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A CONCEPTUAL FRAMEWORK OF REQUIREMENTS FOR THE DEVELOPMENT OF E-LEARNING OFFERINGS FROM A PRODUCT SERVICE SYSTEM PERSPECTIVE

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ABSTRACT

The term e-learning subsumes all forms learning where electronic media is used for the presentation and distribution of the course content. Although various guidelines and models exist, the development and operation of e-learning offerings has shown to be a difficult task. Often existing approaches focus on single aspects such as technical details or the content of teaching, while neglecting other aspects such as level of service requirements. As e-learning offerings are IT-based systems consisting of hardware, software, and services that have to be considered from a lifecycle perspective, they exhibit similar characteristics as Product Service Systems. We, therefore, suggest designing e-learning offerings from a systems perspective. As a first step, we synthesize a requirements framework for e-learning offerings from the e-learning and PSS literatures. We enrich the framework with examples from a real-life e-learning offering and argue why the PSS approach is useful for the design of e-learning offerings.

Keywords

Product Service System, PSS, e-learning, conceptual framework, services

INTRODUCTION

E-learning is a form of learning where electronic media is used for the presentation and distribution of course content (Urdan and Weggen, 2000). E-learning is a major trend at universities and other educational institutions worldwide. Different approaches for the development of e-learning offerings have been proposed and their implementation has led to a variety of different e-learning systems (ADL, 2008; Hoppe, 2005). However, the existing approaches often focus on either the technical details or on the content of teaching. According to Penna and Stara (2007) such unilateral view on e-learning offerings leads to many e-learning failures. Other studies (cf. Thomas, 2003) show that focusing only on content details or on technical details lead to lower acceptance of the e-learning and have significant impact on the overall quality of e-learning offerings. Thus, several authors (Ehlers, 2004; Euler et al., 2008) call for a holistic approach for the development of e-learning offerings that accounts for multiple requirements domains, e.g., technical, content, level of service, at the same time.

Since e-learning offerings are IT-based systems consisting of hardware, software and services (Breitner and Hopppe, 2004) that have to be considered from a lifecycle perspective, they exhibit similar characteristics as Product Service Systems (PSS) (Burianek et al., 2009; Leimeister, 2008). We, therefore, propose to see e-learning offerings through the lens of PSS. Thus, we can make use of a variety of contributions on systems engineering for the design of e-learning offerings and also better understand the user's intentions of e-learning offerings through relating e-learning to research on service marketing.

As a first step for the development and operation of e-learning offerings as PSS, we derive a conceptual design framework of requirements consisting of five top-level slots combining project, teaching, functionality, lifecycle, and level of service requirements. Our framework based on the results of a literature analysis in the e-learning and PSS domains as well as our experience from an e-learning development and operation project. The conceptual framework is described in detail in this article and examples from our e-learning project are given for each slot. For an initial verification of the framework, we surveyed 65 participants with different backgrounds (MIS and business) on several characteristics of the framework. We then argue why the systems approach is a useful lens on e-learning offerings and end with a conclusion.

METHODS

Following the guidelines by Webster and Watson (2002), we start our search for relevant literature within the leading journals and conferences in the Information Systems discipline. We search in all Quality IS Literature stated in Levy and Ellis (2006) for the contributions based on following key words: Product Service Systems, PSS, e-learning models, e-learning standards, e-learning quality, PSS requirements, e-learning requirements, hybrid products, hardware, software and service engineering, e-learning quality standards. We also included scientific databases such as 'Ebsco', 'IEEE Xplore', 'CiteSeerX Beta', 'Springer Link', and 'Google Scholar' for the same words. The selected keywords resulted in a total of 236 documents. We screen and eliminate the duplicates and irrelevant documents manually. While ensuring the applicability in the context of e-learning offerings, we identify 23 documents as relevant.

Also, our experiences with a real-life e-learning offering, that we designed and developed at our university, contribute to the structure and design of the framework in many details. The e-learning offering is a strategic business simulation where students have run a bank and make complex decisions.

