Investigating Upstream versus Downstream Decision-Making in Software Product Management

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Abstract

Decision outcomes and their lead times are critical in product management, as the market success of a product may strongly depend on the both the decisions themselves and their timing in relation to the market and competitors. This paper presents an investigation of one particular industrial case study data set by comparing upstream scoping decisions with downstream change decision. The results in this case indicate that changes are more likely to be accepted during upstream decision-making compared to downstream. We also found that the most common value for upstream decision lead-time is three days, while only one day for downstream. The results trigger a general discussion on factors that may impact or explain decision lead-time. Assumptions and questions for further investigation in the context of product management decision-making are proposed.

1. Introduction

A product manager (PM) plays an important and critical role in the success of a software company's product. Product management is rather complex where the PM has several important tasks, such as requirements management, release planning, and scope change management [11]. Requirements engineering (RE) is a process that takes place before and throughout the product life cycle, and drives the vision of a product [4]. For a product to be successful, market needs must be successfully identified and translated into the scope of a product [4]. However, requirements for complex systems may be counted in thousands and generated from internal (e.g., engineers) and external (e.g., customers) sources [6]. Deciding what requirements to include into a product's scope is not a trivial task, and only a sub-set of the requirements may be included and hence postpone the implementation of other requirements to a later point in time [7, 12]. Reaching this often uneasy compromise sometimes means that the development of already made commitments may need to be sacrificed at the expense of wasted effort. In many cases, already made decisions have to be reconsidered. Decision-making is considered to be complex [8], where the complexity of pre-project (upstream) decisions is not easy since they are often based on abstract and uncertain information.

Ebert [4] defines upstream processes as those that analyze the business opportunities and relate to initial development, while downstream processes relate to project definition and execution. Based on those definitions, we define upstream decisions as those that are made before the requirements are settled and the implementation phase starts. Downstream decisions on the other hand relate to decisions involving formal requirements change management procedures during implementation. When the implementation phase starts, development teams often refine goals and features into system-oriented requirements specifications. This refinement often results in new change requests. These requests are often analyzed and decided by the project management. One downstream decision may consequently create many change requests that need to be decided.

Our objective with this paper is to investigate and discuss decision lead-time for upstream and downstream decisions. Do downstream decisions require a more thorough investigation of the impact of the decision and therefore result in longer decision lead-time? Are upstream decisions faster than downstream? The lead-time of decisions is an important factor in the quality of the decision-making process, as the timing of decisions can be crucial to market success.

Our investigation and discussions are based on data from a case study, where lead-times of decisions both upstream and downstream have been recorded in a requirement database.

This paper is structured as follows. Section 2 describes the investigation methodology. In section 3, background information about the case study is provided while section 4 presents the results. In section 5, the results are discussed and concluded.

2. Investigation Methodology

This case study is an open-ended document analysis [10]. The focus is on understanding upstream and downstream decisions, in particular, decision lead-time and decision outcome. A document analysis is an unobtrusive study of an artifact, and analyzing the content is a quantified codification of the artifact [10]. Metrics were collected from the decision log for both upstream and downstream decisions from three large projects. The number of features in each project varies between 175 and 530. Each project includes about 20 technical areas. A content analysis [10] is performed to quantify the decision logs. The decisions are analyzed based on the two most important attributes for this study from the decision logs, namely decision lead-time and decision outcome. Decision lead-time is the time between the introduction of a change in the decision log until a decision is made. Decision outcome is the actual decision, which in this study can be *accepted*, *rejected*, or *closed*. In this study, only accepted and rejected outcomes are analyzed since they were represented in all analyzed projects. In total, 3042 decisions are analyzed where 2167 decisions are downstream and 875 are upstream decisions, which can be seen in Table 1.

