

Challenges of Knowledge and Collaboration in Roadmapping

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Abstract

Today's software organizations need to cope with ever intensifying technical and commercial turbulence. In such environment, the level of market orientation could be the deciding factor determining the future success of a company. The activities bridging market orientation to software product development terminology have commonly been linked to terms such as roadmapping and release planning. The purpose of this paper is to explore the roadmapping practices currently followed in software product development organizations. Due to the lack of established theories of roadmapping practices, exploratory and inductive research methods were used. The study resulted with a conceptualized view of roadmapping activities. We identified three types of participants that need to be present in a roadmapping context. Each of the identified participant types relates to particular set of challenges regarding knowledge and collaboration in a roadmapping context. When comparing our results to the existing theories, we found out that the knowledge-based theory of the firm could contribute to further theory development in market-oriented software development and related areas.

1. Introduction

Today's software organizations need to cope with ever intensifying turbulence of technical and commercial environments. These challenges are often further complicated with the global competition. In such operating environment one would assume that understanding the demand originating from the market would be a source of competitive advantage. In other words, the level of *market orientation* could be the deciding factor determining the future success of a company. Yet, according to Boehm [1], much of current software engineering practice and research is done in a value-neutral setting, in which every requirement, use case, object, and defect is treated as equally important. The current practice and research mostly sees software

engineers as responsible for turning software requirements into verified code – without giving a greater thought about business or market priorities and values.

Why there appears to be a gap between the recognized need of market oriented product development activities and the actual practices currently followed in software organizations? What are the obstacles of introducing market orientation to software organizations? Such largely unanswered questions motivated us to gain a deeper understanding of market oriented product development in practice. In our learning process, we wanted to pay our particular attention to the activities where the future direction of a product is under discussion, namely to the processes of roadmapping and release planning. We believed that the results of such study would be important because, as expressed in [2], “a distinct and workable conceptualization of market oriented product development is the first step towards understanding the implementation process”.

The topic of market orientation in general has been widely researched from various perspectives resulting with several definitions for it. In their work on finding synthesis from the most cited market orientation definitions, Jaworski and Kohli [3] proposed their own definition as: “the organization wide *generation* of market intelligence pertaining to customers, competitors, and forces affecting them, internal *dissemination* of the intelligence, and reactive as well as proactive *responsiveness* to the intelligence”.

The relationship between market orientation and software product development has still been uncovered to a large extent. The activities and artifacts bridging market orientation to software product development terminology have commonly been linked to terms such as *roadmapping*, *release planning* and *a roadmap*. For the sake of clarity we will provide the definitions used in this paper for these terms. The definition for *a roadmap* has been adopted from [4] as: “A roadmap describes a future environment, objectives to be achieved within that environment, and plans for how those objectives will be achieved over time”. A roadmap usually includes a description of how the pieces of technology fit together and how they evolve in the future. The definition for

roadmapping has also been adopted from [4]: “The roadmapping process helps a team gather diverse perspectives on all aspects of the environment and the plan. It also helps the team build consensus and gets buy-in of its members to carry out the plan”. For term *release planning* we use the following definition from [5]: “The release planning is the activity of determining a feasible combination of dates, features, and resourcing for the *next* release of a software product”. Based on these definitions we consider release planning as a subset of roadmapping activities. Therefore, the following findings from existing literature regarding release planning can be considered relevant also to the activity of roadmapping.

Several studies (e.g. [6, 7]) have identified the necessity of listening the success critical stakeholders and understanding the value of their needs when planning the future releases of a product. However, despite the importance of these objectives, the current practice of release planning has been reported to be problematic with such identified issues as lack of systematic release planning practices, lack of resource considerations and insufficient stakeholder involvement [8]. An important factor that may potentially result as poor release planning practices could be the complex nature of the release planning phenomenon. Supporting evidence for such proposition can be found from [6] with a conclusion that “The initial attempt at supporting release planning proved to be based on overly simplistic and structuralistic view”.