For an initial verification of the framework, we surveyed 65 students with the help of a semi-structured questionnaire. All the survey respondents were former participants in the business game. We deemed the participant group especially valuable, as all the participants both have a MIS or business background and are familiar with e-learning offerings.

BACKGROUND

In this section we give an overview of literature in the PSS and e-learning domain, whereby we focus on the systems idea of PSS and aspects related to requirements engineering in both PSS and e-learning.

Product Service Systems (PSS)

PSS are defined as bundles of products and services combined into a system (Berkovich et al., 2009). Products are tangible commodities that are manufactured to be sold, while services can be understood as activities done for others, which exhibit an economic value. PSS is a general term which is used in several industries, e.g., manufacturing and IT (Baines et al. 2007). IT-based service systems are a subgroup of PSS in the IT industry. Burianek et al. (2009) suggest defining PSS based on the following three characteristics:

(1) PSS are combinations of product and service components

A PSS is not a fixed combination of product and service components, but different combinations of products and services are possible. Customers who purchase a PSS are not interested in the single parts, but in a solution to their problem (Burianek et al., 2009). Moreover, a PSS cannot directly be attributed a value, but the provider makes a value proposition when offering a PSS.

(2) PSS are tailored to fulfill individual customer needs

PSS are designed to meet the customer's individual needs (Leimeister and Glauner, 2008; Becker and Krcmar, 2008). The PSS provider has to offer activities of a customer-provider relational solution process. Those activities are comprised of requirements analysis, customization, implementation/ deployment, and servicing/operations. The customer and the provider consequently enter a relational business connection (Tuli et al., 2007; Burianek et al., 2009).

(3) PSS are highly integrated

Integration refers to the technical-organizational combination of PSS components. The more inclusive a PSS becomes, the more important it is to fully adapt single components to each other as the number of compatibility constraints increases (Berkovich et al., 2009).

E-learning

According to Urdan and Weggen (2000) e-learning is a form of learning where electronic media is used for the presentation and distribution of course content. E-learning has been viewed as synonymous with Web-based learning, Internet-based training, Advanced Distributed Learning, Web-based Instruction, Online Learning, and Open/Flexible Learning (Khan, 2001). E-learning offerings consequently can be considered as a PSS or more specifically as an IT-based service system.

E-learning offerings have in common that different factors influence the success and users acceptance of the offering (Hoppe, 2005; Garzaldeen and Münzer, 2003; Selim, 2007). Some authors (ADL, 2008; Selim, 2007) point out that e-learning offerings nowadays need to account for interaction functionalities, e.g., chats or wikis.

Moreover, according to Euler et al. (2008) and Ehlers (2004), level of service requirements such as responsiveness and performance play an important role during the operational phase. An e-learning offering not satisfying the standard level of service requirements the student is used to would not be accepted.

Some authors (Euler et al., 2008; Baume, 2009) furthermore propose to embed the e-learning offering development in a project and to perform typical project management tasks such as developing a timetable and setting up a project controlling. Another important aspect is to develop the e-learning offering in close relation to the future user in order to best adapt to the users' requirements (Breitner and Hopppe, 2004).

A CONCEPTUAL FRAMEWORK FOR REQUIREMENTS OF THE DEVELOPMENT OF E-LEARNING OFFERS

In this chapter, the conceptual framework of requirements for the design of e-learning offerings is derived and described. The proposed framework consists of five main slots *Project Requirements*, *Teaching Requirements, Functionality Requirements, Lifecycle Requirements* and *Level of Service Requirements* (cf. Figure 1).

