ERP Clients: Browser-Based or Dedicated: Do We Need Both?—An Evaluation Based on User Perceptions

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Abstract Due to recent technological developments, enabling mobility to users becomes more and more important for ERP manufacturers. With mobile devices employees can use their ERP applications on the road to take advantage of business capabilities. Here, "putting everything into the browser" is a challenge for ERP manufacturers. Additionally, the question arises whether to provide only one client—a browser-based one—or to still provide additionally a dedicated client? To gain first insight for answering this question, we measured the workload of selected ERP users by using NASA's Task Load Index (TLX) while fulfilling tasks of a limited business scenario within a dedicated client and within a browser-based client. According to our results the workload for the dedicated client is lower whereas usability is rated higher with the browser-based client. Therefore, a browser-based client could be a good enhancement for ERP systems, but dedicated clients are still necessary.

1 Introduction

Today's enterprises are faced with the globalization of markets and fast changes in the economy. In order to be able to cope with these conditions, the use of information and communication systems as well as technology is almost mandatory. Specifically, the adoption of enterprise resource planning (ERP) systems as standardized systems that encompass the actions of whole enterprises has become an important factor in today's business [1]. Therefore, during the last few decades, ERP system

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software represented one of the fastest growing segments in the software market; indeed, these systems are one of the most important recent developments within information technology. Due to the saturation of ERP markets targeting large-scaled enterprises, current ERP system manufacturers are also now concentrating on the growing market of small and medium-sized enterprises (SMEs) [2, 3]. This has resulted in a highly fragmented ERP market and a great diffusion of ERP systems throughout enterprises of nearly every industry and every size [4, 5]. Thereby, ERP systems claim to combine best business practices that replace separate functional systems. A properly selected and implemented ERP system offers several benefits such as considerable reductions in inventory costs, raw material costs, lead time for customers, production time, and production costs [6, 7]. Therefore, current standardized ERP systems are used in a majority of enterprises around the world. For example, according to a survey conducted in Germany in 2009, ERP systems are used in more than 92 % of all German industrial enterprises [8].

Due to technological revolution and developments, enabling mobility to users becomes increasingly important [9]. With mobile devices such as laptops, PDAs, and tablets, employees can use their ERP applications on the road to take advantage of business capabilities. They can access mobile information from home or any other location as a place of work [10]. Therefore, the business world is beginning to adopt mobile capabilities in their evaluation, selection, and implementation or upgrades of enterprise software systems. Studies from IFS indicate that 47 % of employees access information on the move once or twice a week. With remote access, 63 % would even reason to work outside of normal business hours [11].

However, "putting everything into the browser" is a challenge for software and IT system vendors and manufacturers. For example, it is mandatory for web-based application not only to provide web-access to all necessary functionalities but also to ensure clarity and good usability of their user interfaces [12], since much time is lost by users who encounter frustrating experiences with information systems, for example, caused by inappropriate usability of user interfaces or missing functionality [13].

Here, ERP systems, as information systems with complex structure and functions, were designed with dedicated clients during the last decades. And even today, most systems are still using dedicated clients. However, some ERP manufacturers have already shifted towards browser-based clients and are only providing this type of access for the newer versions of their systems; whereas other manufacturers provide both—a dedicated client and a browser-based client. Therefore, the question arises whether to provide only one client—a browser-based one—or to still provide additionally a dedicated client?

To gain first insight for answering the above question, we focus on user and expert perceptions. Therefore, we created a scenario that builds upon delimited business processes that had to be completed by selected experts who had to fulfill the tasks of the scenario and to evaluate the scenario within a dedicated client and within a web browser.

As an ERP system, we selected Microsoft Dynamics NAV due to our background and since the upcoming release of NAV will provide a browser-based

client parallel to its dedicated one. However, this integration functionality was not fully provided within the NAV version (NAV 2009) that was available for our study. Therefore, to test and to evaluate the browser integration we provided a web-access using Microsoft Office Sharepoint. Selected results of this evaluation will be presented within this paper.

Therefore, the paper is structured as follows. Next to the introduction we describe shortly our methodology. We will explain the scenario itself as well as the evaluation methodology. Afterwards, Sect. 3 will be the main part of this paper. Here, selected results of the expert evaluation considering the NAV dedicated client versus the browser-based application will be given. Finally, the paper ends with the conclusion, limitations, and future work.

