Linking business and requirements engineering: is solution planning a missing activity in software product companies?

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Abstract A strong link between strategy and product development is important, since companies need to select requirements for forthcoming releases. However, in practice, connecting requirements engineering (RE) and business planning is far from trivial. This paper describes the lessons learned from four software product companies that have recognized the need for more business-oriented long-term planning. The study was conducted using the action research approach. We identified five practices that seem to strengthen the link between business decisions and RE. These are (1) explicating the planning levels and time horizons; (2) separating the planning of products' business goals from R&D resource allocation; (3) planning open-endedly with a pre-defined rhythm; (4) emphasizing whole-product thinking; and (5) making solution planning visible. To support whole-product thinking and solution planning, we suggest that companies create solution concepts. The purpose of the solution concept is to provide a big picture of the solution and guide RE activities.

1 Introduction

For a software company, product development is an investment that should provide maximal added value [1]. Providing value for different customer and end-user segments by means of the product is a lifeline for the sales of the product, and via that, to the business of the company. This means that a company needs the ability to implement the most valuable requirements in a software product in each product release. Especially in the software product business, the role of a successful selection of the feature enhancements (i.e., requirements) in product releases is recognized to be extremely important [2, 3].

However, market-driven requirements engineering (RE) seems to entail special challenges [4]. The selection and prioritization of requirements in particular has been recognized as a challenging activity [5–7]. Many of the challenges involved in the selection and prioritization of requirements are related to the inability of those involved to understand the business value of individual requirements and the business consequences of the available opportunities [7, 8].

The need to make business-based product development decisions means that a company needs the ability to connect business management and software development [9]. Only by integrating upstream (that is, long-term planning) and downstream (that is, software development) processes, can value-based decisions concerning the future features of the products be made [10, 11]. Unfortunately, in research on RE, the viewpoint has mostly been that of bespoke

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software development [4], while RE outside projects (e.g., long-term product planning) has had less emphasis.

Long-term product planning (typically called roadmapping [12, 13]) is one approach that companies have used to bridge the gap between business planning and product development. Roadmapping is widely used as a technique in manufacturing industry [14]. However, the application of the approach in the software engineering field is rather new and has been investigated less. Additionally, the practical implications of long-term product planning in software product companies in terms of the state of practice or of good practices are not widely known.

In this paper, we investigated the current state of long-term planning in four Finnish software product companies that operate in international markets. As a result, we provide the lessons learned from how the companies link business decisions to RE by long-term planning. Furthermore, we provide the lessons learned from introducing solution-level planning practices between strategy and product development. The research is an ongoing part of a long-term action research relationship with the case study companies.

This paper is structured as follows. Section 2 presents related work. In Sect. 3, we describe the research design. The current state of the long-term planning of the case companies is explained in Sect. 4. Section 5 introduces five practices that seem to strengthen the link between business view and RE. The results of the study are discussed in Sect. 6. Finally, the paper summarizes the key results and suggests directions for further research.

2 Related work

2.1 Market-driven requirements engineering

Software companies can be roughly divided into two: companies operating in the software project business (other terms used are 'bespoke software' and 'software services') and in the software product business (also called 'market-driven software development') [15–17]. However, new service-oriented business models, such as Software as a Service (SaaS) and "free, but not free" software, have recently confused the traditional division [18].

Market-driven requirements engineering refers to requirements engineering in companies operating in the software product business. According to Nambisan, software companies moving towards the software product business from project business face new managerial product development challenges [17]. The differences between the business models seem to be reflected in requirements engineering as well. For example, Karlsson et al. reported that requirements engineering for commercial off-the-shelf software packages entails special challenges such as a

communication gap between marketing staff and development personnel [4].

One of the key effects that the transition to product business has had on requirements engineering is the increasing importance of requirements prioritization and selection [19]. Software product companies have to deal with a steady stream of new requirements as well as selecting an optimal set of these requirements for implementation in the next version [20]. This implies that, in market-driven situations, requirements engineering is not just a within-project activity.

Lately, in many software product companies, the revenue from services has become greater than that from products [18]. However, while the service sector has grown over several decades to its current position of a leading market, the scientific understanding of present services is undeveloped [21]. This implies that requirements engineering should not only concentrate on product properties, but also enlarge its focus to include services as well.

2.2 Value-based requirements prioritization

Wiegers defines a requirement as a property that a product must have to provide value to a stakeholder [22]. The challenge (in product development) is to select the 'right' requirements out of a given superset of candidate requirements so that all the different key interests, technical constraints, and preferences of the critical stakeholders are fulfilled and the overall business value is maximized [23]. Unfortunately, much current software engineering practice and research is conducted in a value-neutral setting, in which every requirement is treated as equally important [1].

In a market-driven situation, the traditional monolithic requirements specification is of limited value when managing a steady stream of incoming requirements of varying quality [4]. Additionally, Wiegers suggests that priorities should be evaluated and adjusted periodically throughout development as customer needs, market conditions, and business goals evolve [22].

However, the viewpoint in the requirements engineering literature has usually been that of bespoke software development [4]. As a whole, requirements engineering outside projects seems not to have been discussed that much in the literature. According to Ebert, this might be because of its complexity (e.g., overlapping ownerships) and the historical division between product management and requirements engineering, which was perceived as an internal engineering discipline [10].

2.3 Long-term product planning

Earlier studies indicate that requirements documents for short projects are not sufficient to ensure the

comprehensive understanding in the organization that developing software products for wide markets requires [4, 11]. Long-term product planning is one route that software product companies follow to explicate the link that is needed between business decisions and requirements engineering [11].

Typically, long-term product planning is called roadmapping in software product companies. In general, roadmapping can be defined as a flexible technique that is used to support strategic and long-range planning [12]. The basic purpose of roadmapping is to explore and communicate the dynamic linkages between markets, products, and technologies over a period of time [12]. A generic roadmap is a time-based chart that typically includes both commercial and technological perspectives [12]. In the context of software development, roadmapping can be defined as a popular metaphor for planning and portraying artefacts, resource usage, and their relationships over a period of time [24].

