

Web-based collaboration system for interdisciplinary and interorganizational development teams: case study

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Abstract

The automotive industry faces three major challenges – shortage of fossil fuels, politics of global warming and rising competition. In order to remain competitive companies have to develop more efficient and alternative fuel vehicles. Out of these challenges new cooperation models become inevitable. The development of complex products like automobiles claims skills of various disciplines e.g. engineering, IT. Furthermore, these skills are spread all over various companies within the supply chain and beyond. Hence, supporting IT systems for collaborative, innovative work is absolutely essential.

Interdisciplinary and interorganizational development has new demands on information systems. These demands are not well analyzed at the moment and therefore, existing collaboration platforms cannot address them. In order to determine these new requirements and show the gap to existing collaboration platform we performed a case study.

In this case study, we analyze the research campus “Active Research Environment for the Next Generation of Automobiles” (ARENA2036). It is a new cooperation form, where diverse partners from the industry, research institutes and universities elaborate collaboratively future topics in the field of production and light weight construction under “one single roof”. We focus on the special needs of the interdisciplinary, interorganizational partners.

The requirements were polled by a questionnaire. About 80 percent of the active research workers in ARENA2036 answered the questionnaire. By the answers we can identify the special needs and also role profiles of the collaborators. The resulting role profiles specify the personal requirements. These are used for an evaluation of existing information platforms. The deficits between the offered features and the demands of the partners, as well as new technologies supporting the individual needs of users are the foundation for the information system concept for ARENA2036. In our findings we present a role-based view on requirements for the development of an information system for collaboration and cooperation. Based on these requirements we then develop a concept for mobile apps with focus on a role-based design.

Keywords: collaboration, web-based, platform,

1. Introduction/Motivation

The automotive industry faces three major challenges – shortage of fossil fuels, politics of global warming, rising competition. In order to remain competitive companies have to develop more efficient and alternative fuel vehicles. Functional integration combined with new technologies and materials are the keys to stable success in this industry. The development of complex products like automobiles claim skills of various disciplines e.g. engineering, IT. Furthermore, these skills are spread all over the supply chain and also beyond the boundaries of the automotive industry. Research establishments and governmental institutions gain importance. Hence, cooperation and collaborative innovation is absolutely essential. In order to support such teams, cooperation systems are needed. Cooperation systems offer functionality for group file and document handling, computer referencing, electronic workspace, and electronic meeting systems. In detail, they include tools for chat, electronic calendaring, task list, content management etc. Nonetheless, new kinds of cooperation and collaboration work require new kinds of collaborative tools.

Interdisciplinary and interorganizational development has high demands on collaborative systems. Interdisciplinarity leads to heterogeneity of users, who have a wide range of individual requirements what makes collaborative development more complex. In addition interorganizationality implies that all users have different computing environment where the collaborative system have to run. Web-based collaborative systems enable a platform independent access.

As case example we regard the research campus “Active Research Environment for the Next Generation of Automobiles” (ARENA2036). ARENA2036 is a new cooperation form, where diverse partners from the industry, research institutes and universities elaborate collaboratively future topics in the field of production and light weight construction under “one single roof”.

In ARENA2036 Bitrix, a web-based collaborative tool, is established. It has a wide range of functionalities such as communication tools, calendar, content management, human resource information management as well as project management. Despite of these rich functionalities, Bitrix is rarely used by the ARENA2036 participants according to the low utilization rate.

Our theses are that due to the interdisciplinarity users have different requirements and prioritization on collaborative systems. In order to verify this and getting additional information about why it is not used, we held a brainstorming workshop with five ARENA2036 workers. Their opinions are not directly integrated in this paper but were used as opinion formers beforehand. Based on the results of this workshop and a literature review a questionnaire was developed. The questionnaire was completed by 28 ARENA2036 collaborators. At the moment of elicitation of the data 35 active researchers in ARENA2036 and about 40 involved persons. Therefore, we cover 80 percent of the collaborators that frequently need a web-based collaborative tool in ARENA2036.

In this paper we will answer the following research questions regarding the case example ARENA 2036 empirically. The research questions are:

1. What functionalities are required by the users?
2. What kind of applications have to be integrated in the web based platform?
3. What channel is used to exchange data at the moment?
4. What information is important for all users?
5. What is the impression of the users about the security of the available data exchange possibilities?