2 Data Collection Methodology

2.1 Microsoft Dynamics NAV: Browser Integration

Microsoft Dynamics NAV is an ERP system from Microsoft for medium sized businesses. It is part of the product group Microsoft Dynamics such as Microsoft Dynamics AX, Microsoft Dynamics GP, and Microsoft Dynamics SL.

The release used in our study is Microsoft Dynamics NAV 2009 R2. A new version, Microsoft Dynamics NAV 7, is already under development where browser integration will be embedded.

Microsoft Dynamics NAV provides two clients to work with, currently. The Classic Client is the original user interface for working and customizing business logic. To increase the customizability and flexibility, Microsoft Dynamics NAV 2009 offers the Role-Tailored Client (RTC) based on .NET. With the upcoming release of Microsoft Dynamics NAV 7, Microsoft provides a third client for Microsoft Office SharePoint [14]. The user interface of the Classic Client is very similar to the one of Microsoft Office. The RTC inherits its appearance from a web browser. Unlike the Classic Client, pages are displayed in independent new windows and not as inner-framed windows. With Microsoft Dynamics NAV 7 (the upcoming release), an integration of pages in Microsoft Office SharePoint is planned. It will include web browser capability to access data in the cloud or on premises. Integration into a browser application such as Microsoft Office SharePoint would bring out quite some benefits. Of ERP users, 29 % see the SharePoint as an alternative to hard-to-use enterprise software. Therefore, they outsource missing functionality of the ERP system. Even more, 72 % use Microsoft Office Excel to store data [11]. Since Microsoft Office SharePoint is directly linked to Microsoft Office products, browser integration could merge functionality of both systems and allow the user to work with his files more easily.

2.2 Business Process Scenario

To evaluate the usability of such a browser-based client, we created a scenario with integration of selected business processes connected to NAV 2009.

According to Holtstiege et al. [14], the major business processes of Microsoft Dynamics NAV are purchase, warehouse, sales, and finance. Due to a high complexity of finance, a mainly setting-character of warehouse and a high customer need of time reporting, the selection for our study differs. Magal and Word [15] define the procurement, production, and fulfillment as general key business processes of an organization. To evaluate possible browser integration we focused on routine tasks that need a high system support (see [16]). Those tasks are for example purchase and sales order processing as well as time reporting. The tasks of the scenario are, therefore, as follows: (1) To create an item; (2) To create a purchase query; (3) To convert the purchase query into an order; (4) To create a sales query; (5) To convert the sales query into an order; (6) To report times.

Those business processes have to be done in both systems to be compared. The complexity of the scenario is orientated on a lower level of understanding ERP systems. Therefore, the tasks are designed simple with the result that the most important processes, which need a high system support, are covered. Every process can be done without completing the previous one. This was necessary to enable continuous progression even after failing in one of the tasks. The detailed scenario will not be part of this paper but can be provided upon request.

2.3 Evaluation and Data Collection Methodology

Interacting with an ERP system requires among others a certain amount of concentration and time. The Human Performance Group at NASA Ames Research Center developed a procedure for collecting workload ratings between human and machines. Asking people to describe the feelings they experienced is one way to learn about workload. Therefore, the so-called Task Load Index (TLX) uses the dimensions Mental, Physical and Temporal Demands to the demands imposed on the subject and Effort, Frustration and Performance to the interaction of a subject with the task [17]. The TLX represents the workload necessary to fulfill the completion of a task. To calculate the TLX, all participants had to answer questions about the mentioned factors directly after accomplishing the scenario tasks. Therefore, for the TLX the participants had to answer a survey both after performing the scenario tasks with the RTC of Microsoft Dynamics NAV and also after using the browser-based client. Each factor was rated in a 20-point Likert scale and mapped on a value between 0 and 100. Comparisons of the workload according to TLX and additional questions like the needed time and handling of the tasks give an overview about which system is preferred to fulfill and solve the task of the scenario and which one is more convenient.