3. The case company

The case study is based on empirical data from industrial projects at a large company that is using a product line approach [9]. The company has more than 5000 employees and develops embedded systems for a global market. There are several consecutive releases of the platform, a common code base of the product line, where each of them is the basis for one or more products that reuse the platform's functionality and qualities. The company uses a stage-gate model with several increments [3]. The complexity of requirements engineering is driven by a large and diverse set of stakeholders, both external to the company and internal. Similar to the case in [5], requirements originating from external stakeholders (called *market requirements*) are separated from but linked to *system requirements* that are input to platform scoping in a product line setting. To control the project process the case company defined four milestone of requirements management phase, namely MS1-MS4. Until MS4 is reached, all decisions are related to scope control, hence, considered as upstream decisions. After MS4, the final scope of the *platform* project is decided and the implementation phase starts. In subsequent *product* projects the platform is utilized as the basis for product configuration and development. All proposed changes after MS4 are considered as change control decisions, therefore, classified as downstream, with respect to the platform project.

4. Results

This section presents the results discovered during the document analysis. The difference between the analyzed upstream and downstream decisions is displayed in Table 1. The results in Figure 1 and 2 are presented in a percentage form to minimize time-span and size differences between analyzed projects. In total, 875 upstream decisions were analyzed and 671 of the proposed changes were accepted. Only 102 of the upstream decisions were rejected in the scope control decision-making. The remaining 102 upstream decisions had another outcome than accepted or rejected, for example, closed, postponed, or a decision has yet to be made. Of the 2167 downstream decisions that were analyzed, 1272 were accepted while as many as 629 were rejected in the change control decision-making. For downstream decisions, 266 change requests had another outcome than accept or reject.

Table 1. Number of decisions of the analyzed projects

	All decisions	Accepted	Rejected
Upstream	875	671	102
Downstream	2167	1272	629

The results for decision lead-time show that as many as 72% of all upstream decisions were decided in three days (see Figure 1). In addition, more than 10% of the upstream decisions took two days. This shows that 85% of all upstream decisions are decided between two and three days. The results show that the mode value for upstream decision lead-time is three days. For downstream decisions, 30% of all decisions took only one day. As can be seen in Figure 1, the mode value for downstream decision lead-time is one day.

When we compared the percentage of accepted versus rejected decisions, the results show that about 77% of all upstream decisions were accepted, which can be seen in Table 1. Only 12% of the 875 upstream decisions were rejected. For all downstream decisions

(2167 decisions), 59% were accepted and as many as 29% were rejected. The results indicate that changes are more likely to be accepted during scope control (upstream) decision-making compared to change control (downstream). Consequently, more changes are rejected in change control decision-making than scope control.

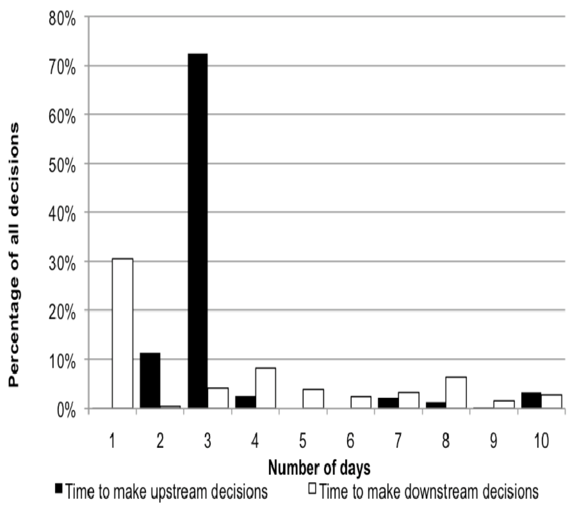

Figure 1. Decision lead-time distributions

In Figure 2, a comparison of accepted versus rejected decisions for upstream and downstream decision-making is shown. The results show that almost 80% of all accepted upstream decisions were decided in three days. Three days is also the mode value for accepted decision lead-time in upstream decision-making. Furthermore, almost 10% of the accepted upstream decisions took two days, meaning that as many as nine out of ten accepted changes are decided between two and three days.

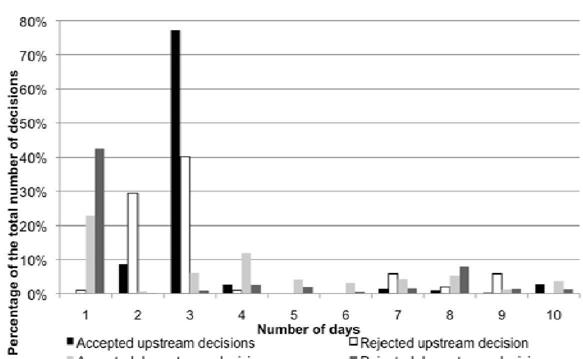

Figure 2. Distribution of accept and reject decision lead-time

For rejected upstream decisions, 40% are decided in three days and almost 30% in two days. This result is similar to the accepted upstream decisions where only the percentage of made decisions between two and three days differs.