Based on the results, we derive new requirements to improve the existing collaboration systems. Furthermore, we propose a solution to improve web-based communication. The remainder of this paper is structured as follows: Section two gives a background of ARENA2036, collaboration tools and Bitrix. Section three describes the applied methodology and section four shows the results answering the research questions. An improvement concept is presented in section five. A conclusion is given in section six.

2. Background

In this section, the background of this paper is given. First, the research campus ARENA2036 is introduced followed by an explanation of collaboration platforms. Finally, an overview of Bitrix, the implemented collaboration platform in ARENA2036, is given.

1.1 ARENA2036

ARENA2036 is a new cooperation that started July 2013 after it won the competition for “public-private partnerships for innovation” of the German Federal Ministry of Education and Research. The cooperation focusses on the future automobile especially on function-integrated lightweight construction and sustainable, flexible and adaptable production. All activities within ARENA2036 will be systematically consolidated in one research factory where the results can be tested and implications for further projects can be achieved.

The manner of collaborative R&D in ARENA2036 is unprecedented. Divers partners from research establishments, universities and the industry, including small and medium sized companies do research on innovative future topics concerning manufacturing and lightweight construction under “one single roof”. At the moment the ARENA2036 building is built, where all partners can do research together. The building is about to be finished in 2016. The design of the cooperation model of ARENA2036 matches largely the characteristics of a research campus. The coordination of the collaborators e.g.

organizational or financial issues, public relations etc. is supported by a management team which works full-time for ARENA2036.

ARENA2036 started with seven partners therefrom three industrial and four scientific institutions. Today it grew up to 13 partners. Hence the research campus doubled within the first one and a half years and is continuing to grow constantly. All the new partners have an industrial background. Together they invest 23 million Euros in addition to the funds of the German Federal Ministry of Education and Research within the first five years. In total about 60 million Euros are invested in the first period, including the construction of the ARENA2036 building.

Even though the partners can work together in one building the communication is inhibited. They are used to their company or institute communication systems that are not interoperable or have restricted connection gateways. Furthermore, there are experts from divers disciplines working together who have different requirements to a web-based collaboration system, e.g. the partners that simulate the behavior of materials will need more capacity to exchange data than an engineer who develops new material.

The research in ARENA2036 focusses on fibre-reinforced plastics. This research is divided into three separate projects which are linked to each other:

1. **LeiFu:** intelligent light weight construction with integration of functions
2. **DigitPro:** Digital prototyping of new materials and processes
3. **ForschFab:** Research production – the production of the future

These three projects are supported by one further project, KHoch3, that research the cooperation ARENA2036, the ways of knowledge transfer and the creative work. KHoch3 improves and monitors the research campus within itself and across the existing nine research campi in Germany.

1.2 Collaborative Systems

“Collaborative computing encompasses the use of computers to support coordination and cooperation of one or more people who attempt to perform a task or solve a problem together” (Bafoutsou und Mentzas 2002). Thus, collaborative systems comprise multiple functionalities for group file and documentation handling, computer referencing, electronic workspace, and electronic meeting systems (Bafoutsou und Mentzas 2002). In the following, we review the functionalities regarding interdisciplinary and interorganizational R&D teams.

Face-to-Face teams perform better than geographically distributed teams due to imperfect information exchange and less personal interaction that limits communication (Warkentin et al. 1997). Therefore, information exchange and communication support is the most important requirement for web-based collaborative work. For interdisciplinary, interorganizational R&D teams the information needed for the coordination of the teams are similar to those of classic project management (Meredith und Mantel 2012). In this paper the focus lies on the functionalities that support collaboration, therefore, topics like budgeting, project selection or accounting will not be considered.

Looking at the commonly used personal information managers like Microsoft Outlook, the major functions that are also necessary for interdisciplinary, interorganizational collaborations can be identified. The user requires calendar functions that allow planning and scheduling the workday. The planning and scheduling of meetings includes resource planning and the possibility to invite the attendants. Invitations are possible if the contacts are integrated in the personal information manager (Microsoft Outlook 2010 2010).

