

Market-Driven Requirements Engineering Processes for Software Products - a Report on Current Practices

Åsa G. Dahlstedt¹, Lena Karlsson², Anne Persson¹,
Johan Natt och Dag² and Björn Regnell²

¹*Department of Computer Science
University of Skövde,
Box 408, SE-541 28 Skövde, SWEDEN*

²*Department of Communication Systems,
Lund University,
Box 118, SE-221 00 Lund, SWEDEN*

Abstract

This paper reports on some preliminary results from the first stage of an interview survey, focusing on current practices and challenges in market-driven RE. The interviews are analysed based on the characteristics of market-driven RE presented in the literature.

The interviews correspond largely with the literature. Identified discrepancies compared with the literature concerns the time-to-market attribute and documentation of requirements. Two major groupings among the participating companies were found. The RE processes of one of these groupings are focused on facilitating the activities fundamental in market-driven RE, e.g. the release planning activity, while the other is more document-driven. The results of the interviews also include some ideas on how market-driven RE activities may be performed.

1. Introduction

Most Requirements Engineering (RE) literature is focused on bespoke or customer-specific development, where one single customer orders a specific software system and where a requirements specification is used as a contract [1]. However, today the market for software product (packaged software) is constantly growing and, due to this, market-driven RE is gaining increased interest [2, 3]. According to the literature, market-driven RE differs from customer-specific RE and hence poses a number of different demands on RE activities. This implies that theories and research based on customer-specific development cannot be used as-is on market-driven RE [4]. Therefore, further investigations are needed in order to understand the specific needs of market-driven development.

This paper reports on some preliminary results from the first stage of an industrial survey, focusing on current practice and challenges in market-driven

RE in the Swedish software industry. A previous paper [5], reporting on identified *challenges* in market-driven RE, has been published based on this survey. This new paper, however, reports on *current practices* concerning market-driven RE, while comparing the interviews to existing literature on the subject. The main idea of this paper is to show the various approaches that the interviewed companies use to perform their RE activities, which is not covered by [5]. There are, however, some issues mentioned in this paper that may overlap with [5], since the papers are based on the same interview material.

The main aim of the survey is to discover hypotheses for future research and to complement existing surveys on RE. Although there are several surveys that concern or include current practice within RE, e.g. [6, 7, 8, 9, 10, 11, 12], none of these primarily focus on market-driven development. Furthermore, in most of these surveys the participating projects and organizations are fairly large in terms of number of persons and requirements involved, as well as in terms of the duration of the projects. Our ongoing survey provides data from a number of mainly small, and fairly new market-driven development companies¹.

In this initial stage of the survey, seven persons at five different companies participated. It will be followed by forthcoming stages, including workshops with RE experts and an extended interview survey based on these initial results.

This paper starts with a brief description of the research method in Section 2 Section 3 includes a characterisation of market-driven RE, as described in the literature, which will be used as a framework for analysing the results of the interview survey. These

¹ We do not have an absolute definition of small and large project. However, small projects we refer to projects that including around 15 persons (correspond with many of the participating companies), while larger projects include about 60 persons or more.

findings are discussed in Section 4 and the paper ends with some concluding remarks.

2. Research method

The study was carried out using a qualitative interviewing approach. This approach is useful to explore an area of interest, to obtain an overview of a complex area, and to discover diversities rather than similarities [13]. As the purpose of the study is to gain improved understanding of the nature of requirements engineering within market-driven software companies, the qualitative approach is considered suitable.

We aim at interviewing a large number of software development companies. However, it was concluded that this initial stage of the study would benefit from selecting a handful of companies and adjusting the interview instrument before carrying out the full study. Therefore seven interviewees within five Swedish software companies were asked to participate. The companies all have a market-driven development focus. They have had at least one market release of a software product or are just about to release their first.

The interview instrument was divided into three major parts:

- Background: facts about the company, its products, and the interviewee.
- Process issues: questions about the development procedure, requirements activities, and support for decision-making in the development process
- Requirements issues: questions about requirements as entities, how requirements are documented, tool usage, and requirements interdependencies.