Requirements Engineering (RE) has an essential role in accomplishing the goals of release planning task. RE is a multi-disciplinary activity that is concerned with the identification of the goals of stakeholders and their elaboration into precise statements of desired services [9]. Several studies (e.g. [10-12]) have pointed out that market-driven software organizations face unique challenges in their RE activities compared to the customer-specific software organizations. One fundamental difference is due to the large customer base of a product making it difficult to take into account a large number of stakeholders that have varying and often conflicting needs. The global presence of a product exacerbates the RE related challenges even further. It has been claimed [13] that the prioritization and negotiation of customer requirements for a particular release is the most significant challenge of a global organization. Similar findings have also been presented by Lehtola *et.al.* [10] with a statement that “prioritization methods may have limited ability to support decision-making in a complex area like requirements prioritization in market-driven product development”. Therefore, they argue further that prioritization results should be taken more as being indicative than as an ultimate truth.

Relevant to the challenges of roadmapping and release planning, a new discipline of Value-Based Software Engineering (VBSE) has been emerging in recent years

aiming at “integrating value considerations into all of the existing and emerging software engineering principles and practices, and of developing an overall framework in which they compatibly reinforce each other” [1]. Some of the elements in the research agenda of VBSE addressing roadmapping and release planning challenges includes value based requirements engineering for identifying success-critical stakeholders and their objectives, and value-based design and development for ensuring that the objectives and values are inherited by the design and development [1]. More recent advances in the discipline of VBSE can be found from [14], in which the challenge of human involvement in Software Engineering has been acknowledged to result in less formal, timeless and universal theory in terms of situations, stakeholders, and products. Similar findings regarding the challenge of human involvement has also been identified in the context of release planning. Ruhe and Saliu [7] distinguish between the *art of release planning* addressing the need for human intuition, communication, and capabilities to negotiate between conflicting objectives and constraints and the *science of release planning* formalizing the problem and applying computational algorithms to generate best solutions.

Given these findings from existing literature, we have decided to make a deep dive into roadmapping activities in practice and focus our attention to human knowledge and collaboration in the roadmapping context. We believe that this will provide important insights for the further development of roadmapping practices. In particular, we wish to answer the following questions in our study:

- What types of stakeholders should participate in a roadmapping context? Why?
- What types of information is gathered in practice from the product’s stakeholders?
- What types of information has proved to be of most significant value?
- What challenges companies have faced on facilitating roadmapping activities? What could be underlying reasons for the identified problems?
- What challenges companies have faced on disseminating roadmapping knowledge into the organization?

The remaining part of this document is organized as follows. Section 2 describes the research process and methods used in this study. Section 3 presents our findings and observations regarding roadmapping and release planning in practice. In section 4, the research results are reflected to the existing literature and finally section 5 presents the conclusions of the study.

2. Research Process

This study explores roadmapping and release planning practices currently followed in software product

development organizations. The study area has been fairly unexplored up to this point and lack previous theories. Therefore, a qualitative and theory-forming strategy is a necessity. The grounded theory method [15, 16] has proved its suitability for theory-forming research in the disciplines of software engineering and information systems development [17-19]. Because of this fact, we chose grounded theory as the research method in this study.

The study used theme-based interviews as its main data collection method. In total, we used 27 interviews from 7 organizations as the data material for this study. The organizations represented different areas of software industry, such as engineering applications, content management, database management, mobile applications and telecom applications. Common to all the organizations were that a major part of their business was based on software products. The interviewees represented various functions of their organizations, including product management, marketing management, product development, and general management. All interviews were tape-recorded and transcribed to text. The total amount of recordings adds up to 38 hours and the number of transcript pages is in total 554 pages. In addition to the interviews, data was also collected from company and product presentations that were held to us and we also received a good number of additional material, including process, product, and company descriptions and marketing material.