Rautiainen and Lassenius report the three main values that long-term product planning provides for software product companies [24]. These are (1) help in coordinating a complex set of activities; (2) explication of the direction of intent, and (3) help in making short-term decisions and trade-offs. Additionally, Vähäniitty et al. report an experience where a small software company used (product) roadmapping for keeping long-term goals clear and maintaining its focus on the right issues [25]. However, the current state of long-term product planning in software product companies has not been widely investigated.

2.4 Solution development

In this paper, we use the term 'solution' to refer to a core product augmented by everything that is needed for the customer to have a compelling reason to buy it, and to satisfy a customer want or need. The core product is, in the case of a software company, typically a software system. In addition, a solution includes other components, such as training, installation instructions, manuals, support, and other services.

Grönroos motivates the notion of solution by observing that customers do not buy goods or services as such; instead they buy the benefits they provide. The value of a solution cannot be built just by developing product features and by focusing on software development. Further, value for customers is not embedded in products. Instead, value for customers emerges when customers use products. Therefore, the focus should be on customers' value-creating process [26].

Most of the requirements engineering literature focuses on defining requirements for core products. Hutchings and Knox, however, were able to widen the requirements scope

towards a solution view including, e.g., the deployment of the product and service scenarios [27]. This happened mainly by having a cross-functional team for requirements engineering and by generating a "whole-product view". This enabled practitioners to share their understanding of the challenges that customers currently face [27].

3 Research design

This research was conducted as a part of two research projects (Core and Reflex) at the Software Business and Engineering Institute at Helsinki University of Technology between 2003 and 2008. The high-level research goals of the projects were to investigate how organizations can cost-effectively develop products and solutions that provide value for both customers and users.

3.1 Research goals and questions

The high-level objective of this study was to investigate the practices that software product companies have for long-term product and solution planning. The detailed research questions were as follows:

1. What are the characteristics of long-term product planning in software product companies?
2. What practices support linking business decisions to requirements engineering?

This paper is an extended version of our paper published in the proceedings of the 15th IEEE International Conference on Requirements Engineering [28]. This earlier paper described the results of Phase 1 of our study. The focus of Phase 1 was on long-term product planning. In Phase 2, we proceeded with our research collaboration, with the focus on solution planning.

3.2 Research context and case organizations

This paper describes the results of a study performed in two phases (Fig. 1). During Phase 1, we focused on long-term product planning. First, we gathered information about the current state of long-term planning in four Finnish software product companies. The goal was to gain a deep understanding of the existing planning activities in company A and company B. In order to get a wider understanding of long-term product planning, we also gathered information from company C and company D. This means that the researchers were able to compare the findings from case organizations A and B with the findings from case organizations C and D.

After the current-state analysis, we continued our action research with company A and company B. The goal of this
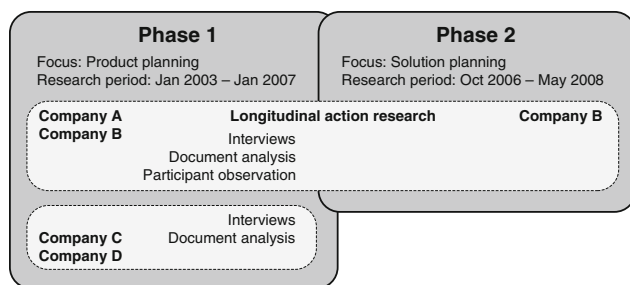
Fig. 1 Overview of the research phases

Table 1 Case companies

Company	Number of employees	Application domain
A	500	Information management systems for building, public infrastructure, and energy distribution designers
B	600	Computer security systems for companies and consumers
C	100	Computer security systems for companies and consumers
D	300	Systems for financial processes and buyer–supplier-related transactions

research collaboration was to support these two companies in developing product planning practices. In other words, the researchers participated in the process improvement work of company A and company B.

In Phase 2, the focus of our research was on solution planning. The idea of focusing on solution planning in this continuation of the study originated from two directions. First, the results of Phase 1 indicated that many case companies were facing challenges in obtaining a coherent overview of their solutions and planning them further. Second, one of the case companies wanted to continue improving their long-term planning practices by focusing on the solution-level.

The second phase of our study was performed in company B, because the company was willing to integrate the solution perspective into long-term planning activities. Company A was also interested in linking its business view and long-term planning more closely to RE practices. Because the research work with them started 8 months later than with company B, we have not yet been able to compare the findings and include them in this paper.

All the participating companies are developing software products for international markets. All of them are medium-sized, and represent three different kinds of application domain. The case companies are introduced in Table 1.

3.3 Research approach

The need for a deep understanding of the long-term planning practices, problems, and needs in software product companies calls for a qualitative research approach and, more precisely, an action research method [29, 30]. According to Avison et al., the particular strength of qualitative methods is their value in explaining what goes on in organizations; furthermore, action research can address complex real-life problems and immediate concerns [29]. In addition, qualitative methods permit the evaluator to study selected issues in depth and detail [31].

Additionally, Potts suggests an "industry-as-laboratory" research approach, where researchers identify problems

through close involvement with industrial projects and create and evaluate practices addressing the problem [32]. This lets researchers emphasize what people actually do or can do in practice, rather than what is possible in principle. Formal research operates at a distance from the everyday lives of practitioners, and, although it provides interesting theoretical perspectives about the nature and complexities of social life, it largely fails to penetrate the experienced reality of their day-to-day work [30]. Action research instead seeks to engage "subjects" as equal and full participants in the research process [30]. According to Avison et al., action research is an iterative process involving researchers and practitioners acting together in a particular cycle of activities, including problem diagnosis, action intervention, and reflective learning [29].

3.4 Data collection

3.4.1 Phase 1

The first phase of the study was performed in all four case companies. This phase consisted of several research activities that are listed in Table 2. The goal of the phase was to gain a deep understanding about the current long-term product planning practices and to learn which practices help to link their business view to RE.

Primary informants were interviewed in all four case companies. By primary informants we mean practitioners who are personally responsible for preparing long-term product plans. In addition, we interviewed secondary informants in the two main case companies (A and B). By secondary informants we mean practitioners that have a business interest in long-term plans. By interviewing representatives of both of these groups we wanted to understand the current planning processes from different viewpoints.