Looking at accepted downstream decisions in Figure 2, about 20% were accepted in one day. In addition, 15% of the accepted downstream decisions were decided in two days. The mode value for accepted downstream decision lead-time is one day. Similar to the accepted decision for downstream, the mode value for rejected decisions lead-time is one day. Fourth percent of all rejected downstream decisions took one day, however; almost 10% of the rejected decisions needed as many as eight days to be decided.

5. Discussion and conclusion

Based on the analyzed empirical data, it seems that downstream decisions have a longer decision lead-time than upstream. A majority of the upstream decisions lead-time in our case study is between two and three days, while a minority of the downstream decisions have a lead-time between one and three days. However, if the most common value is analyzed, downstream decisions lead times have a higher mode value than upstream decision lead times. This is an effect of the large spread in lead-times distribution.

In analyzing accepted versus rejected decisions, the conclusion from our particular case is that more upstream decisions are accepted than downstream. One possible explanation may be related to the cost of late changes. A common hypothesis is that the later a change is introduced, the higher the effort of rework as a result of the change. In addition, downstream decisions may affect other parts of the product and introduce more changes that may affect other requirements as well as software architecture. Time to market may be another factor; introducing late changes may lead to a chance to catch newly discovered market opportunities.

In upstream decision making, the importance to identify the market's need and translate them into requirements may be one reason for the high acceptance rate of proposed changes. If the market needs are not successfully identified, the product may not be successful and the software company may not increase their market share or make a profit.

Another possible explanation may be the introduced complexity of late changes and therefore more time is needed to analyze the proposed change.

In addition, the size and complexity of a change may seriously influence the decision lead-time, however; this is not considered in this analysis due to lack of available data. Thus more thorough analysis of the decision lead-time with respect to more accurate representations of decisions' sizes and complexity is needed in order to draw more conclusions.

A product manager may face a number of dilemmas and may have to make on-the-fly trade-offs based on gut feeling rather than exact knowledge. Such dilemmas may include:

• *Decision Speed vs Decision Certainty*. It may be more important to make a decision now rather than waiting until more information is available, as otherwise the market window may close. What can a product manager do to keep decision lead times as low as possible while achieving adequate decision quality?

• *Efficient Dictates vs Shared Consensus*. It may be efficient, but also potentially counterproductive, to overrule stakeholders and make a decision dictate on the scope. Consensus building among internal and external stakeholders may give good-will and a commonly shared vision that prevails in the long run even if sometimes slower at the outset.

• *Many small wishes for many stakeholders versus Few large wishes for few stakeholders*. There is always a dilemma related how to share development resources. Strategy means selecting one thing over another, but unhappy stakeholders may generate too much bad-will, which may punish the product and its brand in the future.

How can research help in supporting the trade-off analysis needed to handle these dilemmas?

It is also interesting to further investigate what factors that are affecting decision lead time. There are potentially very many such factors, and they are naturally dependent on the domain. The set of factors may include the following general ones:

- Number of stakeholders.
- Complexity of stakeholder wishes.
- Impact analysis complexity.
- Perceived available (or stipulated) time window.

Are these factors different in upstream versus downstream decision-making? Our assumption is that decision-making upstream requires different types of trade-offs compared to down-stream decision-making. This assumption needs further investigation. If it turns out to be relevant, we should also like to see investigations in support methods for decision-making that are adapted to each respective part of the life-cycle.

In general we propose to extend the existing research on RE decision-making [1, 2] with more empirical studies specifically focused on decision outcome in product management and the factors that impact lead-time. Future work will involve analyzing the nature of the decisions, the role of the decision-maker, and to which degree delayed or missing upstream decisions impact downstream performance. In order to strengthen the result, statistical hypothesis testing will also be used. Through empirical understanding of the problem we can propose industrially relevant support for software product management decision-making, both upstream and downstream.

6. References

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