Documents e.g. Microsoft office documents, pictures or CAD data have to be accessible, available and timely for all members of a team (Rojas und Songer 1999). A good collaboration tool offers fast and efficient storage and retrieval of the documents (Sutton, Michael J. D 1996). Regarding interdisciplinary and interorganizational environment a subcategory of information exchange is knowledge management. In order to create a useful wiki, collaborative activities, characteristics of the users, and system acceptance have to be respected (Liaw et al. 2008). An optimal case is when the wiki is self-organized by the users. This ensures that the information presented in the wiki is relevant for the team members (Wagner und Prasarnphanich). Communication tools beyond the telephone are indispensable for a common and homogeneous knowledge level within the project. Communication tools that support visual interaction for example might improve collaborative design (Chiu 2002).

Functions like chats or messengers that are widely accepted in social networks should also be offered (McGrath und Hollingshead 1994).

In addition, there exist non-functional requirements for collaborative systems such as security or usability. In an interorganizational R&D project delicate company information is exchanged, therefore, communication and collaboration tools cannot be implemented if there is not sufficient data security (Pfleeger und Pfleeger 2007). Furthermore, the collaborative systems have to be platform independent, since there is a wide range of used platforms depending on the involved companies or institutions. Therefore, the cooperative system should be web-based since the application can be accessed via browser. Since the collaborators are employed in a company that uses another collaborative system, it is often the case that they don't want to adopt another tool. In order to increase attractiveness, social media have to be integrated. Social media offer the functionality for creation and exchange of User Generated Content in a simple and effective manner (Kaplan und Haenlein 2010).

1.3 Bitrix

Currently ARENA2036 uses Bitrix as collaboration platform. So far it is not accepted by the partners according to the utilization rate. Bitrix is a group-ware software solution to support collaborative work and is developed as web application accessible in all common browsers (Bitrix). Additionally, there exist a desktop app for video calls, messaging and file synchronization as well as mobile apps for Android and iOS for anywhere and anytime access. The application can be hosted on the customers' own server infrastructure or in a cloud. Bitrix comprises various functionalities for communication, calendar, content management, human resource information management as well as project management. They combine all these functionalities and enrich these with social network functionalities and interaction patterns. For example, Bitrix contains an activity stream to feed and receive updates. The human resource information management system provides an organization-wide searchable employee directory, so the users can easily get in contact with co-workers via messaging or video chat. The calendar enables to manage appointments and tasks, creation of group calendars and absent charts. It is also possible to synchronize the calendar with outlook. The document management enables the user to upload documents and share them with different groups. A version control is also available to track and redo changes. Furthermore, it is possible to create and edit online documents with google docs or Microsoft office online. To support the project management, groups can be created and they can share documents, activity feeds, distribute tasks and document progress in a Gantt chart. To store and extent knowledge, wikis can be created.

3. Methodology

The case study is based on ARENA2036. Therefore, a brainstorming workshop with five ARENA2036 workers was held at the beginning of the analysis in order to get an overview of the current views of the partners concerning web-based communication. The workshop results are not directly integrated in this paper. They were used as opinion formers for the further analysis. Based on the results of this workshop and a literature review a questionnaire was developed. The questionnaire was completed by 28 ARENA2036 collaborators, that equals 80 percent of the active ARENA2036 researchers

The questionnaire consists of four parts. In the first part the involvement in ARENA2036 and the professional background of the ARENA workers are detected. The second part focusses on the status quo of the communication within ARENA2036, especially on the kind of information and the way it is shared. Part two ends with the evaluation of the importance degree of certain information. Part three exposes the desired status. The desired status is defined by the functionalities, the content of the ARENA2036-Wiki, the calendar functions, and data security. In the final part the respondents explain how they use Bitrix and what they like and dislike about it.

The first three parts of the questionnaire are standardized using multiple selection and five point Likert-scales. In the fourth part the respondents can state their opinion about Bitrix in a free text. The analysis is carried out using SPSS and contains mainly descriptive statistics.