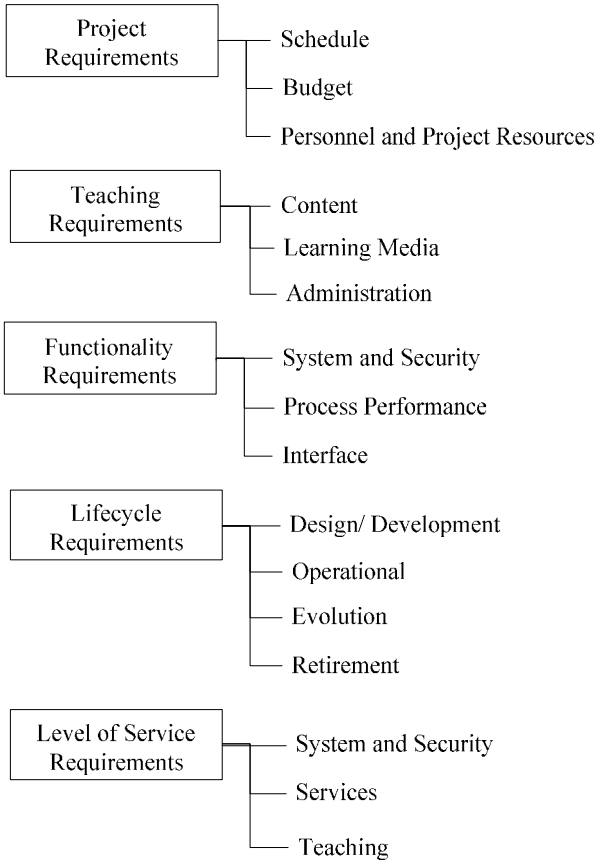

Figure 1. Conceptual framework of requirements for the development of e-learning offerings

Project Requirements

In the analyzed literature, we could identify requirements pertaining to schedule and budget (Boehm et al., 2004; IEEE, 1998; DIN PAS 1032-1, 2004), project staffing, and project resources (DIN PAS 1032-1, 2004).We considered these requirements as project requirements because they relate to how projects are set up and implemented. According to Boehm et al. (2004), we define project requirements as general tasks and restrictions a project team has to fulfill or pay attention to during the project phase.

Schedule

Similar to authors in software and hardware engineering (Boehm et al., 2004; IEEE, 1998), as well as to the e-learning standard (DIN PAS 1032-1, 2004), we define schedule requirements as all important milestones and deadlines that must be met during the project phase.

Budget

Budget requirements are mentioned in hardware and software engineering (Boehm et al., 2004; IEEE, 1998). However, budget requirements and cost calculations also play an important role in the e-learning discipline (Breitner and Hopppe, 2004). We define budget requirements as all kinds of cash flows connected with the project.

Project Personnel and Project Resources

We define project personnel as all people being involved in the project during project time in terms of calendar months and project resources as well as material and equipment needed during the project phase (Boehm et al., 2004; IEEE, 1998).

Teaching Requirements

Authors from the e-learning literature suggest requirements related to content (Breitner and Hopppe, 2004; Selim 2007), learning media (Selim 2007; Jaspers, 1991), and administration (Rosenberg, 2001; ADL, 2008). From a systems approach, we argue to consider those domain requirements along with project or technical systems requirements at the same time. We, therefore, propose to define teaching requirements as all important tasks that have to be fulfilled during the curriculum planning and management as well as the lectures and that impose constraints on the e-learning offering.

Content Requirements

Some authors (Webster and Hackley, 1997; Volery and Lord, 2000) in the e-learning domain suggest content requirements related to course content, learning sequence, and pace of learning. We define content requirements as all important requirements pertaining to the teaching content and its representation from a didactic perspective as well as the resulting constraints that are imposed on the system.

Learning Media Requirements

According to Selim (2007) and Jaspers (1991) the right form of learning media (e.g., text, language, video, simulation, or game) is necessary for a successful knowledge transfer. Learning media requirements include all requirements and constraints for the different kinds of multimedia applications that help to create meaningful e-learning environments from a didactic perspective as well as the resulting constraints that are imposed on the system.

Administration Requirements

Rosenberg (2001) and ADL (2008) suggest administration requirements regarding different lecturer tasks and student services (e.g., registration, counseling, advising, and tutorial services). We define administration requirements as all kinds of recurrent non-lecturing tasks which support the successful course of an e-learning lecture as well as the resulting constraints that are imposed on the system.

