COMMONALITIES AND CONTRASTS: AN INVESTIGATION OF ERP USABILITY IN A COMPARATIVE USER STUDY

Complete Research

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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. However, these findings are based on the situation in a specific country, a singular ERP system and few data samples. Therefore, this paper aims at complementing the related work by results from a comparative user survey from two different European countries: Germany and Latvia. The survey is based on 184 ERP users from Germany and 24 ERP users from Latvia. The results indicated that both countries have several contrasts, but also diverse commonalities in industry, ERP market and culture. However, users in both countries are very homogenous with regard to the assessment of usability problems in their ERP interfaces. This paper investigates elementary usability problems derived from the related work and examines to which extent they are valid in both countries today. The main hypothesis claims that diverse national characteristics do not necessarily lead to a different assessment of usability problems in ERP systems.

Keywords: Enterprise Resource Planning, ERP, usability, user interface, human-computer interaction

1 Introduction

Research concerning the explicit human–computer interaction in ERP is available but is considered to a lesser degree than technological considerations (such as (Seth et al., 2011; Ragusa and Puliafito, 2011)). The few studies available have 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 (e.g., (Bin et al., 2010; Mitakos et al., 2011)). As a consequence, usability and user aspects have been examined mostly from an abstract point of view and have rarely addressed the user interface (UI). Only a few user studies have also incorporated the investigation of usability barriers that are directly related to the UI (e.g., (Topi et al., 2005; Singh and Wesson, 2009)). Nevertheless, their findings revealed important deficiencies, such as 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 the field of ERP usability over the past 10 years, it is still unclear what constitutes a usable and intuitive ERP interface today. The aim of this paper is to investigate to what extent users in different European countries encounter

the same usability problems, although their contexts are different. Latvia and Germany were chosen as exemplary representatives as they have significant differences in geographic dimensions, in population, and in number of enterprises.

The studies from Topi et al. (2005) and Singh and Wesson (2009) build an elementary foundation for this paper, which considers their findings with respect to the situations in Latvia and Germany. Special attention is given to the comparative analysis of ERP usability aspects. To determine the national commonalities and contrasts between both countries, this paper compares their industries, ERP markets and cultures (cf. section 3). Deduced from the commonly identified usability problems in the related work, the authors assume that the results of the Latvian and German surveys might be quite similar, although their characteristics are somewhat different in terms of ERP market, culture and industry. With the help of the survey results in both countries, the following research questions will be answered in a comparative manner:

1 How do users evaluate their ERP systems in terms of usability?

2 Which UI-related aspects have a significant impact on ERP usability?

3 How does the identification task relate to uncertainty in system usage?

4 Which approaches are preferred by users to alleviate current usability problems?

The following sections discuss these research questions in more detail and are consequently focused on the context of Latvia and Germany. First, an overview of the related work presents the findings in the field of usability in ERP systems within the past 10 years. Second, an introduction to the characteristics of the two participating countries is given. Although this section describes and compares both countries also in their cultural dimensions, it is not the primary emphasis of this paper to determine the impact of culture on ERP usability. The comparison of both countries in terms of ERP market, industry and culture rather serves as a foundation for appropriate interpretation of the survey results. Third, the research methodology of our user study is presented, including the survey techniques employed. Fourth, the survey results are discussed, including the involved ERP systems, enterprises, and users. The main focus on usability problems examines the users' ERP system assessments according to complexity, visualization capabilities, level of detail, and amount of information. Furthermore, this section also presents an analysis of the users' uncertainty in system usage. In addition, we investigate how different approaches might help to enhance system usage from a user's point of view. Fifth, the findings are summarized and followed by a conclusion with regard to the limitations of the present study.

2 Related Work

Current ERP systems suffer from numerous usability problems in general (Bishu et al., 2001). As a result, the term "usability" is not often associated with ERP systems from a user's point of view. These systems are typically complex applications that are frustrating to use (Bevan and Macleod, 1994). Concerning the user interface, limited user satisfaction is caused, at least partially, by implementing complex business processes and designing too-general user interfaces that are targeted for multiple industries simultaneously (Parks, 2012; Bishu et al., 2001).

Although interface-specific usability aspects are not widely discussed in the field of ERP, few contributions have investigated important UI factors such as navigation, user guidance, visual factors, minimal memory load, and learnability (Calisir and Calisir, 2004; Ozen and Basoglu, 2006). However, most of this research has measured "attitudes rather than use of the ERP" (Parks, 2012). As a consequence, Parks (2012) 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 incorrectly keyed data might decrease the enterprise performance significantly (e.g., unrealized production targets or incorrect orders). Her user study, with an exemplary inventory use case that includes 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" (Parks, 2012).

In 2005, Topi et al. interviewed ERP users to identify critical deficiencies in their system usage (Topi et al., 2005). Although the results were based on an interview session with just 10 participants, they revealed concrete UI deficiencies that hamper user system interaction. Major difficulties existed in the identification of and 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 and Wesson summarized and classified many of the common usability criteria found in research literature. Their findings originated from a heuristic evaluation with three usability experts and included the major heuristics: navigation, learnability, task support, presentation, and customization (Singh and Wesson, 2009). 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 potential of qualitative studies in usability research on ERP is also part of the work of Scholtz et al. (2010). This work is based on the five ERP heuristics as introduced by Singh and Wesson (2009). 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 and Wesson in a quantitative manner and to obtain comprehensive information about a user's behaviour. With a focus on the heuristics of navigation and presentation, the results noted major problems in "finding functions in the menu," "struggling to search for […] details," and "information overload" (Scholtz et al., 2010). Thus, the results conform to the findings presented above (see table 1).