The data analysis is still at the time of writing an ongoing process. The analysis started with open coding [16], where essential sections of the data were conceptualized and identified as categories. The categories represent regularities or irregularities or any phenomenon that was considered important in relation to the research question. Currently we have continued to axial coding [16], where the relationships between the categories are in focus. This paper presents some of the results of this phase that are related to roadmapping and release planning. The study is currently continuing to selective coding, where a coherent picture or theory of the core category, market-driven software development, will be formed.

3. Challenges of Knowledge and Collaboration in Roadmapping

Why is it hard to be systematic in roadmapping practices? Why stakeholders are not listened to the sufficient extent when making decisions related to future versions of a product? In order to be able to answer such questions, we searched the data for mentions regarding the phenomenon of roadmapping.

Since existing studies had recognized the human knowledge as an important element of roadmapping, we

decided to focus our study to the challenges of human knowledge and collaboration in a roadmapping context. In our view, this was necessary in order to be able to alleviate the obstacles of successful roadmapping practices. In our analysis, we identified the following types of participants that need to be present in a roadmapping context:

- *Contributor*, who bring valuable information to a roadmapping context,
- *Controller*, who ensures that roadmapping is being done in a systematic manner,
- *Distributor*, who absorbs information at a roadmapping context and disseminates it to those who will need to act upon it.

The remaining part of this section will elaborate in detail the identified challenges of knowledge and collaboration regarding each of the identified participant types.

3.1. Helping to see the unseen: Contributor

In order to be able to comprehend the gathered information from the market and transform it to a usable form of knowledge, it is essential that there are *contributors* in a roadmapping context. That is, there must be roadmapping participants that possess such mental models that enable successful outcome of a roadmapping activity. The challenge for the organizations is to understand which mental models should be applied in order to build economically sound understanding regarding product's future. Who should be the ones selected to act as contributors in a roadmapping context? What types of knowledge are most valuable for the activity of roadmapping?

We investigated the practices currently followed in the industry regarding how the future oriented understanding of a product is formed. We searched the data so as to find out in what ways the companies are currently gathering information about the market, how the gathered information is used and what challenges companies have faced when gathering the information. We considered this important in order to build a deeper understanding of the types of market information and their potential contribution to the roadmapping activity. A more detailed description of market-driven practices in one of the companies can be found from [20]. In our analysis, we identified four categories of market knowledge that were differentiated according to their time orientation (present-future) and level of explicitness (explicit-tacit). The identified categories of market knowledge (Figure 1) included:

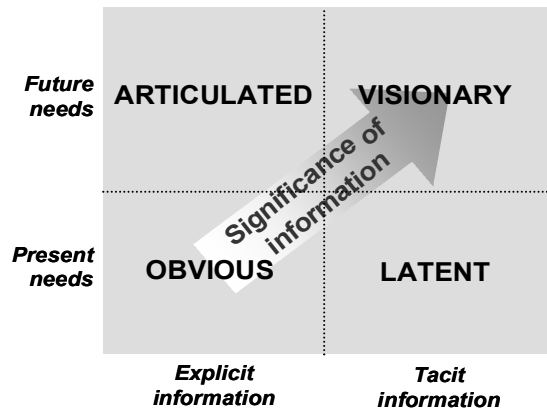


Figure 1. The categories of market information.

- *Obvious* knowledge, that helps to explicitly describe stakeholder's current needs regarding the product,
- *Articulated* knowledge, that helps to explicitly describe stakeholder's future needs regarding the product,
- *Latent* knowledge that helps to constitute understanding about stakeholder's current needs that are beyond their own recognition.
- *Visionary* knowledge that helps to anticipate stakeholder's latent needs they are going to have in future.