Functionality Requirements

All contributions we analyzed from the hardware, software and service engineering disciplines propose requirements for system functions (Ullmann, 2003; White and Edwards, 1995), application capabilities (Boehm et al., 2004), functional requirements (IEEE, 1998), functions (Liechtenstein et al., 2004), core elements (Lovelock and Wright, 2001), or requirements on how the results are achieved (Bullinger et al., 2003). Similarly, authors from the PSS domain frequently mention functions or functional requirements (Burianek et al., 2009; 2008; Tuli et al., 2007). In the e-learning standard SCORM, offerings are divided into functional components, e.g., learning management systems and sharable content objects. We subsume all those requirements as functionality requirements. According to Boehm et al. (2004) and White and Edwards (1995), we define functionality requirements for the conceptual framework as features the e-learning offer has to provide as well as the supported services and its behavior. To reduce complexity, we divide this slot into system and security, process performance, and interface requirements.

System and Security Requirements

We define system functionality requirements as all features related to material and immaterial components connected to the e-learning offering. This includes communication infrastructure (e.g., backup and recovery systems, network security, and accessibility), learning management components (e.g., knowledge tests, features for learning progress monitoring), or collaborating learning functionalities (e.g., chats or wikis) (Breitner and Hopppe, 2004; Selim, 2007).

Process Performance Requirements

Process performance requirements account for all functionalities which relate to effectively managing the processes related to the e-learning system, such as change management, customizations, automation, or integrations with existing support systems. One example is the automation of administrative processes (such as participant list creation, group mailing) to support lecturers (ADL, 2008; Breitner and Hoppe, 2004).

Interface Requirements

Authors from all disciplines analyzed (White and Edwards, 1995; Roman, 1985; IEEE, 1998; Boehm et al., 2004; Liechtenstein et al., 2004; Lovelock and Wright, 2001; ADL, 2008) stress the importance of interface requirements. Thus, we define interface requirements for the conceptual framework according to Boehm et al. (2004) as the requirements which describe the interaction, exchange and communication of the system with users, hardware, software, and services for input and output.

Lifecycle Requirements

Authors from hardware (Ullmann, 2003; White and Edwards, 1995) and service engineering (Lovelock and Wright, 2001; Bullinger et al., 2003) differentiate between requirements which are important in the design phase and which are important in the operation phase. Moreover, software engineering authors (Boehm et al., 2004; IEEE, 1998) differentiate between design and evolution requirements and authors from the PSS (Tuli et al., 2007; Burianek et al., 2009) as well as e-learning discipline (Baume, 2009) distinguish development and operational requirements. Hence, we conclude that different requirements exist in different lifecycle phases. For the conceptual framework, we subsume these requirements as lifecycle requirements and divide the slot into design/development, operational, evolution and retirement requirements.

Design/ Development Requirements

Design/ development requirements are frequently mentioned in hardware (Ullmann, 2003; White and Edwards, 1995), software (Boehm et al., 2004; IEEE, 1998) and service engineering (Liechtenstein et al., 2004; Lovelock and Wright, 2001; Bullinger et al., 2003), as well as in many e-learning standards (ADL, 2008; IEEE, 2002; IMS, 2005). We define design/ development requirements as all requirements that must be considered in the design and development phase of an e-learning offering, e.g., the use of a specific programming language or reference models for service blueprinting.

Operational Requirements

Operational requirements are mentioned in the hardware (Ullmann, 2003; White and Edwards, 1995) and service engineering literatures (Liechtenstein et al., 2004; Lovelock and Wright, 2001; Bullinger et al., 2003). We define all requirements that must be fulfilled during the operational phase and all the resources needed to operate the e-learning offer as operational requirements. In our project, these were the required maintenance personnel and permanently needed resources such as IT and meeting rooms.