Besides the workload, we aimed additionally for a "general" evaluation of the user interfaces of both clients. Therefore, for evaluating ERP user interfaces the five criteria, Navigation, Presentation, Task Support, Learnability, and Customization, can be identified to verify usability problems [18]. Navigation is a design issue that aims to identify how effectively an end-user can access appropriate information, options, reports, elements, and menus. The Presentation of Screen and Output defines the suitability of the layout of menus, controls, dialog boxes and information on the screen, meaning the complexity of the screen display. The Task Support aims to ensure task completion by identifying accurate alignments between the real world and the execution of the system. Learnability is used to assess the effort required to understand and learn the usage. Customization describes the ability of the system to be suited to specific needs of the enterprise's processes [18]. Since our scenario contains only selected and limited business processes, Learnability and Customization cannot be determined, sufficiently. Therefore, those two criteria were discarded and were not part of the data collection.

For understanding what makes socio-technical systems successful, multi-method approaches involving, e.g., case studies, observations, interviews, or other longitudinal techniques, may be appropriate [19]. Therefore, we used a combination of a survey-based data collection and a simple time diary. For our study the whole evaluation is divided into two main parts (see Fig. 1). The first part is about the questions necessary for the TLX. Therefore, two nearly equal questionnaires had to be filled out for this part—one after the completion of the scenario in each

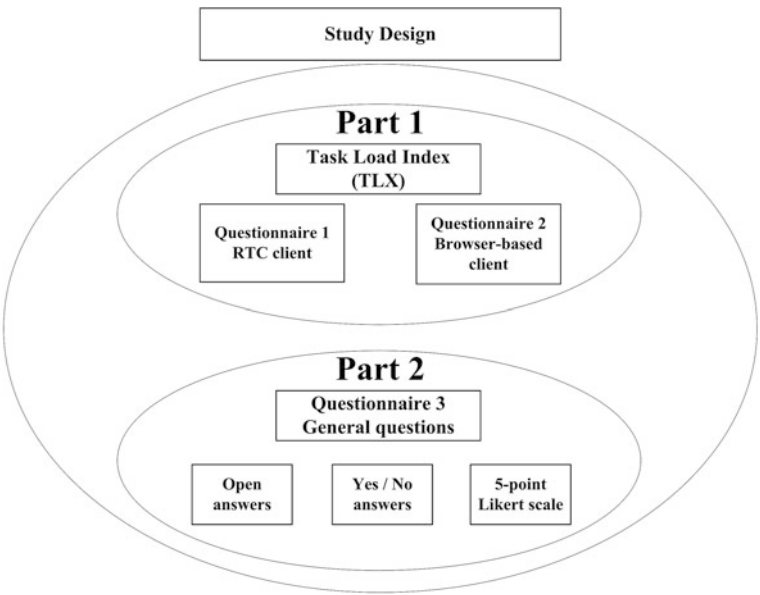

Fig. 1 Study design

of the systems. These questionnaires contained the workload questions and the weight of all six factors (Mental, Physical and Temporal Demands as well as Effort, Frustration and Performance) necessary for the calculation of the TLX. The second part consisted of a third questionnaire containing general questions involving both systems. The answer possibilities for the general questions reach from given options where the user had to select none, one, or multiple possibilities, to open text fields where the respondents could write their own words and opinions.

Due to our background, as participants, we focused on a range of experts to perform and to evaluate the scenario in the RTC and the browser-based client. For our study, experts are people who have to work frequently with an ERP system and run parts of business processes. The experts were supposed to be employees of a German consulting company focusing on Microsoft Business Solution products. For identifying properties [20] the experts can be separated by their jobs in the company (e.g., employees of the sales & marketing department, software engineers, software consultants, and trainees). Further separations can be the knowledge and interaction level with Microsoft Dynamics NAV and Microsoft Office SharePoint as well as the intensity of customer contact. In total the sample had a size of 20 employees who had to complete the scenario in both systems. After the completion of the scenario in each system they had to fill out surveys according to their experience within the systems.

As a pretest (according to [20, 21]), a small group of respondents (experts with high Microsoft Dynamics NAV knowledge and some people who never had contact with an ERP system) tested the questionnaires and reviewed the scenario. After the pretest, only one question was seen as unsure by two respondents and, therefore, was reviewed and reworded. Additionally, the structure of the TLX questions was changed from a big block into separate items.