Author(s)	Year	Sample size	Methodology	System	Main aspects
Topi et al.	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	2009	3 experts	literature review; heuristic evaluation	SAP Business One	navigation presentation task support learnability customization
Scholtz et al.	2010	21 users (students)	user study with questionnaires and diaries	SAP R/3	navigation presentation task support learnability customization
Parks	2012	38 users	user study with talk-aloud and measurements	PeopleSoft	UI complexity task success task time

Table 1. Related work focusing on user interface problems in ERP usability

Research on visual interfaces (Parush et al., 2007) and usability methods (Hornbæk, 2010; Vermeeren et al., 2010) in general has examined typical usability problems in ERP. However, this research is often limited to large-scale systems such as SAP (Singh and Wesson, 2009; Scholtz et al., 2010), Microsoft Navision (Vermeeren et al., 2010), or PeopleSoft (Scott, 2005). In contrast, ERP systems for small- and medium-sized enterprises are rarely addressed in current research, which focuses primarily 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 thus far. In particular, the research described in the preceding section stated concrete usability problems found in ERP within the past eight years. Although these four evaluations range from 2005 to 2012 and differ completely in terms of the scientific approach employed, 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 above).

3 Commonalities and Contrasts

The following sections present essential characteristics of both countries in terms of their industry, ERP market and culture. It seeks to determine to which extent the participating countries, Germany and Latvia, are having commonalities and contrasts. All data presented in this chapter has been acquired from external sources, such as statistical portals or reliable related work.

3.1 Industry

The Federal Republic of Germany achieved a gross domestic product (GDP) of 2,497.6 billion EUR in 2013. With 20.2 billion EUR in 2013, Latvia's GDP represents only a fractional amount, as it is smaller in its geographic dimensions, in its population, and finally, in its number of enterprises. The total number of companies in Latvia in the non-financial business economy is about 79,000 compared to 2.16 million companies in Germany. Whereas the percentage of micro, small, medium, and large enterprises is comparable in both countries, a company's turnover for each size group varies widely (see tables 2 and 3 below). While the group of large-sized enterprises with more than 250 employees represents about 52% of Germany's whole turnover, all company-size groups in Latvia contribute an approximately equal amount of 23% to 26% each. In consequence, the mean turnover per company for all size groups differs widely in both countries and is considerably higher for Germany than for Latvia.

Company size (no. of employees)	Quantity	in %	Turnover (in Mio. EUR)	in %	Mean turnover per company (in th EUR)
Micro (up to 10)	70,399	88.9	10,705.6	24.4	152.07
Small (10-49)	7,284	9.2	11,448.1	26.1	1,571.68
Medium (50-249)	1,368	1.7	11,411.8	26.0	8,341.96
Large (> 250)	192	0.2	10,226.5	23.5	53,263.02
Total	79,243	100	43,792	100	

Table 2. Latvia's business economy in quantity and turnover, 2011, Eurostat, NACE Rev. 2 classes B-J, L-N (Non-financial business economy)

Company size (no. of employees)	Quantity	in %	Turnover (in Mio. EUR)	in %	Mean turnover per company (in th EUR)
Micro (up to 10)	1,764,993	81.8	616,328.0	11.1	349.20
Small (10-49)	327,392	15.2	911,029.8	16.4	2,782.69
Medium (50-249)	55,169	2.5	1,149,613.0	20.6	20,838.03
Large (> 250)	10,541	0.5	2,892,100.9	51.9	274,366.84
Total	2,158,095	100	5,569,071.7	100	

Table 3. Germany's business economy in quantity and turnover, 2011, Eurostat, NACE Rev. 2 classes B-J, L-N (Non-financial business economy)

Although the industries of Latvia and Germany might differ in terms of their total numbers of companies, their GDP, and their mean turnover per company, they also have some similarities. First, the distribution of micro-, small-, medium-, and large-scale companies is comparable in both countries, as illustrated in tables 2 and 3, although the percentage of micro-sized enterprises is slightly higher in Latvia. Second, the distribution of companies located in the main business-sectors industry, services, construction, and agriculture are also comparable for Latvia and Germany (see figure 1, left). However, the percentage of the GDP gained in each business sector is slightly different: Whereas Germany has a higher percentage of companies in the industry sector, its percentage for agriculture is considerably lower than that of Latvia (see figure 1, right).

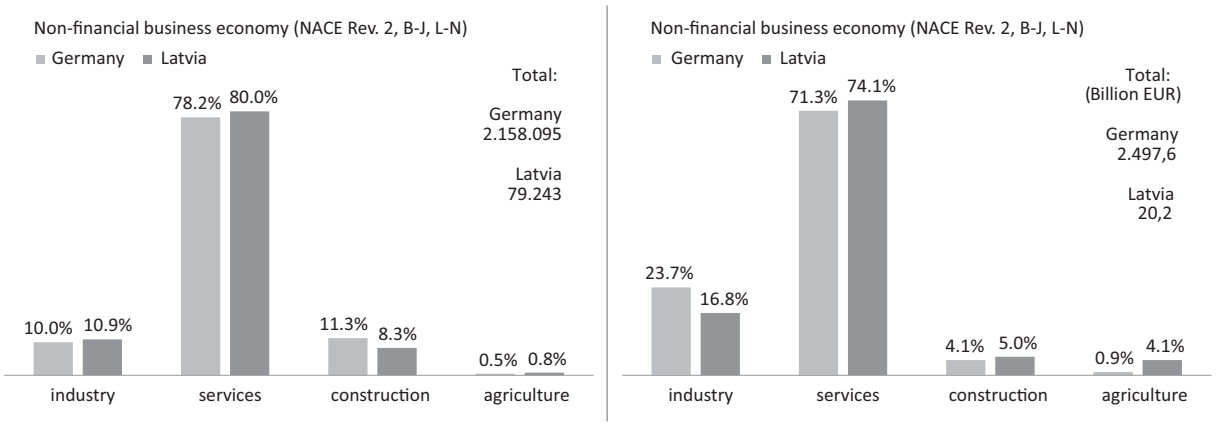

Figure 1. Percentage of companies (left) and GDP (right) in main branches in Latvia and Germany (Source: Eurostat, 2013, epp.eurostat.ec.europa.eu)

3.2 ERP market

The German ERP system market is characterized by a high diversification of ERP vendors as described in (Moller and Chaudhry, 2012). In 2010, approximately 300 (Winkelmann and Matzner, 2009) to 600 (Gronau, 2009) active ERP vendors were located in Germany. However, due to constant changes in the market, it is difficult to determine an accurate figure. The German ERP system market for large-scale enterprises is dominated by the world's market leader, SAP. Its market share in Germany is about 59.4%. However, the market for ERP systems for small- and medium-sized enterprises (SMEs) in Germany is far from being dominated by SAP to the extent that it is for large-scale enterprises. Many smaller vendors such as Sage, Abas, Asseco, or Exact share a leadership role with large companies such as Microsoft, SAP, and DATEV, and 60% of the SME market consists of several ERP vendors with less than 5% of the market share each.