The key criterion for selecting the primary informants was that they have experience and knowledge about the current planning activities. Regarding secondary informants, it was important that the interviewees represented

Table 2 Research activities of Phase 1

	A	B	C	D
Interviews: primary stakeholders	x	x	x	x
Document analysis	x	x	x	x
Experience exchange seminars	x	x	x	x
Informal conversation	x	x	x	x
Interviews: secondary stakeholders	x	x		
Process improvement work	x	x		
Observation	x	x		

Table 3 Primary informants of Phase 1

Company	Informants	
	Roles	Total number
A	Product manager (2)	3
	Product management director	
B	Product manager	3
C	Director of product development	1
D	Product manager	1

Table 4 Secondary informants of Phase 1

Company	Informants	
	Roles	Total number
A	Business area leader	5
	Director of a segment	
	Documentation specialist	
	Marketing planner	
	Service manager	
B	Director, professional services	4
	Director, services	
	Director, software processes	
	Vice-President, R&D	

different perspectives, such as marketing, services, documentation, and R&D. An overview of the primary informants can be found in Table 3 and of the secondary informants in Table 4.

The interviews were semi-structured, meaning that there were certain themes that we discussed in each interview, but the phrasing of the questions varied from time to time. The interview themes included current long-term planning practices, challenges and good practices, and future development ideas that the practitioners have for improving their current practices. The interviewees were also asked to show and explain any documents, process descriptions, and examples related to long-term product planning that they had in the company. The researchers

were also able to take this material with them in order to perform a deeper analysis. The interviews lasted from 1 to 2 h. All the interviews were recorded.

In addition to the interviews, the researchers were involved in process improvement work in case organizations A and B, which allowed them to attain a deeper understanding of the existing processes and practices, improvement needs, and viewpoints of different stakeholders. The researchers were also able to observe actual long-term planning sessions in the two main case companies. We also organized three experience exchange seminars for the practitioners of all the case companies during Phase 1. In these seminars, the practitioners presented their long-term planning practices and were thus able to learn from each other and gain new understanding and insights. The researchers, on the other hand, had an opportunity to follow the current trends and learning curve in the companies. In practice, the researchers worked closely with the two main companies in order to improve their long-term planning practices in co-operation with the practitioners during the research period.

3.4.2 Phase 2

The second phase of our study was based on research collaboration with case company B. The core of the research collaboration consisted of eight interviews and four workshops. The number of interviewees was eight, and ten different practitioners participated in the workshops. The role and total number of the different informants are summarized in Table 5.

The goal of the eight interviews was to investigate what the current state of solution planning was in the company and gain information about how the interviewees would improve the existing practices.

The key criterion for selecting interviewees was that they had knowledge about the current planning activities. In addition, it was important that the informants represented different perspectives, such as strategy planning, long-term product planning, service planning, marketing, R&D, and process improvement. The participants in the interviews were selected by an employee of company B who knew the personnel of different organizational units well. This person was also one of the key informants and the coordinator of the research collaboration in the company.

The interviews were open-ended and semi-structured. The researchers defined five topics for the interviews: (1) long-term planning activities; (2) customers and customer groups; (3) the benefits gained by customers; (4) the components of the solution, and (5) the RE activities and agile approach. In addition, the researchers defined a set of company-specific questions that specified these topics in more detail. The purpose of the topics and questions was to

Table 5 Informants of Phase 2

Company: data source	Informants	
	Roles	Total number
Company B: 8 interviews	Director, professional services	8
	Director of a program	
	Director, services	
	Process developer	
	Vice-President, products & services	
	Vice-President, R&D (3)	
Company B: 4 workshops	Director, professional services	10
	Director of a program	
	Director, services	
	Leader of user experience team	
	Process developer	
	Project manager	
	Product manager	
	Vice-President, products & services	
	Vice -President, R&D (2)	

ensure that the same basic lines of inquiry were followed with each interviewee. However, the interviewers had freedom to change the order of the topics, to build a conversation with each interviewee in whatever direction appeared to be appropriate, and to word questions spontaneously. The interviews lasted from 70 to 90 min. Two researchers participated in all the interviews except one. All the interviews were recorded.

The results of the interviews were processed further in the workshops. The purpose of the workshops was to elaborate the interview results and to create a dialog among the practitioners and between the practitioners and the researchers. The target was to identify and develop together practices that support solution planning and development.

The participants in the workshops were selected by the research coordinator, who was an employee of company B and knew the personnel of the different units in the organization well. This person also participated in all the workshops.

The number of practitioners in the workshops varied from four to seven. Their role was to give feedback about the findings and suggestions presented by the researchers, make their own proposals, and provide more knowledge about the current situation. At least two researchers participated in each workshop. Their role was to present the findings from the data gathered earlier, make suggestions, facilitate the discussion, make observations, and write notes. The last two workshops were also recorded.

In addition to the interviews and workshops, the researchers were able to collect data at five meetings. The

purpose of the meetings was to get the latest information about the planning and RE activities of the case company. Getting this up-to-date information was important because the case company was deploying an agile approach throughout the whole company and this affected both planning and RE activities.

3.5 Data analysis

3.5.1 Phase 1

All of the interviews of Phase 1 were transcribed on the basis of the recordings. The analysis of the interview data was performed in three stages. First, the data were analyzed on an interviewee-by-interviewee basis, then within each case organization, and finally all interview findings together. Quotations related to each theme discussed in the interviews were grouped together. Groups related to different themes were represented using a mind map.

In the first phase, this grouping of quotations was done for each interview separately. In the second phase, the mind maps created in the first phase were combined so that the findings from all the interviews in one company were put into one mind map. In this phase, the researchers also started to build up thematic categories on the basis of similar quotations from different interviews. This ended up in a number of sub-branches of common findings within high-level theme branches in the mind maps. In other words, new categories in the mind maps were built on the basis of common findings in the interviews.

In the third phase, the mind maps were combined so that the findings from all the interviews were put into one mind map and the researcher was able to find more categories by recognizing common findings from the interview quotations.

The focus of the study was more on finding commonalities between the companies in their long-term planning, rather than finding discrepancies and analyzing the rationales for these. However, we also made role-based comparisons in order to understand the role-specific characteristics in the experiences and challenges involved in long-term planning within the case companies.