But what kind of contribution the different types of market knowledge may offer in a roadmapping context? We believed that the answer to the posed question can be found by investigating the current challenges regarding the roadmapping practices. In our analysis, a particular pattern across the interviews was clearly visible. The companies were not in general facing challenges of collecting the explicit needs from the stakeholders. Instead, the problem appeared to be gaining understanding about the potential values behind the stated needs of the market. Without such understanding it was difficult for the companies to optimize the use of their resources while attempting to maximize the value of future work. This challenge can be expressed with the following quotation:

"We receive large amounts of market information, but the typical problem we are facing with it is that the business implication behind the customer need is often missing. In such case, we have difficulties on prioritization. We might not be able to see that focusing on other request would actually benefit us much more. We have a horn of plenty on receiving market information, but understanding the priority of information often gets lost in the abundance of technical details."

This finding indicates that tacit knowledge is valued over explicit knowledge. The finding can be further strengthened with the following quotation:

"There is no equation that can determine the priorities of market needs correctly. It takes certain touch, hunch and experience to understand the priorities. This knowledge has just been built into the organization. [...] The more we have made business, the more we have gained this tacit knowledge."

Furthermore, a repeated theme across the interviews was the necessity of being able to satisfy the unspoken needs of a customer. While this further supports the necessity of having tacit knowledge available in a roadmapping context, it also gives insight about why future-oriented knowledge may be valued over knowledge about present needs:

"We have approximately one year release cycles. If we want to take into account a feature request from a customer, we can consider it to be included to the release that is not currently under implementation. In the worst case, this means that the request will be implemented only after 24 months from the time of request and in such case the customer have definitely searched other options by then. In order to avoid such situations, we need to be able to anticipate customer's latent needs in advance."

We interpret these findings so that, for the success of roadmapping, the future-oriented tacit knowledge regarding the market will be of most significant value. As a result, the roadmapping *contributors* should possess primarily knowledge of *visionary* type.

3.2. Keeping it all intact: Controller

In order to produce a successful outcome from roadmapping activities, the activity needs to be managed. In other words, there need to be *controller* participants in a roadmapping context. Their duty is to introduce and facilitate systematic processes that guide the roadmapping participants to produce desired outcome. How the companies we interviewed have accomplished this in practice? What challenges have they faced? The interviews revealed that facilitating the roadmapping activities is a complex task. A commonly found issue across all interviewed companies was that the companies were facing challenges in establishing systematic practices into a roadmapping context. In particular, it appeared to be challenging to determine which of the articulated market needs should be included in the forthcoming releases of a product:

"Everyone has their own view regarding what the customer has said and how loud they have shouted. After a voice vote [in a roadmapping session] some kind of consensus will emerge describing what features we will be able to do in following 9 months and what features will not be implemented."

One of the underlying causes that complicate the understanding of priorities is that the requirements have often dependencies. One dimension that introduced such dependencies was the global presence of a product:

"We have a challenge in the future that the ever increasing product offering should be taken into global marketplace. How to set the priorities in such situation? They are convergent to some extent [in different geographical areas] but not completely the same."

Another dimension introducing dependencies identified in the interviews was the availability of a product in diverse customer segments:

"It is quite a challenge for our resources and processes that we need to serve pragmatic existing customers while searching new businesses and being a forerunner and a visionary."

An articulated market need requested in a certain geographical area may benefit other regions and other customer segments to some extent. How is it possible then to determine priorities of a market need in a presence of such dependencies? According to our analysis, a great contributor to the problems of determining the priorities of market needs is the inability to understand the value of them. If the needs of market would be complemented with the potential values to the success-critical stakeholders, the prioritization and the decision processes in a roadmapping context could be made more systematic and transparent making the goals of a controller easier to achieve.

3.3. Disseminating the roadmapping knowledge: Distributor

A roadmap is nothing without implementation. The challenge is then to know how to disseminate the results of roadmapping to those who need to act on it. As several studies (e.g. [21, 22]) report the weaknesses on transferring knowledge solely in a written form, it is therefore necessary that there exist *distributors* in a roadmapping context. Their duty is to disseminate the knowledge produced in a roadmapping context to the ones who depend heavily on it. But who should be selected as distributors to a roadmapping context? In order to answer such question, a deeper understanding is needed on who are the consumers of roadmapping knowledge and what is the nature of their need.