The study had a semi-structured interviewing strategy [13], where the base set of questions were the same for all interviewees. However, the order of the questions varied depending on the interviewees' knowledge and role in the company. Additional questions were used to clarify the answers and cover all areas of interest. The duration of the interviews was 90-150 minutes. All interviews were recorded on tape and extensive notes were taken in order not to lose information. Afterwards, the interviews were transcribed in order to facilitate and improve the analysis. The analysis was carried out manually by reading the transcripts and marking sections, which

dealt with any of the characteristics of market-driven RE presented in the next section.

3. Market-driven Requirements Engineering

This section aims to outline a characterisation of market-driven RE, based on a literature survey. This characterisation will be used as a framework for analysing and presenting the results of the interview study. We have focused our literature survey mainly on activities in market-driven RE. For a discussion of differences between market-driven and customer-specific development, see [1, 2, 14, 15]. For an example of a market-driven RE process, see [16].

3.1 Some General Characteristics

There are many general characteristics of market-driven RE in literature, but the following are fairly frequently mentioned.

The primary goal is time-to-market. Time-to-market is considered as a "survival attribute" for market-driven organisations [15]. If a product or a new version of a product is not released to the market on time, market shares may be lost or reduced in favour of competitors [4]. Usually, the release dates are kept fixed and, as a consequence, requirements of a lower priority may be excluded from the current release in case of delay [1].

Requirements are invented. Before the first release of the product, there is typically no discrete set of customers and users, which can be interviewed in order to understand the requirements of the software. There are only potential customers and users [2, 3]. The requirements are, therefore, initially more or less invented by the development organisation, and only later elicited from the customers and users [11, 14]. The primary stakeholder of the software is hence the developing organisation.

Requirements are rarely written. In market-driven development, requirements documents are rarely written. Instead, requirements are most often communicated verbally within the development project, and maintaining requirements documentation is usually perceived as overhead [1, 4, 11]. Sawyer [3] mentions some reasons for this tendency, such as e.g. a lacking demand for a contractual document such as the requirements specification and also that

companies start out small with a clear product vision and therefore never has developed a document-based culture.

3.2 The RE Process

Many of the RE activities mentioned in this chapter exist in customer-specific RE as well as in market-driven, e.g. elicitation, analysis and documentation. However, they usually differ somewhat in their execution. Two distinguishing activities for market-driven RE are prioritisation and release planning.

Elicitation. As discussed above, requirements will initially be more or less invented by the developers based e.g. on strategic business objectives of the development organisation and/or a product vision. Due to the absence of customers and users, traditional requirements elicitation techniques relying on user or customer intervention are usually inappropriate [4, 15]. Instead, market survey is the most common source of user requirements in market-driven RE [18, 19]. Once the product has been released on the market there will be users and customers who can pose new requirements on the system. Requirements are then elicited e.g. through technical support, bug reports, customer visits etc. Since there is usually a continuous stream of new ideas and requirements, the RE process needs to include procedures to capture these [20].

Documentation. This activity is traditionally about developing requirements documents. However, there is not much written about requirements documentation within market-driven organisations in the literature, besides the statement that requirements documents are rarely written. Usually during this RE activity different models are developed describing the requirements and the software, e.g. data models, state charts, and process models, but the requirements may also be documented using natural language. Within market-driven development, customers or users rarely read requirements documents [4], which may affect the way requirements are specified since only the developers' understanding needs to be considered during the documentation.

Analysis. During this activity, the requirements are analysed in order to be fully understood as well as complemented with additional information [21]. Ambiguous requirements as well as diversity within the set of requirements should be discovered and the

requirements feasibility should also be checked. The most important part of requirements analysis within market-driven organisations is to determine the priority of the requirements as well as to carry out a cost estimate for each requirement, i.e. the resources needed to realise them [1, 4]. This information is used as a basis for release planning (see below).

Validation. The absence of customers and users also affects the validation activity. The developers cannot ensure that the user requirements have been addressed until rather late in the process [4]. Techniques such as prototyping, beta versions and requirements inspections are discussed as an aid for this task [3].

Release Planning. Since time-to-market is a critical constraint of market-driven development situations, one of the major tasks is to ensure that the resources are used to meet the most critical requirements [4]. The general goal of release planning is then "to select a set of requirements from a large set of candidates, that maximizes the value added for the customers within the constraints of the fixed release date and the resources available" [1, p. 61]. The most important basis for this decision is requirements priority, cost estimates [5], and requirements interdependencies [1]. Requirements interdependencies concerns relations between requirements and how actions performed on one requirement may affect other requirements in ways not intended or not even anticipated [22, 23].