4. Results

In ARENA2036 several collaborators show different demands concerning web-based collaboration systems. Analyzing the disciplinary background and the tasks of the participants, we observe that the different needs correlate with the assigned project within ARENA2036. The workers in LeiFu and ForschFab are mostly engineers. Nevertheless they show differences in their needs. Taking a closer look at the expertise of the engineers, the LeiFu-engineers are specialized in the development of new technologies and the ForschFab-engineers in production engineering. The workers in DigitPro have a computer science and software engineering background. All other participants have a managerial background or in social science. Therefore the requirements observed in the questionnaire will be grouped by the project.

What functionalities are required by the users?

The following figure illustrates the popularity of the functionalities across all users. The figure shows that no functionality can be eliminated since they are seen as important by the users.

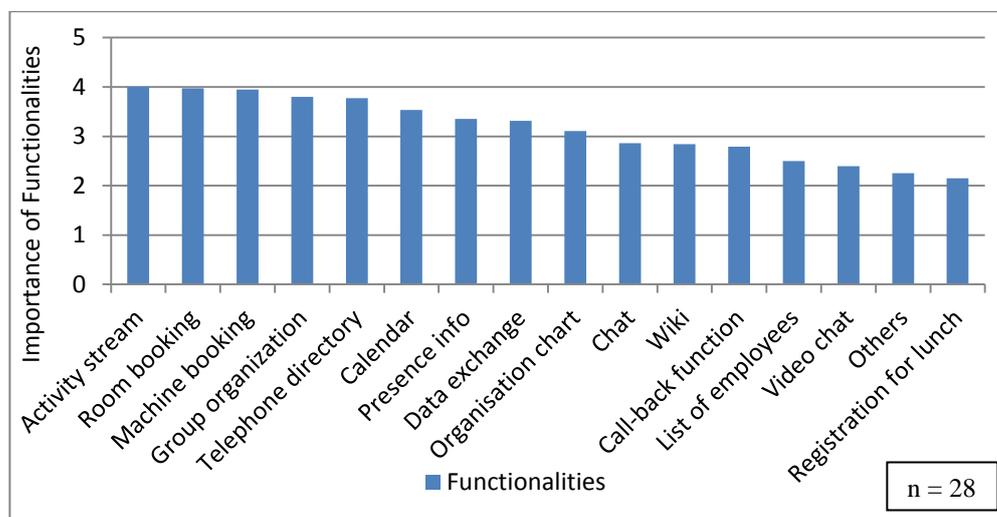


Figure 1: Importance of functionalities

The required functionalities differ in priority across the user groups. For example, the most desired functionality for DigitPro and Management is the activity stream. In contrast to the Forschfab team, where it is room booking or Leifu that is machine booking and group organization. On the second place is the functionality telephone directory for Forschfab, group organization for digit pro and room booking for Leifu and Management.

What kind of applications have to be integrated in the web based platform?

As described in section 2, one major requirement of web-based collaborative systems is to enable information exchange between team members. This include share and work on the same file. Bitrix has already the functionality to open and work on office documents. The question is, if there is a need to share and work on other types of files. This requires the integration of other applications. In order to find the appropriate applications, we analyze the most frequently exchanged type of data. All over ARENA2036 Office and picture files are frequently exchanged. In contrast to this result, in the workshops measurement data and program code files were mentioned. Separating the results according to the discovered user groups we find that especially DigitPro and ForschFab exchange program code files. Measurement data is exchanged by all user groups except Management. Hence, it would be sufficient if applications were integrated that operates on such files. There is a wide range of data types for measurement data and program code files. In order to identify the required applications, the data types have to be analyzed in detail as well as which applications can operate on the data files. However, the frequency the users exchange such data is “almost never”, the question is if it is appropriate to

invest in this functionality. A simpler solution can be the integration of a text editor with the functionality of syntax highlighting.

What channel is used to exchange data at the moment?

Besides the sort of data the exchange channel which the users are familiar with are important for the concept of a web-based collaborative system. There is no variability in between the user groups concerning the frequency they are used. Fig. 1 shows the distribution. Email, company or institute servers are most frequently used.