The interview results were validated in case companies A and B. The researchers started the process improvement work in these case companies by presenting the interview results to practitioners. In both companies, these findings were discussed with a representative group of practitioners. These discussions provided the researchers with new insights that helped them understand the interview findings better. Within these validation discussions the misunderstandings from the interviews were also corrected.

During the improvement work itself, the researcher kept a research diary in which she wrote her field notes. Case

write-ups were written after every meeting. The field notes were mostly descriptions about half a page long of what happened in each meeting and, typically, a few sentences of analysis of observations concerning, for example, conflicts between participants or the motivation of participants. The field notes can be seen both as notes from the meetings and as a type of preliminary analysis. The field note findings were not added as such to the mind maps, but they were compared to the findings from the mind maps. Even though only one researcher did the interviews in this part of the study, another researcher, who also participated in the process improvement, reviewed the findings.

The results of Phase 1 consisted of two main areas: a description of the current state of the planning activities in the case companies and practices that seem to link business to RE. The description of the current state was formed on the basis of commonalities between the companies. The practices that link business to RE were selected on the basis of the researchers' analysis of the current practices and existing bottlenecks in the case organizations.

3.5.2 Phase 2

All of the interviews from Phase 2 were transcribed on the basis of the recordings. Three researchers analyzed and coded the transcripts. Each of them had his or her own themes for the coding. The themes were (1) long-term planning activities; (2) customers; (3) customer benefits; (4) the development of solutions, and (5) RE activities. During the coding phase, the researchers identified quotations related to the themes and marked these quotations with a color code in the transcripts. The purpose of this color-coding was to enable the researchers to follow each other's coding process and check that all the relevant issues had been identified and marked.

After coding, each researcher analyzed the coded material further from the perspective of his or her themes and grouped the quotations from the individual interviews into categories. For example, the analysis of the quotations related to long-term planning activities led to three main categories: (1) planning levels; (2) planning horizons, and (3) challenges related to planning.

Each researcher presented the results of his or her analysis to the other two researchers to validate the findings. On the basis of the analysis, the researchers wrote a case report that summarized the key findings from the interviews. The purpose of the case report was to illuminate the interview results and form a starting point for the research collaboration to be done with company B.

The results of the interviews were validated and processed further in the workshops that were organized for the practitioners of the case company. In other words, the data collection and analysis process was iterative and incremental. In each workshop, the researchers presented the key findings from the previous workshop and introduced new ideas for supporting solution planning and development. These ideas emerged from the data gathered from the practitioners of company B, existing literature, and the experience of the researchers.

To concretize the iterative nature of the data collection and analysis, we give an example here. The interviews revealed the fact that people seemed to have different views of who the customers of one of the solutions were. The researchers presented this finding in the first workshop. The finding created lively discussion among the participants. The following two issues were especially elaborated in the first workshop: (1) who the main customers were, and (2) how customer-oriented the company was.

The theme of the second workshop was "customer value". This theme was selected because the findings from the interviews and the first workshop indicated that there was a need to clarify what kind of customer groups the company has and what kind of benefits the solutions of the company provided for customers. The researchers proposed customer segmentation as a practice to be used at the solution-level. The original idea for customer segmentation came from one of the interviewees, who emphasized the need to divide customers into smaller categories.

As a summary, the data analysis of Phase 2 was iterative. Two researchers analyzed the collected data and evaluated the findings together before the workshops. In the workshops, the findings were elaborated together with the personnel of the case company.

3.6 State of the practice in the case companies

In this section, we summarize the main reasons why the companies deemed long-term product planning important and necessary. In addition, we describe the characteristics of existing practices in the area.

3.7 Rationale for long-term product planning

3.7.1 The need to gain and share a holistic long-term view of the future with different stakeholders

Sharing a common and holistic long-term view of the future development steps of the software products within the organization was recognized as important in the case companies. All the case companies had found that requirements documents for short projects were not sufficient to ensure the necessary kind of wide understanding in the organization. Both the internal and external communication of the products' future development steps and their rationales were critical issues that the companies had had problems with. By 'holistic', we mean that an important

need for many of the case companies was that they wanted to inform and involve more stakeholders (R&D, marketing and sales, and management) within the company earlier in the development cycle. The companies wanted to start the development by setting the high-level targets co-operatively beforehand so that the marketing and sales functions were able to prepare their activities at the same time as the product development activities.

3.7.2 The need to link business decisions to product development

The practitioners in the case companies felt that they needed some articulated decisions, not only concerning the future features of subsequent releases, but also the expected customer segments, and which geographical areas they were to satisfy most with the different releases. This was seen as necessary for preparing for the future and for understanding the priorities of the potential features better.

3.7.3 The need to explicate the links between the development needs of different products

In all of the case companies, the product managers were fighting for the same product development resources. This means that the practitioners needed to be able to communicate their future ideas and resource needs to other product managers in a way that was understandable. This communication was also needed to find and realize potential synergies that might exist between different products and their future development directions.

In addition, the management in most of the case companies faced the challenge of comparing different projects and feature ideas with each other. This is why, in many of the case companies, the management had compelled practitioners to prepare the roadmaps in such a way that the management could see all the planned releases in the same format and thus were able to compare them in order to make trade-offs.

3.8 Characteristics of existing practices

3.8.1 Focus is usually on features of one product

Typically, the roadmaps depicted a high-level view of the most important features of the forthcoming releases. In two of the case companies, the roadmap templates also covered issues such as marketing arguments or product positioning in the markets. However, practitioners saw that kind of information as quite static, and therefore the dynamic planning of these items via roadmaps had not worked properly.

Most case companies saw, for example, announcements of forthcoming language versions and dropped features (compared to earlier versions) as important information that should be covered in the roadmaps. However, integrating these issues into roadmaps was not systematic in the case companies. In addition, roadmapping was usually performed for individual software products, while possible links to other products and synergies were not explicitly recognized.

3.8.2 Link from business decisions to requirement engineering decisions not explicit

All of the case companies felt that the feature-level roadmapping was not enough, and that a more business-oriented view of the future was needed. Furthermore, explicit linking between different planning levels was needed to understand which business targets are affected if certain features are not implemented, or which products are affected by different business targets. However, the relationships between business goals and decisions regarding features seemed to be quite difficult to identify in practice.