The Latvian ERP system market is significantly smaller, and thus, exact numbers about its composition are difficult to determine. The estimated sales of ERP systems and related products in Latvia are about 11 to 14 million EUR per year (Pavuk, 2011). The annual revenues for the three to four biggest integrators are within 1.4 million EUR, whereas the remaining integrators' revenues are at about several tens of thousands of Euros per year. The costs for globally available, large-scale ERP systems, such as SAP, are inadequate for the majority of enterprises in Latvia. Compared to the low average turnover achieved by Latvian SMEs, these ERP systems are mainly used in enterprises that operate internationally (e.g., Procter & Gamble, Cemex) and in a few local large-scale enterprises. The rest of the SMEs employ light-weight ERP solutions or locally developed ERP systems.

3.3 Culture

Cultural context plays an important role in ERP system usage, but its quantitative measurement remains a challenge. Most of the current research is based on Hofstede's model of culture using the six dimensions *power distance*, *uncertainty avoidance*, *masculinity*, *individualism*, *long-term orientation*, and *indulgence* (Hofstede, 2010). Although this model is widely used, it has been highly discussed in research. In particular, McSweeney criticized the measurement methodology with its several shortcomings in terms of validity and argues that Hofstede is using "stories as proof" (McSweeney, 2002). In contrast, Jones mentions several arguments in support of Hofstede and concludes: "While the level of controversy surrounding this work is still quite high, it remains the most valuable piece of work on culture for both scholars and practitioners." (Jones, 2007) Following this argumentation, the cultural dimensions of Germany and Latvia are described below using Hofstede's results.

Hofstede categorises Germany and Latvia as typical Western countries. His results show that both countries have a low power distance (see figure 2, PDI). This implies a very direct and participative form of communication and a dislike of control (Agourram, 2009). Latvian culture is characterized by a sense of loyalty and deference towards authority and status among the older generation (Hofstede, 2013). Today's inhabitants are more focused on themselves than on the welfare of groups (IDV). Both nations have high scores in the uncertainty avoidance criteria (UAI) and low scores in long-term orientation (LTO).

Differences mainly exist in two criteria. Germany is a typically masculine country (MAS), where performance is highly valued and status is often demonstrated. In contrast, Latvia is an extremely feminine country. People are modest and more awkward about being praised. Germany is a country of high indulgence (IND); it stands for a society that allows relatively free gratification of basic and natural human drives related to enjoying life and having fun (Hofstede, 2011). In contrast, Latvia is a country with low indulgence.

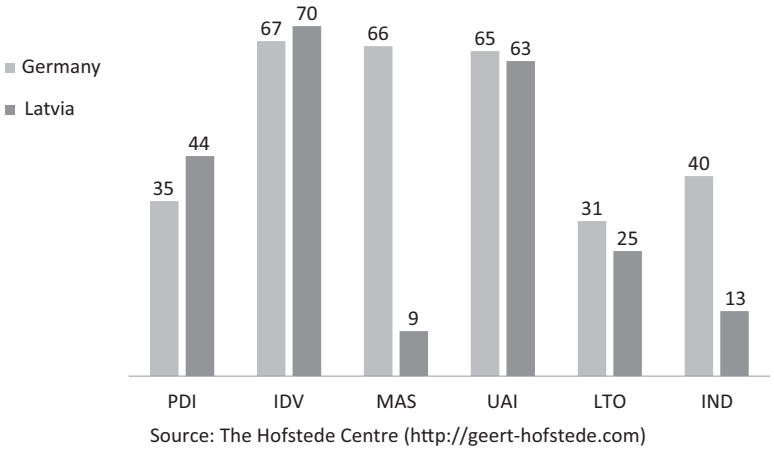

Figure 2. Cultural comparison of Latvia and Germany in scores

In their literature review, Leidner and Kayworth (2006) concluded that differences in culture result in differences in use and outcome of IT in general. In the scope of ERP, research is mainly focussed on critical success factors in implementation projects across different countries (Krumbholz and Maiden, 2000; Ngai *et al.*, 2008; Palomino Murcia and Whitley, 2007). Cultural dimensions affecting user satisfaction in ERP are rarely discussed (e.g. Kanthawongs and Kanthawongs, 2011).

3.4 Characteristics summary

The comparison of the countries described above identified some commonalities but also essential contrasts. These differences are primarily prominent in country dimensions, total numbers of companies, turnover, GDP and ERP system market composition. The structure of Latvian industry is profoundly characterized by a high percentage of micro- and small-sized enterprises and is slightly more focused on agriculture compared to German industry. A further major difference can be seen in the ERP market; this is highly branch-specific in Germany, which is somehow atypical for the Latvian market, which is based on smaller and regional ERP vendors. From a cultural point of view, the differences are especially prominent in the masculine and the indulgence criteria, whereas both countries are very similar in the other dimensions. In the following, the term "national characteristic" is defined as the industry, ERP market, and culture of a country as a whole. Based on the comparison of both nations discussed above, it can be summarized that at least two of the three criteria (namely industry and ERP market) are different, whereas the cultural criteria only differs in one third (masculine and indulgence). Although both countries are not completely polarized, the authors conclude that Latvia and Germany possess a certain and inherent difference in their national characteristics.

3.5 Hypotheses and Limitations

Due to differences in language (terminology, characters, abbreviations, or numbering systems), legal framework, or specificities such as the format of data entries (e.g., date, addresses), requirements for ERP systems are, in general, dependent on the country (Davison, 2002; Soh et al., 2000). Different requirements may lead to different assessments of ERP systems and to varying degrees of user satisfaction (Himmel et al., 2013).

