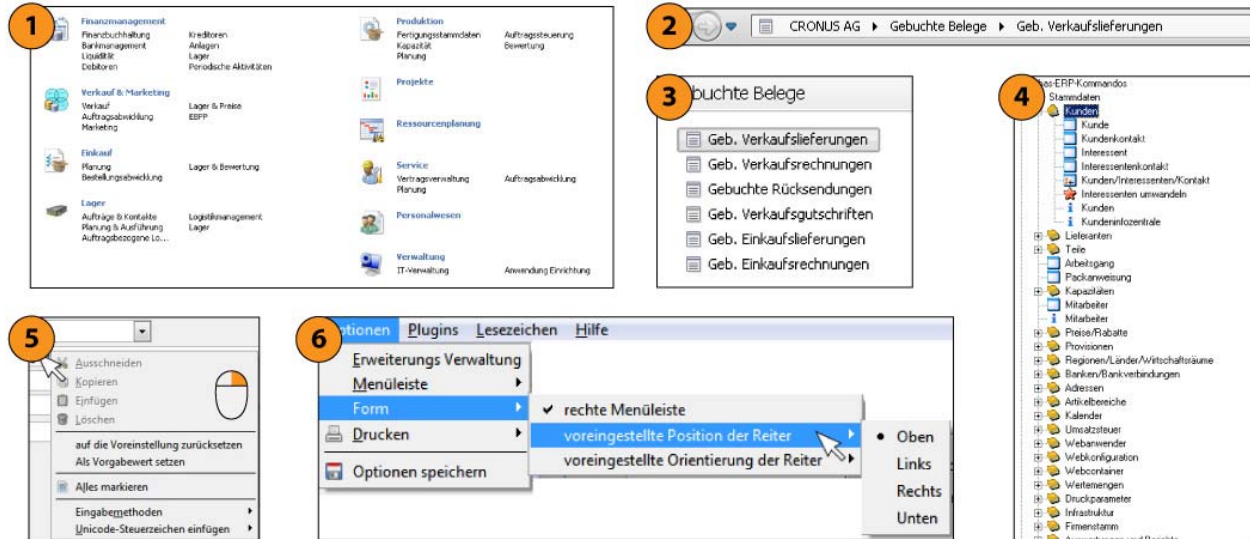
Figure 2. Presented menu types: directory (1), breadcrumb (2), list (3), tree (4), context (5), main (6)

(2.33) is more appropriate to locate required functions than the worse rated tree menu (2.66).

A hypothetical reason for this finding might be the high number of functions contained in most tree menus, whereas context menus usually present only a context-dependent subset. However, the dissemination rates indicate that the low rated tree menu is more often present (73.33%) than the better rated context menu (34.00%).

4.4 Support in problem situations

An error-tolerant ERP system assists the user by providing information about the problem, recommendations to solve it, prevents the occurrence of errors and gives feedback about possible corrections. In addition, it should also be understandable for users, but obscure codes are very often contained in the error message. This is a typical problem with ERP systems as described in [5], [22].

Mechanisms to prevent errors in ERP already exist, such as the utilization of a context-sensitive help [23]. The system provides help on the interface component the user is currently working with, but often contextual information depending on organizational, user's, and task's behavior is missing [22], [23]. As pointed out by Topi et al., "some of the most significant and most commonly mentioned difficulties with using the system were caused by insufficient or misleading error messages" [5]. The user ends up in a trouble situation where he or she is unable to use the system and to achieve the goals. As a result, the more frequent occurrence of error situations has an impact on user satisfaction [24]. The authors hypothesize that the

users' evaluation of the error support has an impact on the evaluation of overall system complexity.

The ratings of problem support (cf. table 3, no. 1) reveal a significant, negative correlation with the degree of feeling overwhelmed by the ERP system's complexity (no. 2): the better users rate their support received in problem situations, the less they feel lost. (N = 145, r = -.42, p < .001). In addition, the better users rate the support, the more awareness about their actions' consequences they state to possess (N = 142, r = .315, p < .001).

Especially novice users need assistance in their daily work with the ERP system. Occasional users need reminding and experienced users often do not require a support mechanism at all. In consequence, the authors predicted that users with less experience in working with ERP systems rate the error support more negatively.