3.8.3 Typical planning horizon is a few releases ahead

The most typical planning horizon in the case companies was from one to two releases ahead. The time horizon for planning was usually open-ended so that the near future was planned in more detail. The more remote future was also outlined, but in less detail.

3.8.4 Preparation of roadmaps is mostly the product managers' responsibility

Product managers were usually responsible for preparing the roadmaps. This is quite natural since the decisions concerning the future of the products were their responsibility. The most important stakeholder groups to which the contents of roadmaps were communicated and with whom the product managers should negotiate were management, sales and channel partners, and customers. However, the viewpoint of the developer was usually less emphasized in the case companies than that of other stakeholders.

4 Practices that link business view to RE

In this section, the practices that seem to strengthen the link between business decisions and requirements engineering

are presented. The corresponding practices are summarized in the bullet points below:

- Explicate planning levels and time horizons
- Separate planning of products' business goals from R&D resource allocation
- Plan open-endedly with a pre-defined rhythm
- Emphasize whole-product thinking
- Make solution planning visible.

4.1 Explicate planning levels and time horizons

It seems that one of the first things to do for a company developing or improving its long-term planning practices is to explicate the planning levels and time horizons that are needed. The term 'planning level' refers to items that are planned, while the term 'time horizon' refers to the length of the time period for the plans and should be made explicit for each planning level. In practice, this means that companies should discuss the questions: "What, in our case, needs to be planned and for how long forward?" For example, do we make plans concerning the features of a single software product for its next release? Do we need separate plans for the future development of a product line?

At the beginning of the research collaboration, both of the main case companies (A and B) lacked a clear understanding of the planning levels and time horizons they currently employed. Furthermore, in both of the companies, it was unclear which roles were responsible for planning what, since the current organizational structure did not support the planning levels that they currently had. For example, in company B, the technical product managers were responsible for making decisions concerning the prospective features of individual software products. However, the software products were not sold as such, but as parts of solutions. From the business viewpoint, the solutions were entities, but no one in the company planned for the solutions' future as a whole; no one was responsible for taking care of where the solutions as a whole were going.

The terms 'product' and 'solution' were not explicitly defined in the case companies. Therefore, practitioners used these terms in varying ways when referring to the elements of their offerings. Typically, by 'product' practitioners meant the software that builds up the core of a solution. For example, in the case of software security systems, the product could be a certain version of the software aimed at protecting computers from viruses. Predominantly, practitioners used the term 'solution' to refer to a set of several software products that can be offered as a bundle to customers. Occasionally, the term 'solution' meant the combination of software added to other components that makes the offering useful for customers. Other components
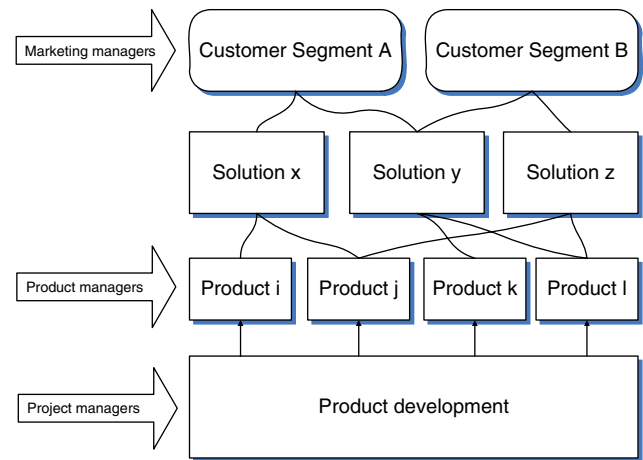

Fig. 2 Visualization of planning levels and responsibilities

in the companies' offerings were both physical, such as training material, quick installation instructions, and user manuals, and non-physical, such as customer training, online customer support, upgrade service, and other services.

The relationships between different planning levels and the corresponding responsibilities modified from the situation in case company B are illustrated in Fig. 2. This diagram was drawn by the first author. After seeing the diagram, the practitioners in company B felt that they were better able to understand their current situation and challenges. A similar diagram was also introduced to the other case companies during an experience exchange seminar. The participants from the other case companies also agreed that they could clearly benefit from their own situation being depicted in a similar way.

Another possible visualization for analyzing the planning levels and time horizons employed by a company and for finding potential gaps in long-term planning practices is shown in Fig. 3. There is no simple answer to the question of how many different levels of abstraction for planning a company should have. For example, company size and its organizational structure obviously play a role. On the basis of our experience, the gap between company strategy and the requirements for a single release is not bridged by a single level of planning (for example, having a product roadmap only).

4.2 Separate the planning of products' business goals from R&D resource allocation

According to our findings, it seems that business goals for the products should be discussed separately from R&D resource allocation. Practitioners from all of the four case companies complained that they had problems in seeing the 'big picture'. By this they meant that it was difficult for them to see what the goals of further releases were, and
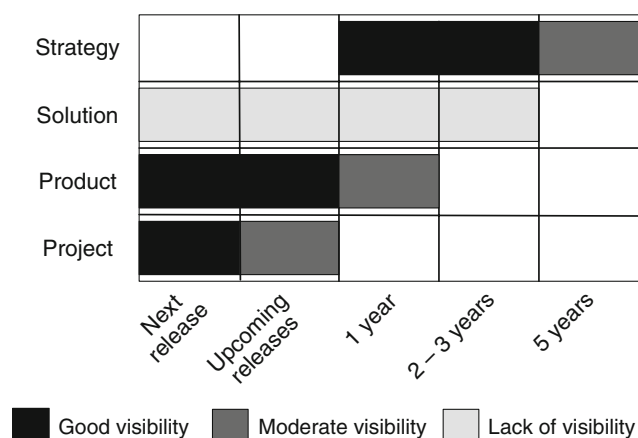
Fig. 3 Visualization of planning levels and horizons

how well the decisions made concerning features matched the needs of different customer segments.

In these companies, roadmaps were mainly used for planning what features would be implemented by which teams in following releases. The business goals for the products and how they changed over time were not discussed in separate sessions, and planning for them was in danger of being overrun by small-scale product features and the above-mentioned detailed allocation of R&D resources.