Therefore, due to the different national characteristics of Germany and Latvia, it can be concluded that ERP system users in both countries might have different needs and might, therefore, experience different problems when using ERP systems. In contrast to this assumption, a lot of research has identified similar usability problems in the field of ERP, among these navigation, system access, system complexity, and insufficient support in error situations (see section 2). Even though the related work summarized in table 1 differ in terms of user groups, sample sizes, ERP systems, and year, they have identified similar usability problems. As an extension to these observations, the authors hypothesize that users in both countries encounter similar problems in the use of their ERP systems, without regard to national characteristics or other aspects, such as the system itself or the company size. This would imply that current usability problems in ERP interfaces are more general and only marginally influenced by factors such as the branch of industry, the ERP market, or the cultural context. Hence, the hypotheses of this paper are as follows:

H1 *"Users in SMEs in Germany and Latvia encounter similar problems in their ERP UI."*
H2 *"A visually rich interface is perceived as less complex by ERP users in Germany and Latvia."*
H3 *"Uncertainty in system usage is perceived equally by users in Germany and Latvia."*
H4 *"Approaches to overcoming ERP usability problems are being evaluated similarly by users in Germany and Latvia."*

The survey is not limited to a specific ERP system, user group or industry branch to allow a more general application of its results. However, the investigation of cultural dimensions has not been part of the questionnaire itself (e.g. implemented as a moderating variable), as the measurement of cultural

dimensions is highly controversial and not the exclusive emphasis of this research. Its importance for this survey is rather equivalent to the considerations on the ERP market or the industry of both countries and therefore constitutes an external basis for the interpretation of the survey results.

4 Methodology

The survey was composed as an online questionnaire for small- and medium-sized enterprises and was first conducted in Germany (Lambeck *et al.*, 2014) and afterwards in Latvia (both in 2013). The initial data acquisition of potential participants was based on a European enterprise information service (Bureau van Dijk, 2013). The companies were selected on the basis of their size (micro-, small-, and medium-sized enterprises), their branch (NACE Rev. 2, sections C,G,H,J,K,M,N,S), their country, and the availability of a contact option. Due to the resulting high number of 566,470 enterprises (523,095 in Germany and 43,375 in Latvia), a random sample was selected for each country. Based on this subset, the authors initially conducted phone calls requesting participation and asking for a valid and personalized email address. The positive contacts received an invitation via the online system. A reminder was sent one week after the initial invitation. Finally, a total of 324 responses, 277 from Germany and 65 from Latvia, were used for the subsequent analysis.

The structure of the questionnaire comprised four sections to gather information about the company, the ERP system, usability aspects, and finally, the participant. The user's path through the online survey was adapted according to position in the company, availability of an ERP system, and use of supplementary software. User paths ranged from 14 questions (no ERP system and no supplementary software present; employee user) to 24 questions (ERP system and supplementary software present; CEO/CIO user). Most of the assessment questions use a five-point Likert scale. For the evaluation of statements that require a clear position of the user in terms of agreement or disagreement, a six-point Likert scale is used. All questions also included an "I don't know" option in order to avoid incorrect answers (i.e., misuse of the mid-value in five-point scales).

5 Results

This section presents our findings to prove or disprove the hypotheses in both participating countries. The results comprise the assessment of the used ERP systems, users' uncertainty in system usage, and finally, the evaluation of potential solutions to overcome these barriers. Special attention is given to the commonalities and contrasts between the German and the Latvian user groups.

5.1 Companies and users

The nature of both user group samples is highly different in terms of gender and age. Whereas 81% of the German participants are male, this is only the case for 57% of the Latvian users. Furthermore, the Latvian users are significantly younger compared to the German user group (Germany | Latvia: up to 30 years: 8% | 22%, 31-40 years: 27% | 46%, 41-50 years: 40% | 22%, 51-60 years: 23% | 11%, 60 years and older: 2% | 0%).

Based on 58 answers from Latvia, only a minority of 41.38% of the companies are using an ERP system, whereas from the total set of 277 German companies the majority (66.4%) are using an ERP system (184 users). The main reasons for not implementing an ERP system in Latvia are high procurement costs followed by high levels in terms of cost and/or time for its implementation. If one compares the mean turnovers achieved by a micro- or small-sized Latvian enterprise with an equivalent German enterprise (cf. table 2 and 3), it becomes obvious that the high costs for standard ERP systems are a significant and major challenge for Latvian enterprises.

These ERP systems are employed for diverse enterprise divisions, such as production, wholesale and retail trade and transportation (cf. figure 3, top). The German user group has a higher percentage of

production, whereas the Latvian user group has higher percentages of transportation, information and scientific activities.

The diverse composition of both data sets with regard to company size is a second important differentiation. Whereas the data sample for Germany consists mostly of small-, medium- and large-scale enterprises, the resulting set for Latvia is based essentially on medium-sized enterprises (figure 3, bottom left). Micro- or large-scale enterprises are rarely included. Whereas the Latvian user group consists of a higher percentage of employees, the German user group consist of a higher percentage of department managers (figure 3, bottom right).