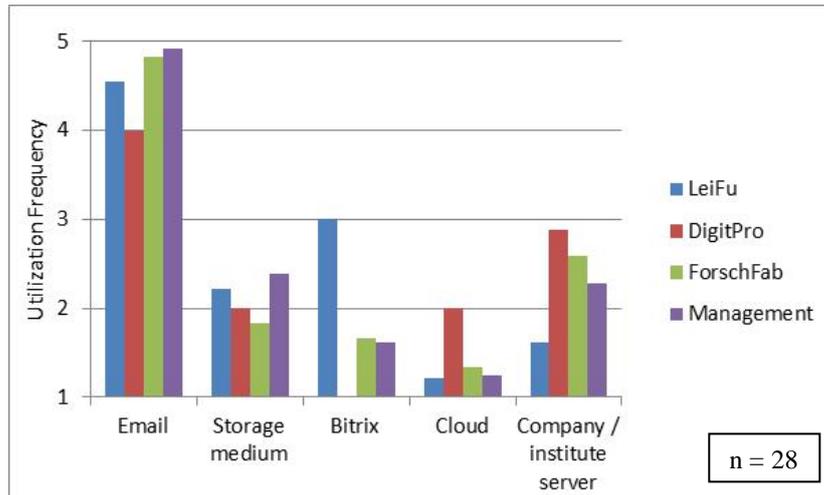


Figure 2: Utilization frequency of data exchange channels

Conspicuously, clouds and Bitrix are rarely used against the expectations. After consulting the participants of the survey we found out that all collaborators who belong to an industry company are not allowed to use clouds and they have no access to public clouds. (Bafoutsou und Mentzas 2002)

What information is important for all users?

In addition to the functionalities some information is important for all ARENA2036 collaborators. This information could be presented in a wiki that is one of the required functionalities of the web-based collaboration system. As illustrated in the following Figure all partners require an introductory course for new members, forms, description of responsibilities, and project relevant information.

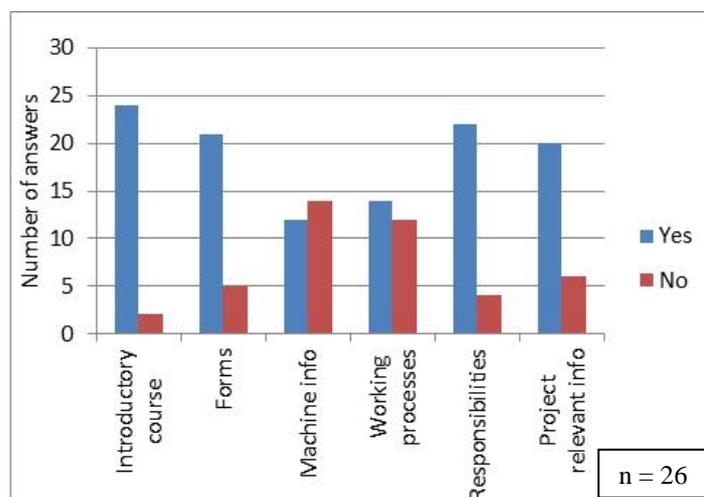


Figure 3: Important information

The results about machine information and working process do not show a clear decision about the necessity in the wiki. We found out that the term “working process” does not have the same meaning to the interdisciplinary ARENA2036 workers. Therefore, the result for working process does not have any significance. Regarding machine information twelve interviewees said it is necessary and 14 that it is not necessary. Analyzing the rate of necessary vs. not necessary information within the projects, we find that 75 % of DigitPro and 57 % of LeiFu need the machine information. ForschFab and the management state with 72 % respectively 67 % that machine information is not necessary. As a solution machine information can be presented within the DigitPro and LeiFu groups instead of the wiki.

What is the impression of the users about the security of the available data exchange possibilities?

One result of our workshop was that the coordinators have security concerns regarding storing confidential documents in web-based collaboration systems. Especially collaborators employed in companies are sensitized to not using web-based document sharing platform. There are multiple ways to increase the security level. Looking at data exchange over the internet it is more secure to send encrypted emails instead of sending emails in plain text for example. However, users are not experts in this field and cannot make a clear statement. One third users answered “don’t know” regarding the security level of data exchange possibilities. The detailed results are shown in the following Figure.