During the study, two of the four case companies decided to separate business opportunity sketching and goal setting (i.e., strategic level) from software production planning (i.e., operation level). On the basis of our observations in these case companies, it seems that at least two distinct levels in long-term planning could be beneficial. Market-oriented or commercial roadmaps form an overall view of the offering and give an understanding of how well different customer segments would be served in the future. On this level, the roadmap(s) might depict issues such as the needs of target customer segments, the positioning of the products, and different market trends for the next few years. In addition, it might be important to communicate possible changes in the sales channels and marketing arguments. These roadmaps would serve as a basis for more detailed planning. On the other hand, lower-level release or software roadmaps are needed from the perspective of managing software development. Each software product could have its own roadmap to provide information about the features to be implemented in the upcoming releases. These roadmaps are needed for allocating product development resources to different software products and for giving product developers additional information.

4.3 Plan open-endedly with a pre-defined rhythm

All of the four case companies performed open-ended planning with a pre-defined rhythm. Open-ended planning
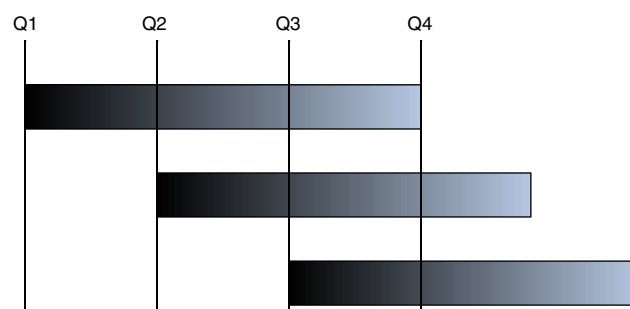

Fig. 4 Open-ended planning with a pre-defined rhythm

means that the time horizon for future planning is not fixed. The steps for the near future (e.g., the next release) are planned in more detail, but the remote future is also outlined to some degree. By pre-defined we mean that planning is undertaken at regular intervals. Figure 4 illustrates this kind of planning and how the content of the following releases sharpens in each planning round.

The practitioners in the companies felt that this kind of planning suits market-driven planning where the decisions are typically trade-offs between 'now' and 'later' rather than clear-cut 'no's. The actual implementation of open-ended planning varied in the case companies. In company B, for example, the next 12 months for a product was discussed every month. This implied that, in practice, the content of one 1-month project was iterated 12 times. In the other case company, open-ended planning was performed by means of a tool by allocating features to following releases.

4.4 Emphasize whole-product thinking

It seems important to widen the planning scope from the features of individual products to solution planning. We use the term 'whole-product thinking' to refer to this kind of widened planning scope, or more generally, addressing different stakeholder concerns in different activities. Launching a software product release needs cross-functional effort and outputs from functions other than R&D as well. For example, marketing material, product documentation, and sales campaigns need to be planned and implemented before a product can be launched as a whole-product. This requires cross-functional effort even in the early planning phase.

In the early days, the case companies saw long-term product planning as product management's internal discussion about forthcoming features of the software. The functions other than product management (such as marketing, sales or documentation) were not seen as being very important to stakeholders when talking about future plans. However, the customer and user needs that the company should meet were not related only to the software. For

example, the customer requires good enough information about the product, a place where to buy it, and maybe some additional services.

Centralized software planning seemed to complicate and delay release launches and cause resource challenges to functions other than R&D. First, other functions (e.g., documentation, marketing, and sales) had continuous resource problems, since their resource needs were not planned early enough. Furthermore, their limitations were not taken into account, since only R&D resources were thought of when decisions were made as to what should and could be done during the following months. Second, the functions other than R&D were frequently late in starting their work. This was because they did not get enough information about forthcoming features of the products early enough to allow them to start their work when the software development was still ongoing. Third, the value that the product provides for the customers was more or less implicitly seen as something that comes only via new product features. The product managers did not come up with ideas for, for example, improving services instead of new features for certain customer segments.

During the study, the two main case companies concluded that they needed a cross-functional project team for planning the main product release launches from the early phases of development. The other case company had already started this practice and found it to be a good experience. The project group consisted of members from marketing, product management, documentation, and service. The group gathered once a week throughout the product development project. During this time they made preparations for launching the release. The practice improved their ability to synchronize other functions with R&D and also to prepare outputs other than software earlier than before.

Company A even changed their organizational structure from a functional one to a more market segment-based one. In this new structure, every market segment had its own segment team that included representatives from many internal functions (product management, sales, marketing and service). The team is jointly responsible for integrating segment development plans into the overall product development plan. The practitioners feel that this type of organization has brought experts from different functions nearer to each other and improved their communication. In addition, the shared responsibility has forced the practitioners themselves to truly co-operate with each other.

4.5 Make solution planning visible

This section is based on the research results of Phase 2, i.e., the research collaboration done with case company B. This collaboration consisted of interviews and workshops. The
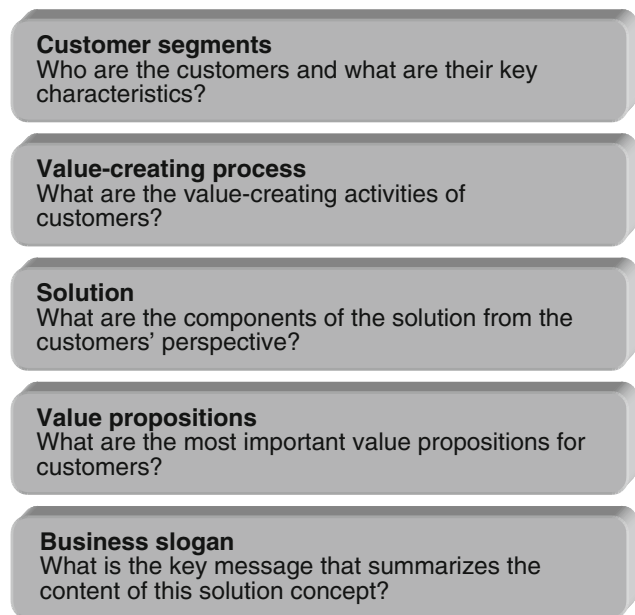
Customer segments
Who are the customers and what are their key characteristics?