The survey revealed that support in error situations is not related to the user's years of employment in the company or to his or her general ERP usage in years. Conversely, the support ratings correlate positively with a user's subjective assessment of his or her experience in ERP usage (N = 136, r = .27, p < .001). The better users rated their subjective experience, the more satisfied they have been with the problem support offered.

4.5 Approach evaluation

The preceding sections investigated usability problems in current ERP systems based on prior research. Furthermore, their potential causes have been examined by additional and UI-related research questions about menu types or support in problem

situations, for example. The following section is dedicated to the evaluation of potential approaches, which might be appropriate to solve some of the identified deficiencies.

As stated in [25], current ERP interfaces are often still dealing with UI concepts, which have been introduced in the 1990s. To mitigate at least some of the examined shortcomings, the authors suggest applying innovative interface concepts whenever the scenario permits it. First, such approaches should rely on visually rich interfaces. "In general, since data in ERP systems is highly structured, it lends itself to be presented better graphically." [17] Second, they should additionally employ direct-manipulative interaction concepts, which have proven its benefits in numerous scenarios in the enterprise domain. [26] By offering an intuitive system usage, barriers which currently hamper the user-system-interaction might be decreased.

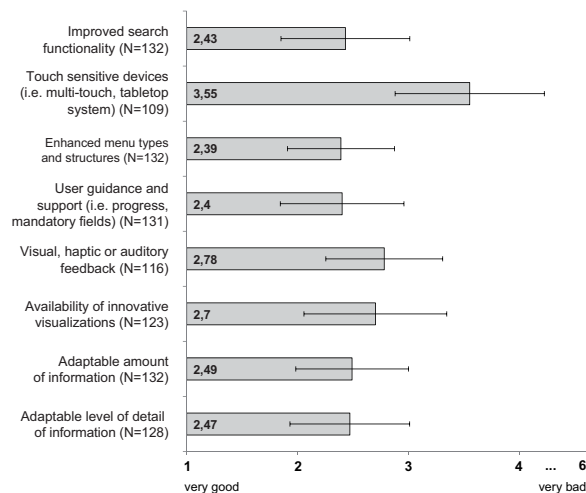„How do you evaluate the following approaches to handle problems in ERP system usage?"

Figure 3. Mean values and standard deviations for approaches to ease the system usage (six-point Likert scale from "1 – very good" to "6 – very bad")

Most users are already familiar with tablet devices, interactive screens and visually rich interfaces, so the application of these new interface paradigms in the ERP domain might already comply with their private life expectations.

However, the authors hypothesize that concepts such as touch-sensitive devices are not an ERP user's first choice, when being asked to identify potential concepts to improve ERP usability. The present user study offered eight general and quite abstract approaches to the participants for evaluation, which also contained the option "touch-sensitive devices

(e.g., multi-touch, tabletop system)" (cf. figure 3, no. 2). Despite the worst assessment of all presented approaches (N = 109, M = 3.55, SD = 1.33), this item also received the highest abstention, as 21.6% of the users answered with "I don't know". Thus it seems possible that the unfavorable ratings were at least partly caused by the unawareness of the term "touch sensitive devices", rather than being based on a rejection of the technology itself. To test this possibility, all users from the production domain got presented the mock-up illustrated in figure 4. The picture was supplemented by the italic description below:

The following concept supports the production planning and therefore utilizes
- *a tabletop system,*
- *top-view on machines or workbenches and their material flows,*
- *related and interactive Gantt charts.*

Every user input and selection will be enforced by direct touch or tangible objects (cf. red cubes in the right picture). Furthermore, a color scheme eases the readability. Please evaluate your first impression of the presented concept regarding its degree of innovation and the expected usefulness.

This concept received quite favorable ratings for its innovation (N = 58, M = 1.91, SD = .93) and usefulness (N = 58, M = 1.97, SD = 1.02) on a six-point ordinal scale ranging from "1 - very good" to "6 - very bad". This allows for the assumptions that the term itself might be unknown (high abstention), that users are unable to imagine concrete potentials of this technology in their domain (high abstention and low rating) or that they know the technology, but are sure to have no benefits out of it (low rating). Due to the briefly described mock-up, the findings are not able to verify the impact of multi-touch interaction in the production domain. Nevertheless, there seems to be a certain applicability of this paradigm, at least in the field of production planning (such as SCM and APS scenarios).