Evolution Requirements

Evolution requirements are suggested in hardware engineering (Boehm et al., 2004; IEEE, 1998), software engineering (Boehm et al., 2004; IEEE, 1998), and service engineering (Liechtenstein et al., 2004; Lovelock and Wright, 2001; Bullinger et al., 2003). Moreover, authors from the e-learning (Baume, 2009) and PSS (Burianek et al., 2009; Tuli et al., 2007) domains emphasize the importance of growth and expansion. We subsume all those requirements as evolution requirements and define evolution requirements to take into account all foreseeable developments and future growth expectations.

Retirement Requirements

Retirement requirements are common in hardware engineering (Ullmann, 2003). We define retirement requirements of an e-learning offering as all requirements related to assigning personnel and material resources to new purposes. For example, we did not choose a physical but a virtual server for the operation of the e-learning offering as we can use the servers for other purposes after the shutdown of the business game.

Level of Service Requirements

Authors from various disciplines we analyzed suggest performance requirements (IEEE, 1998; Liechtenstein et al., 2004; Ullmann, 2003), service levels (Boehm et al., 2004), non-functional requirements (Roman, 1985; White and Edwards, 1995), and level of service requirements (Lovelock and Wright, 2001; Bullinger et al., 2003). According to Boehm et al. (2004), we define level of service requirements as how well given requirements are performed. To reduce complexity, level of service requirements are subdivided into system and security, services, and teaching level of service requirements.

System and Security

Authors in hardware engineering have proposed a variety of level of service and security requirements (White and Edwards, 1995; Ullmann, 2003; Roman, 1985). In software engineering, many authors refer to the term as „the -illities", like „reliability", „maintainability", and „flexibility". We suggest reverting to Garvin (1984) and Boehm et al. (2004) for e-learning offering level of service requirements, who identify and define level of system requirements such as performance, availability, maintainability, usability, reusability, and system security.

Services

The service engineering discipline is nascent (Berkovich et al., 2009). Moreover, level of service requirements for services are often considered at a very technical level. For this reason we refer to Zeithaml et al. (1990), who identified ten general level of service determinants: reliability, responsiveness, competence, access, courtesy, communication, credibility, security, understanding, and tangibles.

Teaching

As we consider e-learning offerings from a systems perspective, we also suggest including level of service requirements for teaching aspects. E-learning standards (ADL, 2008; IMS, 2005) frequently include the following requirements related to teaching and coursework aspects: evaluation of teacher's didactical competency, teacher responsiveness, quality of content and learning material.

As next, we analyze the initial interaction between the identified requirements, which we summarize in Table 1.

	Project	Teaching	Functionality	Lifecycle	Level of Service
Project	-	-	-	-	-
Teaching	x	-	-	-	-
Functionality	x	x	-	x	-
Lifecycle	x	-	-	-	-
Level of Service	x	x	x	x	-

Table 1. Matrix of hypothesized effects between identified requirements

Project requirements are affected by all other identified requirements, as they pertain to the requirements and assumptions about the proposed e-learning offering and the needed resources. Level of service requirements affect teaching, functionality and lifecycle requirements, as they define and analyze how efficient given requirements are performed. Finally, functionality requirements affect teaching and lifecycle requirements as they define how an e-learning offering should serve and which functionalities and services it should provide.

EVALUATION

For the evaluation, we used a semi-structured questionnaire consisting of a total of 16 questions. 4 questions regarded the overall framework completeness, intuitiveness, and usefulness, as well as the usefulness to consider content and technical aspects at the same time. Answers were given on a 7 point Likert scale (7: strongly agree, 4: neutral, 1: strongly disagree). Another 6 Yes-No questions with additionally text fields asked for improvement suggestions. Finally, 6 questions pertained to the participants' personal backgrounds. The survey's objective was to get the students feedback and their impressions of the proposed framework. The students were given a handout with an overview of the framework and with written definitions of each category such as proposed in the main chapter. 65 students took part in our survey. All surveyed students were master degree students that participated in our business game course and had either a MIS (90.7%) or a business (9.2%) background. Most of the students (81.5%) already have work experience and 28 (43%) of them see themselves as "experienced" to "very experienced" in software and system development. The results from the survey are shown in Table 2.