Value-creating process
What are the value-creating activities of customers?

Solution
What are the components of the solution from the customers' perspective?

Value propositions
What are the most important value propositions for customers?

Business slogan
What is the key message that summarizes the content of this solution concept?

Fig. 5 Contents of the solution concept

interviews with the stakeholders revealed that there was a need to gain and share a holistic long-term view of the solutions. In the context of the company, a solution means a comprehensive set of software and service components that are needed to fulfill customer needs.

On the basis of the interview results, the researchers proposed solution concepts for the case company. In addition to supporting different stakeholders in solution planning, the purpose of concept descriptions is to provide a big picture of the solution for all employees and guide requirements engineering activities.

The contents of solution concepts were processed and evaluated with different stakeholders in the workshops. Figure 5 illustrates the latest version of the contents. The key principle of the solution concept is that it should be short and visual. At the moment, the template for concept descriptions is an A4 poster. In other words, the high-level description of the solution concept is supposed to be just one page. The rest of this section describes the five elements of the solution concept in more detail.

4.5.1 Customer segments

This part of the solution concept gives an overview of different customer segments. The basic idea of customer segmentation is to analyze existing customers, identify homogenous groups and describe their main characteristics. In practice, customers are often seen as one big group, especially in software development. Customers can, however, have very differing needs, and therefore, an organization can seldom offer one solution for all of them.

During the interviews, one of the practitioners emphasized the need to divide customers into smaller categories. He recommended that the business potential of customers to be used as a basis for this segmentation. Segmentation was also discussed in one workshop, and the participants supported the idea of dividing customers into smaller groups (i.e., segments). The case company has now started a segmentation project for one of the most important solutions.

4.5.2 Value-creating process

This part of the solution concept presents a high-level view of activities that customers perform relating to the solution. The challenge is that software product development is often feature- and technology-driven. Furthermore, product development personnel seldom seem to have an understanding of how the customers are using the product in practice.

According to Grönroos, value for customers emerges when customers use products, and therefore, the focus should be on the customers' value-creating process [26]. This approach of focusing on the customers' process was first discussed in one workshop, and the participants found the approach appealing. In the following workshop, the participants analyzed the customers' value-creating process relating to one successful solution. The participants experienced this analysis as being useful. For example, one of the participants stated that "We have focused so much on the core software product that maybe we don't understand the customers' processes. We are missing quite a big part of the problem if we only focus on software".

One of the participants said that they have had some ideas about reviewing parts of the customer process together with the customers. This participant also mentioned that they have not yet implemented these ideas because they have been blind to process issues. He also pointed out that they should revisit the customer processes from time to time because things change.

4.5.3 Solution

In this part of the solution concept, the different types of components of the solution are presented in order to form a common understanding of the solution elements. Analyzing the components of a solution from different viewpoints is important in order to understand the value and role of different components of the solution, and to develop the solution further.

The components of the solution can be categorized in different ways depending on the need. One very valuable approach is to categorize from the perspective of customer segments. Other possible ways include the type of solution components or parties in the organization who are responsible for developing the components.

In the company, the researchers formed an example of a solution. This example was generated to meet the real components of one of the company's solutions on the basis of the interviews. The example solution consisted of many different types of components, not just software. For example, a business model, customization services, training material, user manuals, and software updates were the components of the solution.

In the workshops held after that, the practitioners showed an interest in describing their solutions in this way. They felt that this kind of complete set of components helps to communicate what kind of solution they are developing and identify the static parts of the solution. One of the participants also wanted to go through the example with his subordinates, since he wanted them to look at the solution in a wider way rather than just as software. Furthermore, the analysis of the components raised new questions such as how the components of the solution other than software can be conceptualized.

4.5.4 Value propositions

This part of the solution concept represents the main reasons why customers want to purchase or use the solution. Value propositions can be short statements such as service experience, cost efficiency, convenience, and predictability. The purpose of defining value propositions is to clarify the customer benefits. The values listed in the concept should also help in focusing and communicating those benefits.

In our case, visualizing value propositions not just for direct customers but also for customers' customers revealed new information. Mapping proposed values with the customer chain seemed to raise questions concerning the customers that were served best by the current and future solutions.

4.5.5 Business slogan

The business slogan is a market-driven statement summarizing the business idea as effectively as possible. The slogan should be self-descriptive and crystallize the primary business rationale of the solution for different stakeholders such as product management, development, documentation, marketing, and sales personnel.

In one of the workshops, the practitioners commented that the business slogan is useful in validating the solution idea. On one hand, they felt that the slogan should not be created too early in order not to restrict the innovation. On the other hand, creating the slogan as one of the final phases of concept development put a team in a situation

where they have to conclude what the most important focus of the solution is.

5 Discussion

In this section, we reiterate the results from Phase 1 and 2 separately, and discuss their internal and external validity.

5.1 Phase 1

The results of Phase 1 shed light on the rationale for long-term planning and identified existing practices in the software product companies. Our study suggests that software product development organizations need long-term product planning for transparent, business-driven and co-operative decision-making and rational utilization of R&D resources over time. However, in practice, product planning seems to be focused on features of individual products. Furthermore, our findings indicate that there is a need to involve stakeholders such as sales, marketing and management in long-term planning. In addition, the planning horizon is typically relatively short, typically few releases ahead.

Our results indicate that adding intermediate planning levels between business decisions and requirements engineering helps to link them together. For example, marketing arguments are easier to tie to high-level features than to individual, small-scale requirements. In addition, gaining and sharing a holistic long-term view of the future with different stakeholders is important for co-ordination of resources over time. For example, sales and marketing need early information about future developments. Furthermore, explicit links between the development needs of different products are needed, since product development resources are usually shared. Previously, Karlsson et al. found that the co-operation between different stakeholders in market-driven companies requires other ways of communicating than low-level requirements [4].

We proposed a small set of practices to strengthen the link between business decisions and RE. First, explicating the necessary planning levels and time horizons helps to clarify of different kinds of plans and planning between strategy and software development. Second, by separating the planning of the business goals relating to a product from R&D resource allocation and detailed feature-level planning, it is easier to see the big picture from the business viewpoint. This also avoids getting entangled in details. Similarly, Vähäniitty and Rautiainen discuss separating different levels of planning from each other [33].