5. Summary and limitations

This paper presented an extract from our empirical user study on ERP usability and comprised a large sample of users to gain an initial overview of the problems they encounter. The research questions investigated concrete causes of the usability problems reported in the related work (section 2), but were also extended by additional issues.
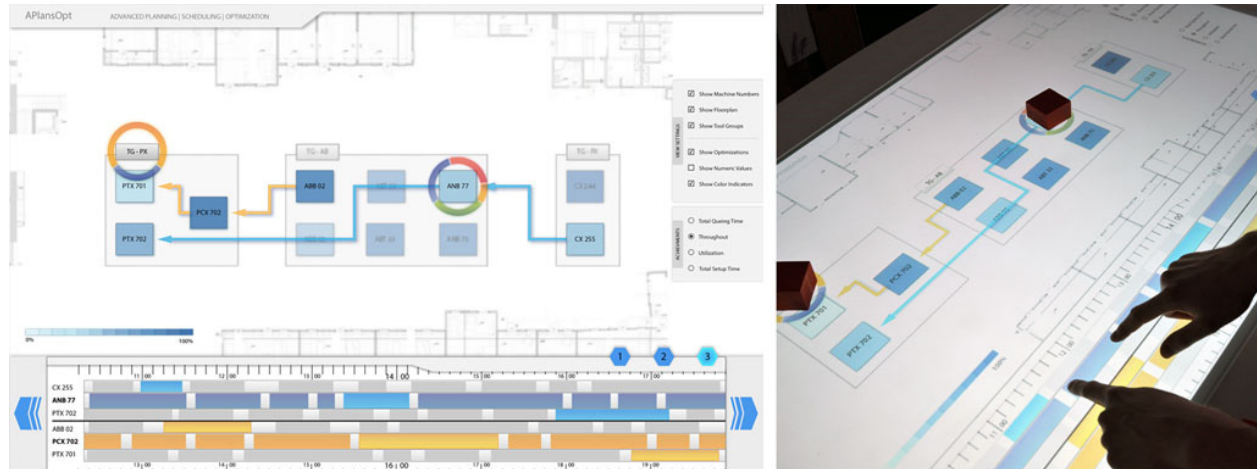
Figure 4. Mock-up of a planning and scheduling interface, which utilizes multi-touch and tangible interaction on a tabletop system in the production domain [30]

The findings of our first focus on ERP assessment stated that users are facing only medium to minor problems in their overall system usage. However, the comparison with supplementary software products constituted a higher level of complexity as well as a higher amount and detail of information in the ERP system. In contrast, supplementary applications provide more useful visualizations compared to ERP systems. The second focus on uncertainty in system usage identified that a user's assessment of locating required functionality in the ERP system is inferior to his or her process knowledge or the awareness of his or her action's consequences. To locate required functions, context menus seem to be slightly more appropriate than tree menus. Furthermore, the results demonstrate that the better users rate the support in problem situations, the less they feel lost and the more awareness about their actions' consequences they have. Summarizing, this survey demonstrated that usability problems, which have been identified in the past years, still exist today, but don't seem to be as critical as described in prior research. The analysis of the users' ratings of their ERP system compared to their supplementary system emphasizes that there are still some efforts required to achieve the vision of an easy-to-use ERP interface.

The contrary ratings of touch-sensitive devices on the one hand, and the industrial production scenario utilizing a tabletop system on the other, have illustrated that the application of new UI paradigms should be investigated in more detail as their benefits in ERP haven't been sufficiently considered yet. The correlation between the availability of numerous, useful visualizations and system complexity indicates that future ERP systems should further extend their visual capabilities, as also mentioned in [17].

Although this paper contributes pertinent findings to the field of ERP UI design, its reliability and validity is limited: The findings rely on one item per construct only and have not been validated with an independent sample so far. In addition, the findings base on the situation in German enterprises without distinguishing between requirements of different company sizes.

Next to the improvement of the validity and reliability, our future work will address further research questions, such as the influence of private (mobile) IT usage on ERP assessment. This future work also focuses on a comparative evaluation of the situation in several European countries, to determine regional differences and finally, gain a European-wide insight on usability aspects in ERP interface design.

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