3 Selected Results of the Client's Evaluation

The processing of data is achieved by using statistical analysis as well as graphical presentations. The statistical analysis can therefore be distinguished in a descriptive statistic, meaning the description of data based on measured parameters, and an inferential statistic. In this paper we focus on descriptive statistics to present the results. The differentiation of property values that display the data happens by determining categories to delimit and group the information. The standard deviation is used to describe the variation of the average. It has the same measuring unit and means based on the arithmetic average that the data deviate around this value [21].

Each participant completed the scenarios on his own computer without any additional help besides the accompanying documents. In total, they had 2 weeks, January 2, 2012 to January 16, 2012, to fulfill the tasks and answer all questions. Not a single person had problems that led to aborting the study. Therefore, all

Table 1 Response rate by occupation

Job description	Sample	Usable responses	Response rate (%)
Software engineer	10	8	80
Software consultant	5	5	100
Trainee	3	1	33.3
Sales & marketing	2	1	50
Total	20	15	75

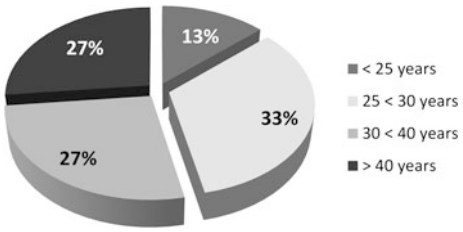

Fig. 2 Respondent's age

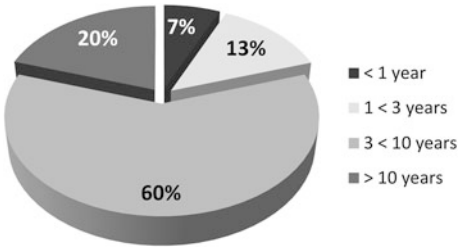

Fig. 3 Respondent's ERP experience

participants who decided to fulfill the scenario completed all tasks and answered all questions of the questionnaires. One reminder email after the first week helped to gather additional results. Table 1 shows the response rate of 75 %, itemized by the occupation. Except the trainees, more than 50 % of each group participated in the study.

An age analysis (see Fig. 2) shows that the respondents are spread pretty much even among younger and older employees. 54 % are 30 years or older; 33 % are between 25 and 30 years; and 13 % are younger than 25 years. The experience with ERP systems (see Fig. 3) is high with 80 % who has worked 3 years or longer in the business. The sample represents thereby experienced participants with excellent knowledge to judge both systems. About 87 % do actually have a deeper contact with customers and can partially estimate their business processes.

3.1 Results of Working with the RTC of Microsoft Dynamics NAV

Figure 4 shows the results of the rating for each factor and each respondent. Flat bars point to low demands or a positive satisfaction (performance). The high values represent negative characteristics because major effort was necessary to complete the task.

The results reveal that some factors, especially performance, are rated very different (see Fig. 4). Some respondents see their accomplishing of the goals as very good and some see it as very bad. Since everybody successfully finished the scenario, this could be caused by misunderstanding the question or accidentally interchanging the scale. Some factors such as effort and physical demand have a lower variance in answers. A full list of the average values and the variance is illustrated in Table 2. Since the maximum possible value is 100 and all factors are less than 30, the tasks seem to be minor demanding. In comparison against each other, with average values of 25–28, the mental demand, the temporal demand, and the frustration are assessed highest. In other words, the most stressful were the thinking, time pressure, and insecurity. The general effort is with about 18.25 a bit less behind and a value of 7.02 for the physical demand indicates nearly no need in physical activity at all.

The rating of all factors is subjective and can vary much among different people (see Fig. 5). Therefore, the TLX procedure weights the items to differ the importance of each factor for each person. The respondents answered thereby

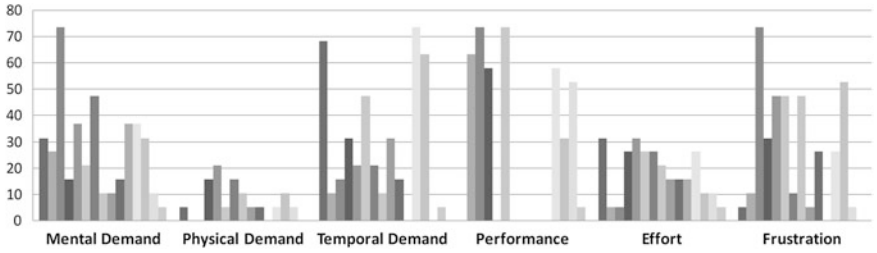

Fig. 4 TLX factors for the RTC (rectified scale)