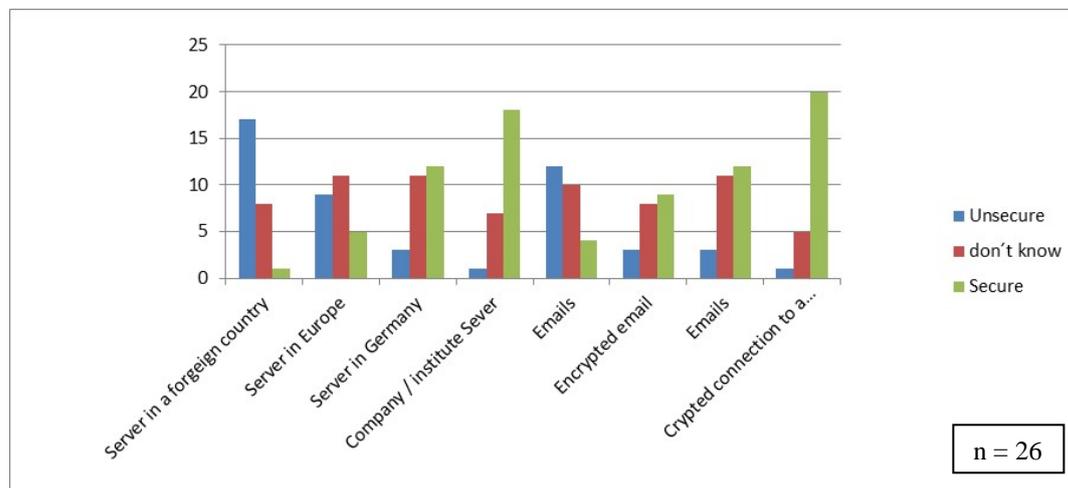


Figure 4: Security valuation of data exchange channels

When we compare the most frequently used data exchange channels and the security concerns of the ARENA 2036 collaborators we find that they do not feel comfortable with Emails. Bitrix is hosted on a German server. Therefore, the collaborators should feel more secure exchanging data through this platform. An improvement could be achieved by hosting Bitrix on an institute or company server. It has to be taken into account that the different requirements concerning the kind of data that is exchanged have to be respected.

The final question of the survey was an open question concerning the experience of the ARENA2036 collaborators with Bitrix. Many of the interviewees stated that they cannot answer the question since they do not use Bitrix. They explained that they already use Outlook and company internal systems and do not want to login into another platform. Others said that the effort to maintain another platform is too high. Bitrix users criticized that some functions like the chat are too slow and that e.g. the up- and download function are “weird”.

Summary

The conclusion of our results are (1) the prioritization of the functionalities varies according to the corresponding projects of the users (2) Bitrix already has almost all necessary functionalities but Bitrix is not used yet because there is no additional information available and they use other channels to communicate or data exchange such as emails from the coordinators perspective and (3) security concerns are obstacles to use Bitrix.

On the basis of our results, some improvements of the collaboration system can be derived. Prioritization of the functionalities varies according the corresponding projects. For example, user assigned to the ForschFab project appreciate the most the functionality "room booking, machine booking and telephone directory". In contrast to DigitPro, they prefer "activity stream" and "group organization". In order to address these different needs in the collaborative systems, the visibility and the accessibility of functionalities should be different according to the users' preferences. If the functionality has a high priority, the visibility should be high and the accessibility should be easy. For example, for the Management and DigitPro the activity stream should be shown up at the start page, whereas "room booking" should be the start page for Forschfab and "group organization" and "machine booking" for Leifu. This means, the collaboration platform adapts to the user profiles.

In our workshop and in the open part of the questionnaire it emerges that coordinators don't use Bitrix because they think they have no added value. This has two reasons. The first one is that at the moment there are no exclusive information in Bitrix. Either the information do not exist, such as introductory guide or coordinators get the information from another channel such as emails. The participants would like to have more information, but they have no time to insert them. Therefore, the goal should be to make more information available on Bitrix. The second reason is that the collaborators have other collaboration tools in their organizations as for example outlook and they don't want to use another one because of data synchronization, another login, etc. Therefore, Bitrix should have a deeper integration in Outlook.