Requirements Management. Sawyer et al. [4] stress the need of proper requirements management, where the requirements are stored in a persistent, retrievable and traceable form. After the first release, new requirements start emerging from customers and users, which calls for requirements management routines allowing that requirements not implemented in the current release, are preserved. This includes: uniquely identifying each requirement, defining a change management process, using tools to manage the requirements, and recording rejected requirements. Yeh [21] emphasises the need of a centralised repository, where all known requirements as well as other related information is stored. Higgins [20] conclude, after several years of process improvement in a medical software product company, that it is more efficient to manage the requirements in databases than managing documents filled with requirements. Requirements management is identified as an important area of process improvement within market-driven RE [17].

4. Results from the interview study

The interview study included five companies and seven interviewees. The companies have been in business between 1 and 20 years. They also vary in size, from 12 employees to 1200, but the projects in which the interviewees participated were to a large extent small. For a more thorough description of the participating companies, we refer to [5].

The maturity of the RE processes differs between the studied companies. Company C and D have well-defined and elaborate processes with defined phases and regular evaluation and improvement efforts. Company A has had an elaborated process, but has decreased the work to a minimised process because it was considered too time-consuming to manage and they are now dealing with a mature product with few changes. They still have a controlled process with clear phases, but more narrow. Company E focuses on developing requirements specifications, but there is no defined and documented RE process. The success is based on experienced staff that knows the activities by heart. Company B is currently developing an RE process. The main improvement so far is defining which requirements documents that should be produced. The requirements work is still fairly ad-hoc.

4.1 The general characteristics

In this section, the results concerning the three general characteristics of market-driven RE are presented.

Time-to-market. None of the participating companies mention the time-to-market constraint. However, two major groupings can be found concerning how potential delays are dealt with. Company A, C, and D have hard deadline and fixed resources, and potential delays are dealt with by removing requirements of lower priority from the project/release. Their processes are also structured to facilitate requirements selection and exclusion of requirements from the version currently being developed (see section 4.2). Within Company B and E it is possible to extend the deadline in case of delay, but this is a managerial decision.

Time-to-market is hence not identified as a survival attribute for all studied companies. It is difficult to pinpoint the exact reason for this

discrepancy, due to the small amount of interviewees. However, Company B is more or less the sole provider of their product on the market, and Company E has not yet delivered their product to the market (only a beta-version to selected customers). These facts probably affect the importance of the time-to-market constraint since there are not any competitors.

Invented requirements. All of the studied companies have released at least a beta-version of the product and there are hence actual customers and users of the products. Despite this, only Company E considers their customers as the major source of requirements. Both Company B and C estimate that approximately one half of the requirements are posed by the users and the other half by the developers or managers. Company A's product is based on a certain standard and several requirements origin from this.

A major part of the requirements are hence "invented" by the developers. However, it should be noted that the developers in several of the studied companies are also users of the software product they develop or familiar with its usage domain. The question is, therefore, whether the requirements are experienced real needs rather than invented features in these cases.

Requirements are rarely written. All the studied companies document their requirements, at least before each release. Company B mentions that verbal communication of requirements was common before they started to define their RE process. The extent of requirements documentation and the use of a requirement specification somewhat differs between the companies.

Company A, C, and D use a database to document elicited requirements, from which the requirements for the next release are selected. Company B and E, on the other hand, use a more traditional requirements specification (text document) to document the requirements. Within Company C and D their own tools are used as the only means to communicate and manage their requirements, by requirements status and eXtreme Programming (XP) Story Cards² [24] respectively. Company A structures the relevant requirements from the

² Company D use virtual story cards, stored in their communication tool, and not paper cards as XP advocate.

database and other sources in a Top 10 list in order of importance. This list is published on an internal website, in order to provide the developers with information on requirements and requirements priority.

An interesting observation is that a more traditional requirements specification is used in the two companies with the least elaborated RE processes.

4.2 The RE process

This section includes a summary about current practice concerning each of the activities identified as part of the market-driven RE process.