Table 2 Average and variance of TLX factors for the RTC

Factors	Average	Variance	Standard deviation
Mental demand	27.37	321.28	17.92
Physical demand	7.02	42.22	6.5
Temporal demand	27.72	603.22	24.56
Performance	27.72	987.12	31.42
Effort	18.25	90.52	9.51
Frustration	25.97	536.07	23.15

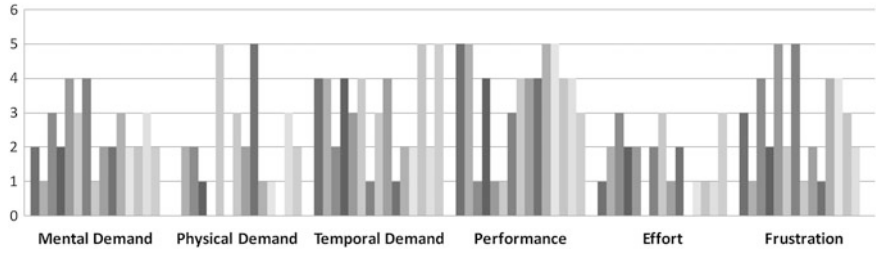

Fig. 5 TLX weighting (points) for the RTC

another 15 contractive questions about the factors. Two characteristics are compared and one point could be assigned for the more important one. The number of favors (points) for each factor is divided by 15 (total number of questions). Figure 5 shows the results (points) for all answers.

The results of the weighting are numbers that yield totalized in 1 (100 %). On average, the most important factors, having thereby a high weighting, are the performance (23.56 %) and the temporal demand (20.4 %). The frustration (17.33 %) and mental demand (16 %) are slightly behind and followed by the less important factors of physical demand (12 %) and effort (10.67 %).

All factors are multiplied with their weighting for each participant and summarized in a total workload. This number represents the TLX. The TLX is a value between 0 and 100. Zero means no effort at all and 100 is an exhausting task demanding everything from the respondent. The final TLX values for the case study are illustrated in Fig. 6. The average is 24.44 and the standard deviation is 13.64. This confirms the previous assumption of the single factor's analysis, which already indicated minor demands to fulfill the first part of the scenario. This value does not show any details. It classifies the full workload that was necessary to complete the tasks while working with the RTC.

A glimpse on the time diaries shows, except for a few aberrations, an obviously more balanced result than the TLX. The average time needed is 21.8 min with a standard deviation of 9.79. The variation can result for example from a different knowledge about the system or a varying of reading speed. Since one participant noted 23 min just for the first stage of the first part, he might have added the time for reading the case study introduction.

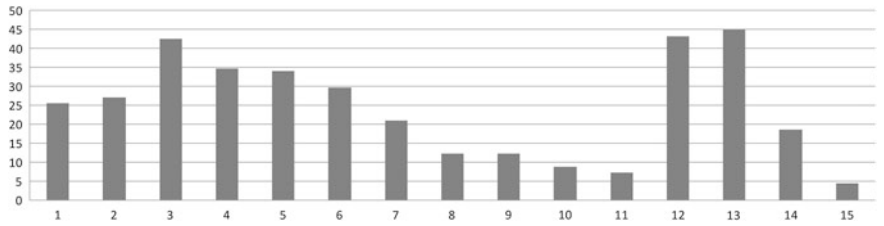

Fig. 6 TLX (per participant) for the RTC

3.2 Results of Working with the Browser-Based Client

All participants had to rate again the six factors for the TLX after completing the scenario using the browser integration. The results (see Fig. 7) are more unequivocal among the participants and have in most cases lower variances compared to the RTC (see Table 3).

Again, the big variance of the factor performance might be caused by misunderstanding the question or scale. The differences of the average values are bigger. The performance is with 42.26 of maximum 100 the highest factor and represents a mediocre satisfaction of task-completion. The frustration (30.53) is also pretty high compared to the others. The mental demand, temporal demand, and effort are among each other similar and in the lower quarter of the scale. Once more, the physical demand is the lowest factor with a value of 6.32.

The results of the TLX for the browser-based client are displayed in Fig. 8. With an average value of 26.9 the workload is again rather low. The standard deviation of 14.95 is slightly higher compared to the RTC. Therefore, the values are a bit more ambiguous.