The main issue in security concerns is that coordinators are no experts in security issues. They have to be informed. Security issues have to be discussed with all participating organizations. One possibility to increase the perceived security, to hosted Bitrix on an institute server. However, there are a lot of different security mechanism to mitigate cloud computing security risk (Carroll et al.), but experts are required to install and take care of them. Furthermore, every organization has different security standards these have to be matched according to the security standards of the deployed software.

5. Improvement Concept

In this chapter, we discuss improvements for Bitrix. We identified four improvement topics:

- Adaption of the cooperation platform according to users' profile,
- Provide value-adding information,
- Extended Integration, and
- Security Concerns.

In our improvement concept we do not consider security concerns since detailed information about the security level of Bitrix and the hosted infrastructure are necessary and are not provided by our questionnaire.

To address the challenge of adaption according to user profiles, we propose to modify the application, that it is context-aware. "A system is context-aware if it uses context to provide relevant information and/or services to the user, where relevancy depends on the user's task." (Abowd et al.). In our case this means, that the context elements are user profile and task and that application should be adapt to these context elements. The prerequisites for context-aware application are to conceive a context model containing all relevant context information. For example Kofod-Petersen and Cassen developed a framework to model context, based on the user context using the Activity Theory. The framework supports an application designer to develop a context model.

Several research already investigates context in collaborative system. For example, Gross et a. point out the importance of adaption to context for the success in cooperative systems (Gross 2011). Context information are transported indirect in contrast to face-to-face communication. This should be also available while working with cooperative system. Therefore, context information needs to be

integrated. Furthermore, Belkadi points out that context elements such as situation, social and task awareness are important for collaborative tools. He creates a generic model to represent context in collaborative work. Specific user profiles are one major part in his approach. On the basis of a context model, several functionalities can be implemented in information systems: “(1) intelligent service provision, (2) realizing adaptive user interfaces, and (3) increasing the accuracy of information retrieval processes” (Stefan Zander und Bernhard Schandl 2012). For example, Veiel et. al propose a framework for context model and an architecture to support adaptivity based on a service-oriented architecture (SOA) infrastructure. With this framework it is possible to adapt the user interface as well as the intelligent service provision (Veiel et al. 2011).

In order to provide value-adding information, we propose to extend the knowledge management. As we see in our questionnaire, there are interests in multifaced information. However, getting the information with high quality into the system is the crucial task. We divided the knowledge information into general information regarding ARENA 2036 and project related information. For general information, there should be a responsible person constituted, which curate the general information data. For project relevant data, the project members are responsible. In this case the problem is, that the project members are knowledge workers and they should concentrate on their core work and should not use time for explicit enter knowledge into a system. (Staab und Schnurr 2002) Therefore, knowledge including the context is stored automatically. Nunes et. al describes patterns as for recording facts and information without interruption (Nunes et al. 2009). There are two ways to increase the integration: integrate the functionality of Bitrix in existing collaboration platform such as Outlook or integrate more useful application into Bitrix.

At the moment it exists the possibility to synchronize Bitrix with Outlook. But more functionalities such as notifications about news even when the user is not logged into Bitrix should be integrated. Analyzing the results of our questionnaire, we found out that some editor with syntax highlighting would be beneficial for some user groups. Mobile Application can also increase the attractiveness of collaboration platforms. In order to identify value added app usage scenarios, Hoos et. al conceived a framework. This provides a methodology including a criteria catalogue, which enables to derive value added mobile use cases systematically (Hoos et. al.).

6. Conclusion

The platform Bitrix actually used in ARENA2036 can meet almost all requirements of the collaborators. It should be adapted to the individual needs of the users as for example machine information is not necessary for computer scientist. Regarding security concerns it is important to communicate the location of the server and how data are transmitted. The main reason why the collaborators do not use Bitrix at the moment, besides the above mentioned, is the worries about additional effort by using Bitrix as an additional system. Therefore, it has to be integrated at least in Outlook. Our core conclusions are:

- The prioritization of the functionalities varies according the corresponding projects of the users
- Bitrix has already almost all necessary functionality but Bitrix is not used yet because from the coordinators perspective there is no additional information available and they use other channels to communicate or data exchange such as emails and
- Security concerns

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