Elicitation. None of the companies mention market surveys as an elicitation technique or source of requirements. Instead, other techniques are used, such as customer visits, meetings with sales personnel, and working in customer projects. Many requirements originate from internal sources, such as developers or other projects.

Company A, C and D facilitate part of the requirements elicitation work by allowing the customers to send feedback directly to the development organisation. Company A and C allow customers to enter requirements directly into their support system and requirements database respectively. These databases include both suggestions for new functionality and failure reports. Company D has a “comment button” in their software tool, which can be used to send requirements and failure reports directly to the developers by e-mail. However, Company A, which has a product that has been on the market for a longer time than the products of Company C and D, has experienced a serious problem with this way of working – requirements overload. Their database contains too many requirements than can be handled and analysed before each release. Routines for dealing with weeding out and deleting requirements must hence be developed in order to fully benefit from the database.

Documentation. The most common way of documenting the requirements is by using natural language. Few of the companies use any modelling language to describe their requirements. The only exceptions are Company B, that may use state charts occasionally, and Company C, which has the possibility to relate any form of image to a

requirement in the database. An interesting question here is whether these companies would benefit from modelling their requirement and, if they are, how this work should be performed.

One common problem is how to formulate clear and consistent requirements that developers can fully understand. Several of the companies found it difficult to understand requirements stated by users and also requirements from other developers, since they were too fuzzy. This is a well-known problem in all requirements work.

Analysis. A common characteristic within the analysis activity is the importance of group collaboration. Most of the work during this activity is performed through discussion in groups consisting of, e.g., developers, product managers, and marketing personnel. There are several benefits with this way of working, e.g., the requirements are discussed and clarified while persons from several groupings are present, including the stakeholder. This enables gaining a multiple perspective on the requirements, e.g. both marketing and technical aspects. The different groupings also gain a better understanding of the requirements and the time/cost estimates are also improved. Several companies emphasise the importance of the developers really understanding the requirements before time/cost estimates are made.

Also concerning this activity the two groupings can be distinguish among the participating companies, both concerning time/cost estimation and prioritisation. Company A, C, and D perform time/cost estimates as well as assign priority to each requirement. Since the estimates affect the priority of requirements, and hence the release planning they are considered to be an important part of the RE process.

Company A uses a simplified version of the Lichtenberg method [25] to analyse and time/cost estimate their requirements while Company D uses Planning Game from XP to discuss, clarify and cost estimate their requirements. Company C handles this task by performing requirements inspections before the requirements are moved to the next status level. Produce correct time/cost estimates for the requirements is considered as a difficult task by most of the companies.

Company C and D assign a priority value to each requirement, while Company A structures the requirements in an ordered list (Top 10) with the highest priority at the top. The most common factor when prioritising the requirements is the customer

profitability of each requirement, i.e. how important the requirement is to the customers.

Company B and E do not perform time/cost estimates for each requirement nor do they assign a priority value to their requirements. Instead, they focus their work on deciding which requirements to include in the requirements specification with respect to the timeframe and resources available for the project.

The analysis activity is important since it provides a basis for the release planning task. Company A, C and D's way of working where the requirements are time/cost estimated and prioritised simplifies requirements selection as well as adding or excluding requirements from the current release.

Validation. As stated in the literature, validation of requirements is difficult due to the absence of customers and users. Besides the requirements analysis above, where the stakeholders are sometimes asked to clarify or explain the requirements, there is not much validation work performed early in the process. Company D validates their requirements somewhat through the Story Cards, which are linked to a website where the stakeholders can check the progress of their requirements. Many of the participating companies, however, release beta-version of their product and allow selected customers to test it.

Release planning. Release planning also differs substantially between Company A, C and D, and Company B and E, which is indicated already during the discussion about the analysis activity.

Company A use their Top 10 list where all relevant requirements are listed in order of importance. How many of the requirements in the Top 10 list that can be implemented in the current version is decided based on the resources available for the project. Company C works with requirement status, where the requirements must fulfil some criteria to be passed on to the next status level. Every other week all new, approved requirements, i.e. those with the requirement status "accepted for prioritisation", are prioritised. Based on this prioritisation and the available resources, the most important requirements are selected for implementation. The selected requirements are given the status "accepted for implementation", which provides the developers with information concerning what requirements they should work with. Company D uses XP Planning Game for their release planning. They have at least one release every month and they

plan for two releases ahead. In contrast to the other companies, they base their release planning not only on requirements priority but also on release themes. During each Planning Game all new, relevant requirements are documented on story cards. These requirements are analysed, explained and time estimated, as well as grouped into technical tasks. Based on this added information, each card is placed into one of the forthcoming four releases.