The total time needed is, with an average value of 14.67 min, low. A standard deviation of 2.44 reveals equal times for all participants. Again, the same participant as in the RTC part needed again the most time to complete the task.

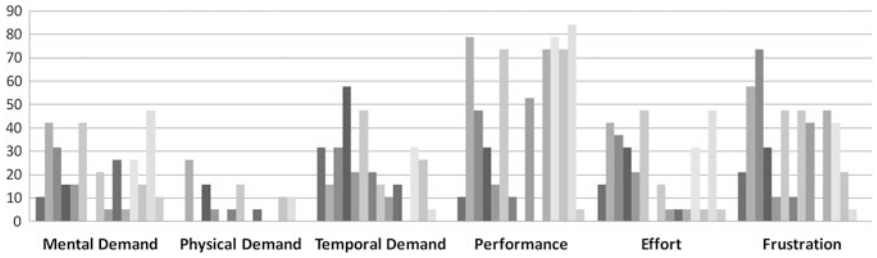

Fig. 7 TLX factors for browser-based client (rectified scale)

Table 3 Average and variance of TLX factors for browser-based client

Factors	Average	Standard deviation browser integration	Standard deviation RTC
Mental demand	21.05	14.62	17.92
Physical demand	6.32	8.01	6.5
Temporal demand	22.11	16.31	24.56
Performance	42.46	33.08	31.42
Effort	21.05	17.0	9.51
Frustration	30.53	22.7	23.15

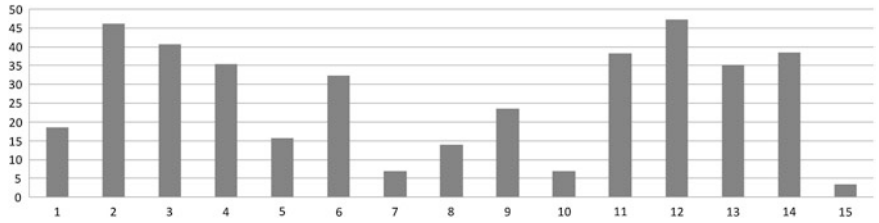

Fig. 8 TLX (per participant) for browser-based client

3.3 Comparison of Both Clients

Way more important than just an analysis of each system is the analysis about the changes from RTC to browser integration and thereby a comparison of both systems as user interfaces.

The average TLX value from the RTC (24.44) is less than the one from the browser integration (26.9). That implies a 9 % lower workload for the tasks of the scenario with the Microsoft Dynamics NAV internal client. In total, 47 % of the participants had a lower TLX value for the browser integration, averagely 30.97 %. The other 53 % of the participants who had an increased workload rated the index on average 90.47 % higher. This shows that the percentages of each side are even, but especially those who had a higher workload, had a particularly higher one. Some of them, such as participant number 11 and 14, show an enormous difference in their TLX. But this does not apply to all participants, as Fig. 9 illustrates.

Analyzing the TLX by each occupation of the experts leads to the values shown in Fig. 10. Because the number of participants for the group trainee and sales is only one each, their results are more ambiguous. Anyhow, they still reflect the increasing value of the TLX from RTC to browser integration. Thereby the trainee had a 107.55 % increased workload, whereas the sales person only had a 2.02 % higher value. The software developers (53 % of the participants) are the only employees who had a lower TLX value for the browser-based client. With a decrease of 3.44 % it is still less than the 17.34 % increase of the software