In our study we investigated how information was exchanged between organizational functions in the context of product development and what challenges the companies have faced regarding such collaboration. Our study revealed that there are different levels related to the consumption of roadmapping knowledge (Figure 2).

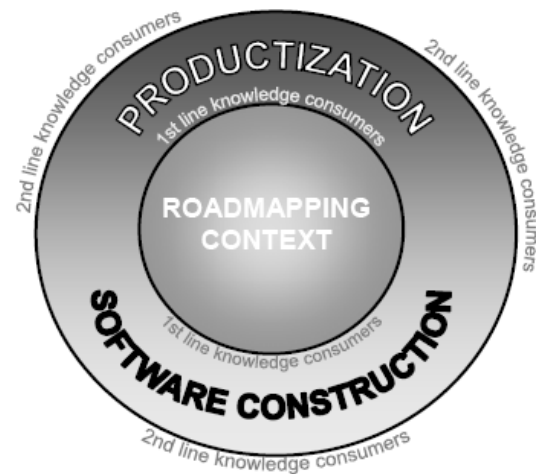


Figure 2. The lines of roadmapping knowledge consumers.

The first line knowledge consumers depend heavily on roadmapping knowledge as a roadmap is one of the main inputs to their activities. The determination of the first line knowledge consumers is a context dependent issue that varies across the companies. However, based on the interviews, two most likely candidates to be regarded as the first line knowledge consumers are those units that are responsible on construction and productization of the software product. The failure of disseminating roadmapping knowledge to such units may leave the employees of an organization ignorant:

"Our marketing department has not been able to write anything related to the new product until the product has been implemented."

or misinformed:

"In many cases, knowing the plans for the future versions would have an impact on the design decisions. If we would know that a certain requirement is actually laying a foundation to something forthcoming, we would implement the requirement differently."

The second line knowledge consumers are less dependent on the richness of roadmapping knowledge. Their information need can therefore be satisfied in most cases with documented form of roadmapping knowledge. In addition, they may be consumers of the knowledge produced by the first line knowledge consumers. As with the first line knowledge consumers, the determination of second line knowledge consumers is a context dependent issue. Some of the typical second line knowledge consumers identified in our study were customers, partners, sales and technical support.

4. Discussion: Reflection to the Knowledge-Based Theory of the Firm

Through the study we have built our understanding regarding the complex phenomenon of roadmapping in software development. The results presented in this paper have been derived inductively from the data. When reflecting the results of this study to the literature, there appears to be a great resemblance with one particular theory. In this section, we will introduce the knowledge-based theory of the firm as it has been described by Nonaka and Toyama in [23] and point out why it appears to be relevant in the context of roadmapping.

The knowledge based theory of the firm can be described with a model of knowledge creation (SECI model) presented in Figure 3. According to Nonaka and Toyama [23], knowledge creation starts with *Socialization*, which is the process of converting new tacit knowledge through shared experiences in day-to-day social interaction. Since tacit knowledge is difficult to formalize and often time- and space-specific, tacit knowledge can be acquired only through shared direct experience, such as spending time together or living in the same environment. In our view, this phase of knowledge creation addresses the challenges of market information elicitation giving support to our finding of valuing the *visionary* type knowledge at a roadmapping context. Elicitation of visionary knowledge requires a deep understanding of the customer's domain and surrounding environment. Such kind of knowledge can be acquired from customers, suppliers and even competitors by empathizing with them through shared experience [23].

The tacit knowledge is articulated into explicit knowledge through the process of *Externalization*. Here, dialogue is an effective method to articulate one's tacit knowledge and share the articulated knowledge with others. Through the dialogue with individuals, one tries to see the entire picture of the reality by interacting with those who see the reality from other angles, that is, sharing their context [23]. In our view this phase represents the early parts of roadmapping activity supporting our finding that it is necessary to have *contributors* in the shared physical context of roadmapping.