The release planning activity within Company B and E is focused on producing a requirements specification, based on the perceived customer benefit of requirements. This work is carried out through discussing with the product manager, marketing personnel and developers.

All interviewees acknowledge that requirements do relate to each other, which affects the development work. The requirements are often grouped together e.g. if they are related to the same part of the product, related to the same release theme, or if they should be implemented by the same person or at the same time. During the development work, the developers also have to deal with conflicting or similar requirements.

Requirements Management. Once again, the way of working differs between company A, C and D and company B and E. Company A, C and D use a database to gather and store the constant flow of new requirements and their way of managing the requirements agree with the literature.

Company A has a support system, where all new requirements as well as failure reports are stored. Company C has a database where all requirements are uniquely identified, and additional information about the requirements are stored as attributes. Company D uses their communication tool to store all relevant requirements on XP story cards. The requirements are uniquely identified and assigned to one story card, which also contains relevant additional information about the requirements. However, due to the requirements overload problem, Company A nowadays also uses their Top10-list. This list includes a link from each requirement to a web page describing the requirement in more detail, as well as the source of the requirement.

Company B and E use a requirement document, where all relevant requirements are listed and described. Within Company B all current documents are stored in a file structure, and Company E classifies requirements in the requirements

document. None of them document any additional information about the requirements.

Company A, C, and D way of analysing and managing their requirements do not only facilitate the release planning activity. It also facilitates change management, i.e. excluding or including requirements from the current release. This is mainly due to the time/cost estimate and the prioritisation made per requirements. The short development cycles of Company C and D (2 weeks and 1 month) also decrease the impact of changing requirements.

Company B on the other hand, manages changes through revision management on the requirements document. They have a steering committee that is responsible for all these types of decisions. If new requirements are to be considered, these must be evaluated and time estimated.

5. Concluding remarks

This paper presents the results from an initial, explorative survey of market-driven RE. The presentation is based on common characteristics of market-driven RE found in the literature.

Although the literature and the results from the interview study largely correspond with each other, there are some differences. Time-to-market is not considered as a survival attribute by all studied companies. The importance of this attribute may depend on whether or not there are competing products on the market. All the companies documented the requirements, in contrast to what is described in the literature, but in different manners.

Two major groupings within the studied companies can be identified with regard to elicitation, analysis, release planning and requirements management. The RE processes of Company A, C and D correspond well to the findings in the literature survey. The only discrepancy is market survey as an elicitation technique, which was not mentioned by any of the companies. The RE process in these three companies are focused on facilitating activities fundamental to market-driven RE e.g. managing the constant flow of new requirements and release planning. Important issues are to analyse, time/cost estimate and prioritise the requirements individually, as well as to store them as single units in a central repository with additional information linked to each requirement. The way of working in each of these activities differed between

the three companies, and section 4.2 can partly be viewed as an idea of how market-driven RE activities can be performed. The Lichtenberg Method, eXtremme Programming, and status-driven requirements management are examples of the approaches mentioned as support for the various RE activities.

Company B and E, on the other hand, work in a fairly different way and their RE processes are focused on developing and maintaining a traditional requirements specification.

The analysis activity was found to be of great importance in order to facilitate release planning. This activity was performed mainly through group collaboration involving all relevant stakeholders while discussing the requirements. This way of working is identified as an important means of improving requirements analysis, including clarifying and increasing the understanding of the requirements, performing correct time/cost estimates of the requirements as well as prioritising them. Despite this, many of the companies found it fairly difficult to estimate the time/cost of implementing the requirements as well as to formulate clear and consistent requirements.

According to the literature, it is important to develop routines to manage the constant flow of new requirements e.g. using a central repository including all known requirements. However, in order to avoid requirements overload, routines for weeding out and deleting requirements must be developed to enable companies to fully benefit from such a central repository. For a discussion about other challenges within market-driven RE identified through the interview survey, see [5].

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