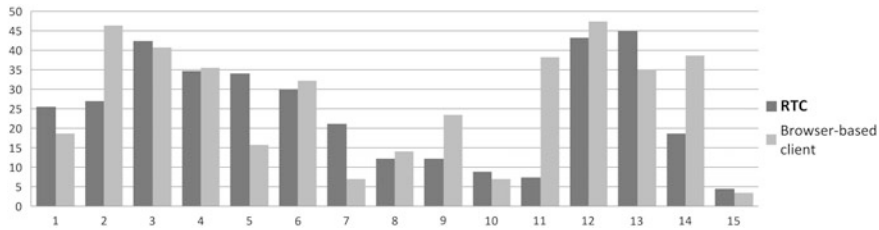

Fig. 9 TLX comparison (per participant) for RTC and browser-based client

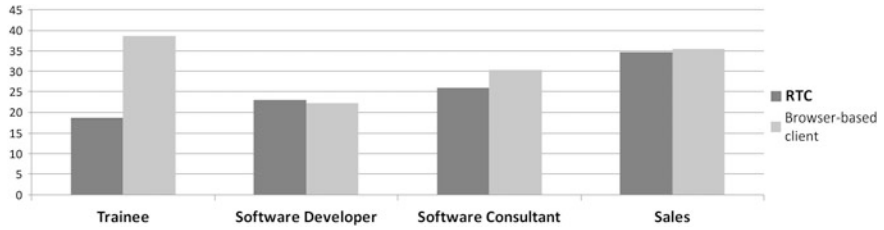

Fig. 10 TLX comparison by occupation

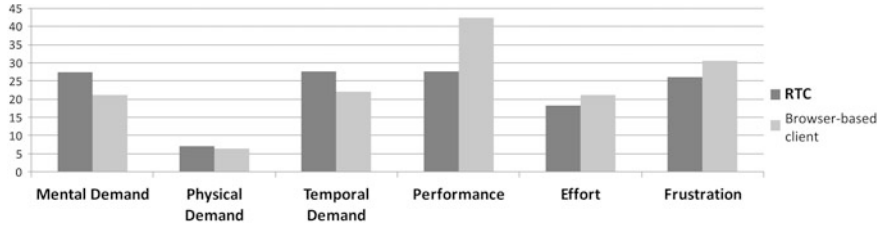

Fig. 11 Average TLX factors for both clients

consultants (33 % of the participants). Since three of four groups have an increased TLX value, a higher workload for the browser-based client is reasonable.

The same goes for the analysis of the TLX values grouped by the respondent's ERP experience. Only one group has a decreased workload, whereas the other three showed with 9.8 % for the rookies (less than 1 year experience with ERP systems), 29.4 % for the beginners (1–3 years), and 24.9 % for the experienced (3–10 years), a nearly constant increase of four to six TLX points. The distribution of the respondents is more regular, since each of the groups consists of two or more participants. The analysis reveals that the TLX is higher for the participants with less experience. Therefore, a higher contact with ERP systems implies a lower workload for both systems.

Comparing the averages of each of the several factors (see Fig. 11) reveals that the three demands are conceived as less stressful with the browser-based client, whereas the accomplishing of the tasks, the degree of work, and the frustration are assessed higher. Especially, the performance shows a 53.2 % increased value, whereas the average difference of all other factors is only 14.38 %.

To sum up, NASA's analysis procedure makes the RTC the better user client to work with Microsoft Dynamics NAV. The workload is assumed higher with the browser-based client. A more detailed view clarifies a lower TLX with both systems for more experienced users. Especially the browser integration profits from more knowledge.

Beside the TLX values we posed some general questions to evaluate both clients. Some of those evaluated attributes can be seen in Fig. 12. Noticeable is

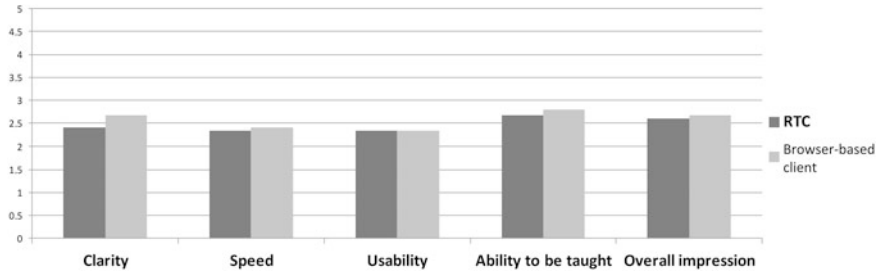

Fig. 12 General evaluation of RTC and browser-based client (rectified scale)

that every attribute is either rated better with the browser integration, or is equivalent. All participants prefer averagely the browser integration.

The clarity has the highest difference with an increase of 11.1 %. The browser-based client does only contain a fractional amount of the functionality. Therefore, the participants conceive the client in Microsoft Office SharePoint 2010 less confusing. A further investigation of the reasons is not possible due to a lack of particularly measurement results. A standard deviation of only 0.737 for the RTC and 0.9 for the browser integration shows a coherent representation of the results.