Third, open-ended planning with a pre-defined rhythm seemed to suit market-driven planning, where the decisions are typically trade-offs between 'now' and 'later', rather than a clear-cut 'no'. Fourth, by emphasizing whole-product thinking, organizational functions other than R&D (such as marketing and services) are better integrated into product planning. Ebert revealed a similar finding, since he found that installing a core team for each release affected the success of the product [10].

Open-ended planning was applied in three case companies and considered a good way of working by many practitioners from these organizations. Whole-product thinking and separating business goals from R&D resource allocation were improvement ideas were suggested by many practitioners.

To assess the internal and external validity of our results, we use the following definitions. Internal validity is the property of an empirical study where the result is consistent within its local context [34]. External validity, on the other hand, is the property of an empirical study where the result is generalizable to other contexts [35].

The threats to internal validity in Phase 1 include the question whether we have been able to gain a comprehensive understanding of the current practices and practical challenges in the case study companies. We used several tactics, especially in the data collection phase to increase the internal validity of the study. First, we triangulated data sources by selecting more than one interviewee from two of the four companies. We also selected interviewees representing different stakeholder groups within the companies. In companies C and D we had only one interviewee per each, which may have biased the results.

Furthermore, we used the triangulation of data collection techniques. Thus we were able to relate the information gathered from the interviews to observation of development practices. Finally, the study was carried out in the case organizations over a long period, which enabled the researchers to better understand the existing practices and practical challenges in more detail.

To improve the external validity of the research results, this study involved four organizations. However, the external validity of the results in Phase 1 is difficult to evaluate, since the number of informants and the research activities in case organization C and D were limited. Therefore, the findings from these companies may represent only a narrow view of the current situation. In addition, all the case companies were Finnish and therefore the results do not necessarily apply to other cultures.

Our co-operative relationship with the companies may have created a sampling bias. The case organizations were selected using a convenience sampling strategy. The organizations were industrial partners in our research projects, which implies that they considered long-term planning and RE essential. Convenience sampling is the least desirable sampling strategy and hence a threat to external validity [31]. However, we believe that the case companies are typical market-driven companies.

The participation of the researchers may also have affected both the internal and external validity of the results. We were able to use investigator triangulation during Phase 1 in a restricted manner only due to the limited budget and the longitudinal nature of the phase: The first author of the paper conducted the interviews of Phase 1 and analyzed the data. To improve internal validity, the findings were discussed with another researcher who had participated in the process improvement work of case organization A and B.

5.2 Phase 2

An important result from Phase 2 is the notion of solution concept consisting of five elements: (1) customer segments; (2) value-creating processes; (3) a solution; (4) value propositions, and (5) a business slogan. The essence of the solution concept is to help practitioners to form a high-level view of the solution and facilitate communication between different stakeholders.

The elements of the solution concepts are supported by a number of authors. Webster has stated that value propositions fuel communication and all decision-making in market-driven companies [36]. Similarly to the business slogan, Kim and Mauborgne argue that a good strategy includes a clear-cut and compelling tagline that delivers a clear message and also advertises the idea truthfully [37]. Besides Grönroos [26], MacMillan and McGrath have also highlighted the importance of understanding all the customer processes and activities that relate to the product or service [38].

We applied a number of methods to improve the internal validity of the results. First, we used triangulation of data sources. The total number of different informants in Phase 2 was 11. Most of the informants were directors and managers, as the focus in Phase 2 was on solution planning and both directors and managers are usually responsible for long-term planning.

We did not interview developers and they did not participate in the workshops during Phase 2. Developers were, however, the key informants of one of our previous studies [39]. This study revealed that requirements were often defined from the technical point of view. Furthermore, both managers and product development engineers held beliefs that prevented the active elicitation of user needs and the systematic documentation of user requirements.

The second way to address the internal validity of the findings was the triangulation of data collection techniques. In Phase 2, we used interviews, informal conversations, and participant observation.

The role of the researchers as active participants in the workshops may have affected the validity of the results, since they acted as facilitators and participant-observers in the company. During the analyses of the findings, the researchers consciously tried to adopt and maintain a stance of neutrality. In order to reduce the potential threat to neutrality, investigator triangulation was used. At least one researcher discussed and challenged the findings and interpretations made by any of the other researchers. In addition, the findings were discussed with the practitioners in the workshops.

Because the content of the solution concept was developed with one software product company (company B), the external validity of the results of Phase 2 is weak. One of our future research actions is to evaluate the solution concept with company A.

6 Conclusions

In conclusion, our results indicate that product planning practices are at a low-level, focusing on the features of individual products. Preparation of plans seemed to be restricted to product managers and long-term plans were missing. Further, we identified five practices to strengthen the link between business decisions and requirements engineering:

- explicate planning levels and time horizons
- separate planning of products' business goals from R&D resource allocation
- plan open-endedly with a pre-defined rhythm
- emphasize whole-product thinking
- make solution planning visible.

Explicit planning levels and time horizons help practitioners to analyze the gaps in their planning processes between business decisions and requirements engineering. Separation of business goals from R&D resource allocation helps practitioners to communicate in business terms and subsequently, focuses on long-term planning. Open-ended planning with predefined rhythm improves the organization's ability to keep long-term discussion alive and involve different stakeholders in the planning process. Emphasizing whole-product thinking helps practitioners to understand their products more broadly than just as software and to bring different viewpoints to the long-term planning process.

Finally, our results indicate that there is a need to make solution planning visible in software product companies. In particular, it seems essential to find answers to the following questions:

- Who are the customers and what are their key characteristics?
- What is the value-creating process of the customers that relates to the solution?
- What are the components of the solution that are needed to support the customers' value-creating process?

- What kind of value does the solution provide for the customers?

We introduced the notion of solution concept and suggest that companies represent the answers to these questions using this notion. Our results on solution planning and solution concept are preliminary. One of our future research objectives is to validate the content of the solution concept and develop it further in new case studies. Our aim is to evaluate how companies can utilize solution concepts in long-term planning. In addition, it is important to investigate how to explicitly link different planning levels in practice, and assess the impact solution concepts have on RE activities.

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