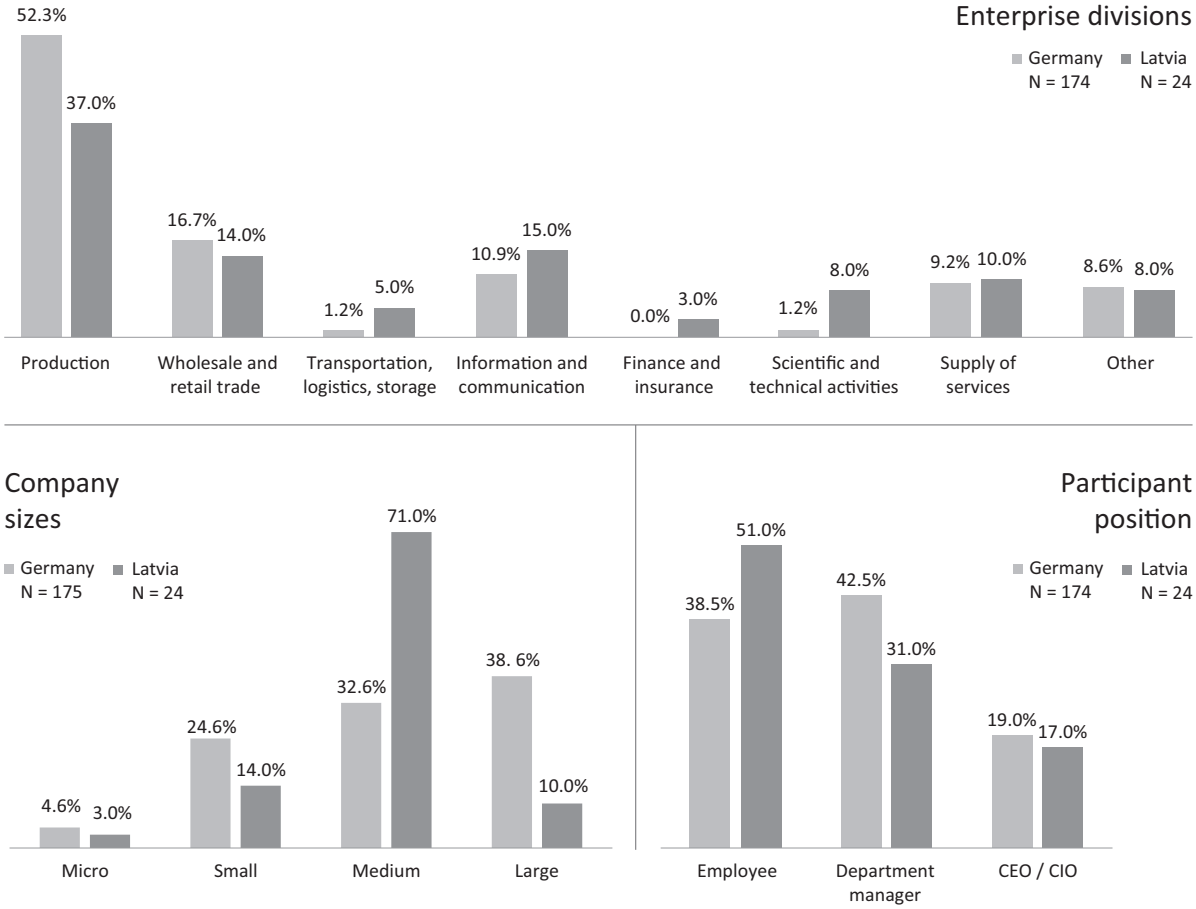

Figure 3. Data sample characteristics for Latvia and Germany: Industry branch (top), company size (bottom left), and participant position (bottom right)

5.2 ERP systems

In the total set of 24 ERP users from Latvia, a broad range of ERP vendors could be found. Most of the participants stated that they use a Microsoft product (N=5), followed by the HORIZON ERP system (N=4). The majority of 10 users stated that they have other systems (SAP, 1C, Axapta, or HansaWorld), which are used by only one participant each. Additionally, five participants did not specify a vendor. Comparable to the situation in Latvia, a broad range of ERP vendors could also be found in the German user group with 184 participants. The most prevalent vendor is SAP with about 28%. Microsoft is the second-most common ERP vendor with a total of 15. These are followed by smaller vendors, such as Infor (n=8), Sage (n=7), and Comarch (n=6), whereas self-developed systems are irrelevant. The results reflect the highly disparate ERP market in Germany.

The summary comparison of both user groups reveals that ERP systems are used for similar enterprise divisions and in a similar percentage in both countries (Germany (N=161) | Latvia (N=19): Accounting: 82.0% | 84.2%; Sales and CRM: 75.2% | 73.7%; Storage and inventory management: 83.2% | 73.7%; Manufacturing: 65.5% | 63.2%; Project and document management: 48.5% | 57.9%; Human Resources: 54.7% | 52.6%; Supply chain management: 60.3% | 57.6%). However, the storage and inventory management sector is higher in Germany, whereas the project and document management sector is higher in Latvia. This might be explained by the larger user group from the production sector in Germany and the higher financial and scientific sector in Latvia.

5.3 ERP system assessment

A first emphasis of our survey is derived from the usability problems identified in recent literature (cf. section 2). It is dedicated to the user's evaluation of the used ERP system according to the statements presented in table 4. These items cover the support in error situations (1), the overall system complexity (2), the amount and level of detail (3), the availability of visualizations (4), and the confusion caused by simultaneously opened windows (5). The participants were asked to evaluate five statements on a six-point, decentralized Likert scale, ranging from "1 – I totally agree" to "6 – I totally disagree." Two statements are positively oriented (polarity +), whereas three statements are negatively oriented (polarity -).

Item	Statement	Polarity	Germany		Latvia	
			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).	+	3.36	1.37	3.69	1.25
2	My ERP system is very complex, which often makes me feel lost.	-	3.97	1.39	4.20	1.42
3	The amount of information and given details is way too high for my needs.	-	4.18	1.31	4.13	1.34
4	My ERP system offers numerous and useful visualizations, which I can choose myself (e.g., tables, diagrams, dashboards, organigrams...).	+	3.70	1.48	3.56	1.45
5	When having opened many application windows simultaneously, I feel hindered or overstrained.	-	4.40	1.29	4.88	1.21

Table 4: ERP assessment in Germany (N=136) and Latvia (N=16)

First of all, the results indicate that users in both countries are assessing these statements quite similarly and are, therefore, encountering common usability problems (see table 4, right). On the one hand — and in contrast to several prior findings from the related work — the perceived overall system complexity as well as the high level of detail seem not to be major concerns. In addition, the presence of multiple application windows, which are opened simultaneously, is not a serious barrier for most users. On the other hand, the support in problem situations in terms of explanation and assistance could be improved. Furthermore, the participants in both groups mentioned having insufficient useful visualizations to select from. In summary, the results confirm the first hypothesis leading to the conclusion that users in both countries have similar problems in the use of their ERP systems.