The speed (2.86 %), ability to be taught (5 %), and overall impression (2.56 %) differ only in a small value. However, they are still rated better with the browser-based client. Interesting is that the participants felt an increase of speed with the browser-based client and simultaneously the total time needed decreased, too. This shows compliance in the perception and the actual reality.

The usability is the only value that has the same average rating with both systems. With an average value of 2.67 of 5 it is only slightly above the half and additionally the worst rated attribute.

4 Conclusion, Limitations and Future Work

Through mobile devices and an expansion of the Internet, mobility of ERP systems is getting more important. So, system access via the Internet and web browser becomes necessary. Therefore, the aim of our study was to gain first insight and first answer for the question whether ERP systems still need both—a dedicated client and a browser-based client.

Therefore, we set up a study and a scenario to evaluate one possible realization of a browser-based client by integrating some selected business processes of Microsoft Dynamics NAV in Microsoft Sharepoint. Delimited and simplified modifications of the business processes warehouse, procurement, sales, and time reporting have been implemented and have been evaluated by 15 experts. They completed therefore the same scenario in two different client types, the Role-Tailored Client (RTC), the dedicated client of Microsoft Dynamics NAV, and a

browser-based client. After fulfilling the tasks of the scenario, the participants had to answer a questionnaire after each part, as well as a general questionnaire at the end of the study. Whereas the first two surveys were directed towards a technique developed by the NASA to measure the workload of a Human Computer Interaction, the so called Task Load Index [17], the last questionnaire was used to collect time diaries, general opinions about characteristics such as the usability, and personal notifications.

Overall, the results of the evaluation are balanced. Minor differences can often only be seen by having a detailed look. According to NASA's analysis procedure, the RTC is the better user client to work with Microsoft Dynamics NAV according to the selected processes. The average workload is with 24.44 of 100 assumed 9 % lower than the TLX value 26.9 of the browser-based client. An analysis of the TLX based on the ERP experience reveals that the index decreases with an increasing knowledge. Thereby, especially the browser-based client benefits with a 71.8 % lower average value for participants who work more than 10 years with ERP systems, whereas the RTC still showed a 28.4 % enhancement. A glimpse on the TLX factors showed that the demands are slightly lower with the browser-based client, while the frustration, effort and performance (dissatisfaction) were obviously higher. This could be caused among others by the familiarity of the RTC for most of the experts.

However, the general survey favors the browser integration. The clarity, ability to be taught, and overall impression were rated averagely 4.8 % higher than using the RTC. Still, with values between 2.6 and 3.1 out of 5, all characteristics were rated with mediocre satisfaction.

In summary, it can be stated that the RTC has a lower workload to complete the scenario, but the participants needed less time with the browser-based client. The participants preferred the browser-based client and rated thereby among others the usability and overall impression higher. The integration into the browser still has weaknesses but wins in a direct comparison three out of four evaluation approaches for the business processes treated in this research's scenario.

So, as a first answer towards the question whether a dedicated and a browser-based client are both necessary or not, it can be stated that at the moment both clients should be provided by ERP manufacturers that are offering systems that provided dedicated clients in the past. According to our results the workload for those dedicated clients would be lower whereas usability may be higher with a browser-based client. Therefore, a browser-based client could be a good enhancement for ERP systems with dedicated clients since an integration of ERP systems into a browser-based application is thereby a frequently claimed demand by many customers. However, some ERP systems may be to complex to put all their functions and functionalities into a browser-based application. So, the system's complexity could be another reason to provide both clients—a dedicated one for the full functionality and a browser-based one for selected functions and services.

As limitations for our study we have to mention that we only focused on a specific ERP system and used only selected business processes. Additionally the used ERP system's version did not provide a browser-based client; so, we

therefore integrated the selected functions into Microsoft Sharepoint to provide web access which is per definition not a classic web client. Another limitation is the composition and the range of our sample. Here, we focused on 15 ERP experts due to our background. Also, we applied only the TLX as measurement instrument. We are aware that other evaluation tools and instrument can be used as well. We will deal with this in future steps.

As for further future work and to cope with those limitations, we seek to extend the range of our sample as well as the extent of the scenario within the upcoming release of Microsoft Dynamics NAV. Another step will be to shift towards other ERP systems, to deepen and widen our insight on the question of the clients.

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