Explicit knowledge is collected from inside or outside the organization and then combined, edited, or processed to form more complex and systematic explicit knowledge through the *Combination* process. The new explicit knowledge is then disseminated among the members of the organization [23]. In our view, this phase is similar to the late parts of roadmapping activities where plan for the future versions of a product is created and disseminated to the organization. This supports our finding regarding the necessity of having *distributors* in a roadmapping context.

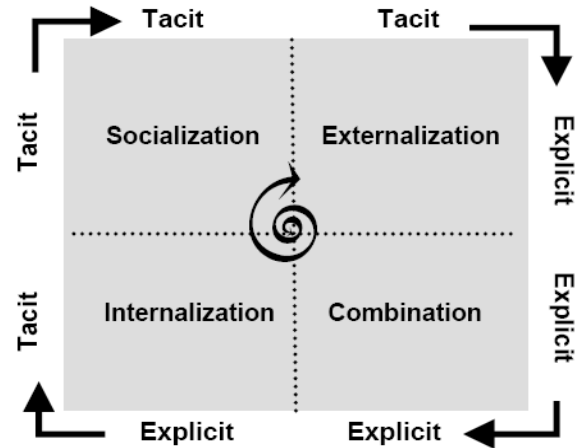


Figure 3. SECI model of knowledge creation adopted from [23].

Explicit knowledge created and shared throughout an organization is then converted into tacit knowledge by individuals through the *Internalization* process. This stage can be understood as praxis, where knowledge is applied and used in practical situations and becomes the base for new routines [23]. In our view this phase relates to the task of implementing new versions of a product and gathering experiences of it. It is thus a precursor phase for the next round of *Socialization*. Organizational knowledge creation can be considered as a never-ending process that upgrades itself continuously [23].

Similar to the roadmapping context, Nonaka and Toyama [23] defines a term *ba* as a shared context in motion, in which knowledge is shared, created, and utilized. They see organizations as organic configurations of various *ba*, where people interact with each other and the environment based on the knowledge they have and the meaning they create. Similarly to our finding of the three roles necessary in a roadmapping context (contributor, controller and distributor), Nonaka and Toyama have identified the need of having three distinct roles in a context of *ba*. That is, there need to be *innovators*, who senses the new reality first; *coaches*, who attains inter-subjectivity by interacting with the innovator and brings in his/her own viewpoint; and *activists*, who take a higher viewpoint and attain trans-subjectivity, make the new reality understandable and tangible for other people and who protects the team from outside influence so that the other roles can keep their own viewpoints.

5. Conclusions

Given that the phenomenon of roadmapping and release planning in software development practice have been rather unexplored up to this point, we conducted a

qualitative study attempting to gain a deeper understanding of the challenges of knowledge and collaboration in a roadmapping context.

When interpreting the gathered data by using grounded theory as the research method, we identified three distinct roles that appeared to be necessary in a roadmapping context. Each of the roles relates to particular challenges regarding the knowledge and collaboration.

In case of *contributor*, the challenge is to determine what type of information is of most significant value at a roadmapping context. We sought for such answer by investigating the practices and the challenges faced regarding current information elicitation mechanisms and concluded that future-oriented tacit knowledge of the market will be most valuable for the organization.

The challenge of *controllers* is to introduce systematic practices to the roadmapping context and provide transparency of the made decisions. One underlying cause for experienced problems appeared to be the inability to understand the values behind the expressed needs.

One of the challenges regarding the dissemination of the roadmapping knowledge into the organization is the ability to understand who are most dependent of the roadmapping knowledge. The answer of such question will help on determining who should be taking the role of *distributor* in a roadmapping context.

When reflecting our findings to existing theories, we identified great resemblance with the knowledge-based theory of the firm [23]. Therefore, this theory could contribute to further theory development in market-oriented software development and related areas, such as Value-Based Software Engineering [14].

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