According to the question of how these items affect each other, the interactions between the five statements have been calculated (cf. table 5). As a first conclusion, the results indicate that appropriate

error support decreases the perceived level of detail, the confusion caused by multiple windows, and the perceived system complexity. Users who stated that they have good error support also stated that they have numerous and useful visualizations. The latter result could also be found in the Latvian user group. As a second result, a high level of detail and the presence of multiple application windows significantly increase the perceived system complexity. The former result is also present in the Latvian user group. Additionally, the availability of numerous and useful visualizations can decrease the user's rating of system complexity. Although many users did not mention having major problems with the information's level of detail or multiple opened windows, both factors are significantly correlated; this was observed in the Latvian user group, too.

To summarize, multiple windows and a high level of detail are affecting ERP UI in a negative manner. In contrast, adequate error support and the availability of useful visualizations are affecting the ERP UI in a positive manner. As the impact of the visualization criteria on perceived complexity could be proven only for the German user group and not for the Latvian group, hypothesis two cannot be fully confirmed. The described correlations are summarized in table 5.

Criteria A	Criteria B	Germany	N = 136	Latvia	N = 14
		r	Sig.	r	Sig.
error support	level of detail	-.277	.001 *		
	useful visualizations	.447	.000 *	.550	.042 **
	multiple windows	-.214	.012 **		
	complexity	-.409	.000 *		
complexity	level of detail	.630	.000 *	.696	.006 *
	useful visualizations	-.322	.000 *		
	multiple windows	.284	.001 *		
level of detail	multiple windows	.266	.002 *	.590	.026 **

* p < .01 ** p < .05

Table 5: Usability factors and their correlations between each other in both survey samples

5.4 Certainty 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 (Topi et al., 2005; Singh and Wesson, 2009). To be able to execute a transaction appropriately, users need to possess knowledge about the business process itself and need to be able to identify and access the required functionality in the UI; they must also have to be aware of the consequences when completing a business task. These three aspects form our definition of certainty in system usage. The participants were asked to evaluate the frequency of uncertainty in all three of these aspects on a five-point Likert scale from "1 – never" to "5 – always."

The ratings for all three of the criteria are significantly higher in Latvia than in Germany ($F(1,155)=4.432$, $p=.037$). The findings revealed that users do not suffer primarily from a lack of process knowledge or an insufficient awareness of the consequences of their actions. Users are hampered, rather in locating required functionality in the ERP system (figure 4). Hence, it can be concluded that basically users know what to do but not necessarily where to find it. Surprisingly, this conclusion is not related to the user's years of employment in the company or to his or her general

experience with ERP systems in number of years. This observation can be confirmed for Latvia ($13<N<15$, all $|r| > .94$, all $p > .12$) and for Germany ($N = 135$, all $|r| < .12$, all $p > .18$). Therefore, the ability to locate required enterprise functionality remains a general usability problem across different levels of experience and across different countries. Finally, the third hypothesis can be confirmed, as both user groups experienced similar frequencies of uncertainty in system usage.

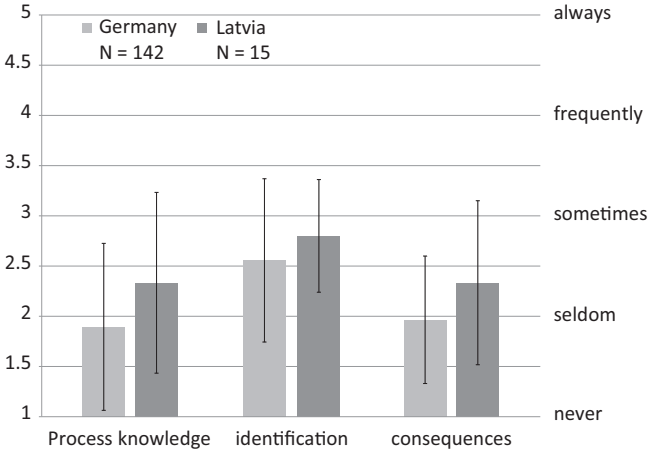

Figure 4. Occurrence of uncertainty in system usage for Germany and Latvia

5.5 Approach evaluation

While the prior sections of this paper have investigated UI-related usability problems in ERP systems, this final part is dedicated to the evaluation of potential approaches that might alleviate some of the identified deficiencies. Hence, the participants were offered seven approaches as illustrated in figure 5 (using a six-point Likert scale from "1 – very good" to "6 – very bad"). The choices were intentionally named quite abstractly in order to receive a first impression of the users' main needs and to identify directions for future work (cf. figure 5).