Framework survey (n = 65)	**Average**	**Variance**

Completeness overall	5.2	1.2
Intuitiveness overall	4.6	2.1
Usefulness overall	4.8	2.1
Usefulness of considering content and technical aspects at the same time	3.9	4.1
	Yes/No Questions:	
Can you think of categories not included in the framework?	Y=29 N=36	
Can you identify requirements that could not be assigned to any of the requirements categories?	Y=16 N=49	
Can you identify requirements that would fit into several requirements categories?	Y=9 N=56	
Can you identify unnecessary requirements categories?	Y=14 N=51	
Would you suggest renaming one or several requirements categories?	Y=9 N=56	

Table 2. Survey Results

The overall results indicate that the respondents found our framework overall complete (mean 5.2), intuitive (mean 4.6), and useful (mean 4.8). The participants slightly disagreed to consider content and technical aspects at the same time (mean 3,9). 29 respondents (44.6%) proposed new requirements categories like security, user, or support. 16 students (24.6%) named requirements they had trouble to assign to a category, e.g., usability, student evaluation, or change management. 9 students (13.8%) suggested change management, usability, administration, and evaluation as requirements that would fit into several requirements categories. Moreover, as 9 students proposed, we renamed a former Content Requirements category into Teaching Requirements, as those requirements do not only relate to the learning content, but to the overall teaching affairs.

Especially with regard to questions one to three, the participants attested that our framework is useful for the design of e-learning offerings. For the next version, we are going to incorporate the participants' feedback into the framework.

DISCUSSION

As we have shown, e-learning offerings are IT-based service systems that comprise hardware, software, service components (Breitner and Hopppe, 2004). Therefore, e-learning offerings qualify as an instantiation of PSS, which developed from the idea that customers are not interested in products or services per se, but in solutions to their individual needs (Baines et al., 2007; Leimeister and Glauner, 2008). The idea of PSS is strongly related to the emerging idea of service systems and the Service Dominant Logic (SDL) (Vargo and Lusch, 2004; Spohrer and Maglio, 2007).

The original idea to consider e-learning offerings as PSS developed when we performed a literature analysis on e-learning and when we came to the conclusion that many existing contributions focus on specific details of an e-learning offering only. Similar to Ackoff (1971), who argues that a systems approach always needs to focus on the whole system and not the single parts, we suggest approaching the design, development, and operation of e-learning offerings from a systems perspective. Our theoretical contribution is, therefore, that we connect the e-learning domain to the PSS and systems approach and, the other way round, that we propose e-learning offerings as a practical example for service researchers.

That said, this research is not without its limitations. We need to show in more detail that e-learning offerings have the same characteristics as the underlying fundamental premises of the SDL, e.g., that providers only can make value propositions, that customer and provider enter a relational business connection, and that both are resource integrators. Although our framework is a practical contribution, more research is required to refine its structure and categories. Experiences form the application of the framework in the field might deliver useful insights for further development. Also, the framework is meant to be used for the requirements elicitation at the beginning of e-learning projects to stimulate thinking, focus effort, and check for thoroughness. In the future, the framework might be more detailed to also be used in later design phases.

CONCLUSION

The conceptual five-part framework is derived from literature on e-learning, PSS and the PSS related disciplines. We moreover enriched the framework with experiences and examples from an e-learning project. Five top-level slots were designated for the framework, including project requirements, teaching requirements, functionality requirements, lifecycle requirements, and level of service requirements. In a first step to validate the framework, we also surveyed 65 students with MIS and business backgrounds.

This paper contributes a novel, single expression of requirements for e-learning offerings based on a PSS perspective. One fundamental idea underlying the PSS perspective is the system approach, which is the consideration of multiple design, development, and operations aspects at the same time. With our framework, we intend to bring together the e-learning and PSS domains. Moreover, we hope that researchers might use the framework as a starting point for the development of e-learning requirements engineering models adopting a systems approach. Practitioners might find or framework useful in collaborative requirements workshops and other settings.

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