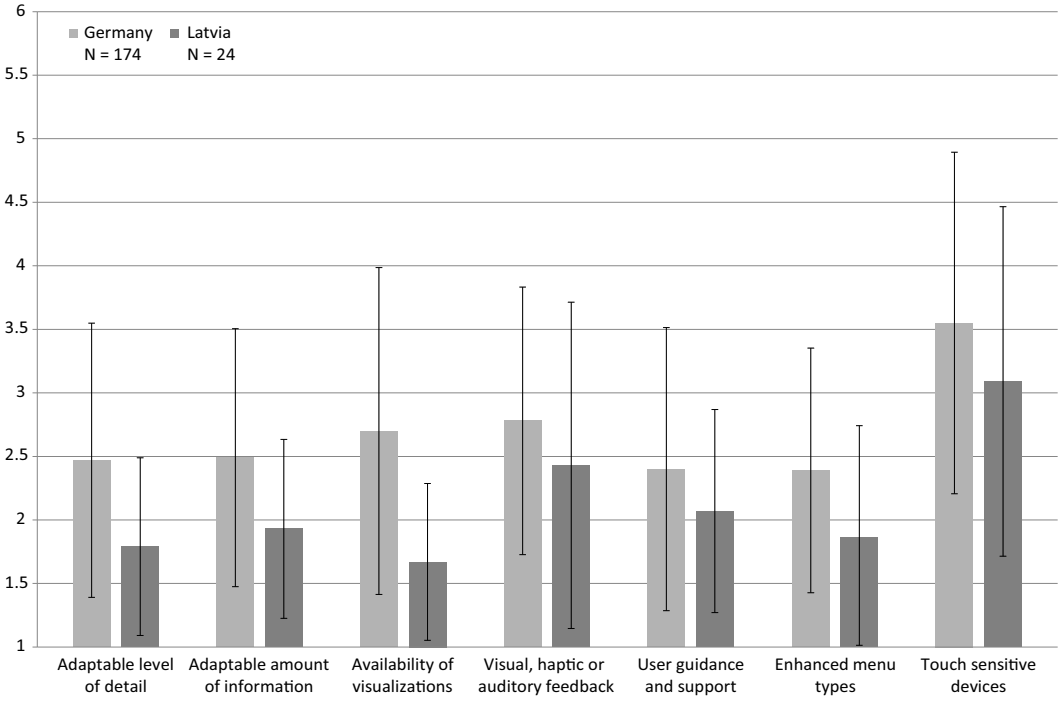

Figure 5. Mean values and standard deviations for the assessment of approaches to enhance ERP usability

In general, the results indicate that users from Latvia assess the approaches more optimistically than German users do. However, neither user group differs significantly in the extent of their ratings ($F(1,102)=1.744$, $p=.190$). The optimistic assessment is most prominent in the aspect of innovative visualizations, which got a rating of 1.67 (N=15, SD=0.617) in Latvia and a rating of 2.7 (N=123, SD=1.286) in Germany. The assessment of touch-sensitive devices received high denial by both user groups. This allows for the assumption that the concept might be unknown, that users might be unable to imagine concrete potentials for their enterprise context, or that they know the technology but are certain that there are no benefits connected with it. Except for the visualization criteria, the results are similar. Although all of the ratings are more pessimistic in the German user group, hypothesis four has been proved.

6 Summary and Conclusion

This paper presented our empirical user study on ERP usability and comprised a large sample of ERP users from Germany and Latvia. The findings from the related-work section acted as an elementary foundation for this research. On the one hand, previous studies in the field of cultural IS-research noted that requirements of users are country-dependant. On the other hand, studies in the field of ERP usability research identified similar problems for different user groups and systems. This contradiction led to the general hypothesis, that users from different countries face similar usability problems in ERP systems. This hypothesis was proven by a user survey that was conducted in Germany and Latvia. Therefore, our findings are contradictory to those from cultural IS-research but facilitate the results from ERP usability research.

Overall system complexity is one of the most-common usability problems found in the related work. The analysis of correlations between all of the assessment criteria manifested a positive impact of error support and useful visualizations on perceived interface complexity. However, the positive impact of the visualization criteria on UI complexity (hypothesis two) could not be confirmed for Latvia but was conformed for Germany. The tasks of navigation and identification of functions are also very often mentioned to cause usability problems that lead to frustration and uncertainty. Hence, the second emphasis was dedicated to uncertainty encountered in system usage and identified that a user's assessment of locating required functionality in the ERP system is lower than his or her process knowledge or the awareness of the consequences of his or her actions. Although both user groups have several differences in their national characteristics, gender and age, their ratings in uncertainty and ERP system assessment were very similar. Although the results were more optimistic in the Latvian user group in general, they did not significantly differ in the extent of their ratings from the German user group. Using the exemplary countries Latvia and Germany, the survey results demonstrated that no significant differences exist between the ratings. The correlation between the availability of numerous, useful visualizations and system complexity indicates that future ERP systems should further extend their visual capabilities.

Although this paper seeks to contribute pertinent findings to the field of ERP UI design, its reliability and validity is limited. The 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. In addition, the findings cannot be generalized for all countries at this point, as further investigations on qualitative and quantitative bases are required. The differentiation between Latvia's and Germany's national characteristics was based on externally acquired data only. In particular, the cultural dimension has not been part of the questionnaire, as its impact on ERP usability has not been the primary emphasis of this survey. This investigation would further require an equivalence of user samples to warrant the existence or nonexistence of cultural differences.

References

Agourram, H. (2009). Defining information system success in Germany. International Journal of Information Management, 29 (2), p.129–137.

Bevan, N. and Macleod, M. (1994). Usability measurement in context. Behaviour and Information Technology, 13, p.132–145.

Bin, W., Chu-hong, Z., Qiong-yu, H. and Zhen-peng, L. (2010). Empirical research on the factor of ERP's user customer satisfaction based on triadic reciprocal determinism. In: Proceedings of the International Conference on Management Science and Engineering (ICMSE), 2010, IEEE, p.58–66.

Bishu, R. R., Kleiner, B. M. and Drury, C. G. (2001). Ergonomic Concerns in Enterprise Resource Planning (ERP) Systems and Its Implementations. In: Proceedings of the Fourth International Conference on the Design of Information Infrastructure Systems for Manufacturing: Global Engineering, Manufacturing and Enterprise Networks (DIISM), 2001, Deventer, The Netherlands: Kluwer, B.V., p.146–155.

Bureau van Dijk. (2013). Amadeus Database. [Online]. Available at: https://amadeus.bvdinfo.com/version-2013530/home.serv?product=amadeusneo [Accessed: 12 June 2013].

Calisir, F. and Calisir, F. (2004). The relation of interface usability characteristics, perceived usefulness, and perceived ease of use to end-user satisfaction with enterprise resource planning (ERP) systems. Computers in Human Behavior, 20 (4), p.505–515.

Davison, R. (2002). Cultural complications of ERP. Communications of the ACM, 45 (7). [Online]. Available at: doi:10.1145/514236.514267 [Accessed: 8 December 2013].

Gronau, N. (2009). Enterprise Systems Knowledge: A New Way to Detect Changes in the ERP Market in Central Europe. In: Proceedings of the 15th Americas Conference on Information Systems (AMCIS), 2009, p.203.

Himmel, S., Ziefle, M. and Arning, K. (2013). From Living Space to Urban Quarter: Acceptance of ICT Monitoring Solutions in an Aging Society. In: Kurosu, M. (ed.), Human-Computer Interaction. Users and Contexts of Use, 8006, Berlin, Heidelberg: Springer Berlin Heidelberg, p.49–58.

Hofstede, G. (2011). Dimensionalizing Cultures: The Hofstede Model in Context. Online Readings in Psychology and Culture, 2 (1). [Online]. Available at: doi:10.9707/2307-0919.1014 [Accessed: 8 December 2013].

Hofstede, G. (2013). The Hofstede Centre. [Online]. Available at: http://geert-hofstede.com/germany.html [Accessed: 8 December 2013].

Hofstede, G. H. (2010). Cultures and organizations: software of the mind: intercultural cooperation and its importance for survival. 3rd ed. New York: McGraw-Hill.

Hornbæk, K. (2010). Dogmas in the assessment of usability evaluation methods. Behav. Inf. Technol., 29 (1), p.97–111.

Jones, M. L. (2007). Hofstede - Culturally questionable? Oxford Business & Economics Conference, 2007, Oxford.

Kanthawongs, P. and Kanthawongs, P. (2011). Cultural Dimensions Affecting User Satisfaction of ERP Systems for a Developing Country. Review of Business Research, 11 (4), p.107–111.

Krumbholz, M. and Maiden, N. A. M. (2000). How Culture Might Impact on the Implementation of Enterprise Resource Planning Packages. In: Wangler, B. and Bergman, L. (eds.), Advanced Information Systems Engineering, 1789, Berlin, Heidelberg: Springer Berlin Heidelberg, p.279–293.

Lambeck, C., Fohrholz, C., Leyh, C. and Müller, R. (2014). (Re-) Evaluating User Interface Aspects in ERP Systems - An Empirical User Study. In: Proceedings of the 47th Hawaiian International Conference on System Sciences, 2014, Waikoloa, Hawaii, USA: IEEE Computer Society.

Leidner, D. E. and Kayworth, T. R. (2006). A Review of Culture in Information Systems Research: Toward a Theory of Information Technology Culture Conflict. MIS Quarterly, 30 (2), p.357–399.

McSweeney, B. (2002). Hofstede's model of national cultural differences and their consequences: A triumph of faith - a failure of analysis. Human Relations, 55, p.89–118.

Mitakos, T., Almaliotis, Ioannis and Demerouti, Anna. (2011). An Auditing Approach for ERP Systems Examining Human Factors that Influence ERP User Satisfaction. Informatica Economica, (14), p.78–92.

Moller, C. and Chaudhry, S. (2012). Advances in Enterprise Information Systems II. Boca Raton: CRC press.

Ngai, E. W. T., Law, C. C. H. and Wat, F. K. T. (2008). Examining the critical success factors in the adoption of enterprise resource planning. Computers in Industry, 59 (6), p.548–564.

Ozen, C. and Basoglu, N. (2006). Impact of Man-Machine Interaction Factors on Enterprise Resource Planning (ERP) Software Design. In: Portland International Conference on Management of Engineering and Technology, 5, 2006, p.2335 –2341.

Palomino Murcia, M. A. and Whitley, E. A. (2007). The effects of national culture on ERP implementation: a study of Colombia and Switzerland. Enterprise Information Systems, 1 (3), p.301–325.

Parks, N. E. (2012). Testing & quantifying ERP usability. In: Proceedings of the 1st Annual Conference on Research in Information Technology (RIIT), 2012, Calgary, Alberta, Canada: ACM Press, p.31–36.

Parush, A., Hod, A. and Shtub, A. (2007). Impact of visualization type and contextual factors on performance with enterprise resource planning systems. Computers & Industrial Engineering, 52 (1), p.133–142.

Pavuk, P. (2011). ERP market in Latvia: a view of insider. The Baltic Course | Baltic States news & analytics. [Online]. Available at: http://www.baltic-course.com/eng/round_table/?doc=40741 [Accessed: 8 December 2013].

Ragusa, C. and Puliafito, A. (2011). Running business applications in the cloud: a use case perspective. In: Proceedings of the 2010 conference on Parallel processing, Euro-Par 2010, 2011, Berlin, Heidelberg: Springer-Verlag, p.595–602.

Scholtz, B., Cilliers, C. and Calitz, A. (2010). Qualitative techniques for evaluating enterprise resource planning (ERP) user interfaces. In: Proceedings of the 2010 Annual Research Conference of the South African Institute of Computer Scientists and Information Technologists, SAICSIT '10, 2010, New York, NY, USA: ACM, p.284–293.

Scott, J. E. (2005). Post-Implementation Usability of ERP Training Manuals: The User's Perspective. Information Systems Management, 22 (2), p.67–77.

Seth, A., Agarwal, H. and Singla, A. R. (2011). Designing a SOA based model. ACM SIGSOFT Software Engineering Notes, 36 (5), p.1–7.

Singh, A. and Wesson, J. (2009). Evaluation criteria for assessing the usability of ERP systems. In: Proceedings of the 2009 Annual Research Conference of the South African Institute of Computer Scientists and Information Technologists, 2009, New York: ACM Press, p.87–95.

Soh, C., Kien, S. S. and Tay-Yap, J. (2000). Enterprise resource planning: cultural fits and misfits: is ERP a universal solution? Communications of the ACM, 43 (4), p.47–51.

Topi, H., Lucas, W. T. and Babaian, T. (2005). Identifying Usability Issues with an ERP Implementation. In: Proceedings of the 7th International Conference on Enterprise Information Systems, 2005, Miami, USA: SCITEPRESS, p.128–133.

Vermeeren, A., Law, E., Roto, V., Obrist, M., Hoonhout, J. and Väänänen-Vainio-Mattila, K. (2010). User experience evaluation methods: current state and development needs. In: Proceedings of the 6th Nordic Conference on Human-Computer Interaction: Extending Boundaries, NordiCHI '10, 2010, New York, NY, USA: ACM, p.521–530.

Winkelmann, A. and Matzner, M. (2009). Teaching Medium-Sized ERP Systems – A Problem-Based Learning Approach. In: Papadopoulos, G. A., Wojtkowski, W., Wojtkowski, G., Wrycza, S. and Zupancic, J. (eds.), Information Systems Development, Boston, MA: Springer US, p.891–901.