

An Industrial Case Study on Distributed Prioritisation in Market-Driven Requirements Engineering for Packaged Software

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When developing packaged software, which is sold ‘off-the-shelf’ on a worldwide marketplace, it is essential to collect needs and opportunities from different market segments and use this information in the prioritisation of requirements for the next software release. This paper presents an industrial case study where a distributed prioritisation process is proposed, observed and evaluated. The stakeholders in the requirements prioritisation process include marketing offices distributed around the world. A major objective of the distributed prioritisation is to gather and highlight the differences and similarities in the requirement priorities of the different market segments. The evaluation through questionnaires shows that the stakeholders found the process useful. The paper also presents novel approaches to visualise the priority distribution among stakeholders, together with measures on disagreement and satisfaction. Product management found the proposed charts valuable as decision support when selecting requirements for the next release, as they revealed unforeseen differences among stakeholder priorities. Conclusions on stakeholder tactics are provided and issues of further research are identified, including ways of addressing identified challenges.

Keywords: COTS; Disagreement; Prioritisation; Product scoping; Release planning; Satisfactory

1. Introduction

Requirements Engineering (RE) research is beginning to address the specific issues in market-driven RE, where

requirements are invented for packaged software offered ‘off-the-shelf’ to a mass market [1,2]. This situation is in many respects different from the contract situation, where a developer interacts with a specific customer to elicit requirements for a bespoke system. A description of the specific challenges of market-driven RE can be found elsewhere [1–4]. As pointed out by Sawyer [5], two major differences between bespoke software development and market-driven software development concern the characteristics of stakeholding and schedule constraints. The developer decides about the requirements and selects the stakeholder representatives. The developer bears all financial risks and there is no single customer who is the principal stakeholder as with bespoke software development. There is a major pressure on time-to-market and the software product is often offered to a market through recurrent releases, requiring careful release planning and requirements prioritisation. Such challenges pose special demands on the RE process. Examples of market-driven RE processes, which try to address these special demands, can be found elsewhere [6–9].

This paper focuses on the important challenge within market-driven RE of how to combine information from different market segments and make a trade-off between their priorities. In particular, the paper focuses on the visualisation of disagreement between stakeholders and differences in the satisfaction with a certain priority decision. A number of charts are proposed, which are intended to be used as decision support when determining what to implement in the coming release of a software package.

The presented work is conducted in the context of an industrial case study, which is a follow-up on the study reported Regnell et al. [6]. One of the main challenges identified in Regnell et al. [6] was to relate the

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continuous prioritisation of incoming requirements to a long-term product strategy for a range of market segments. An important issue here is how to incorporate the expertise from marketing departments and the visions of top-level management in the prioritisation process. This paper focuses on how to elevate a prioritisation strategy (e.g., [10,11]), by making differences in the priorities of the various market segments explicit. The presented case study is conducted as part of an improvement programme for a specific industrial RE process for packaged software, called REPEAT (Requirements Engineering Process at Telelogic), which is enacted by the Swedish CASE-tool vendor Telelogic AB – a company with 450 employees (January 2000), more than 7000 users worldwide, and a revenue for 1999 of 318 million SEK (increase from 178 million SEK, 1998). REPEAT is used in-house at Telelogic for eliciting, selecting, and managing requirements on a product family called Telelogic Tau; a software development tool package for real-time systems, used by many of the world's largest telecom systems providers in their software development. Telelogic Tau supports standardised graphical languages, such as SDL, MSC, TTCN, and UML, and provides code generators for integration with several real-time operating systems (for further information, see www.telelogic.com).

The paper is structured as follows. Section 2 describes the process used within the presented case study for making distributed requirements prioritisation in a worldwide organisation. The planning and operation of the case study are reported in Section 3. The main findings from the questionnaire-based evaluation of the distributed prioritisation case study are summarised in Section 4, together with a description of the visualisation charts for supporting the selection of requirements. Section 5 provides a discussion on the findings and identifies issues of further research.

2. A Distributed Prioritisation Process

When selling packaged software, the potential market segments may be spread worldwide. This calls for a distributed marketing organisation with close relations to targeted customers. The organisation, in which the presented case study has been conducted, is depicted in Fig. 1. The Product Strategy Team (PST) is responsible for making strategic decisions and communicates with a number of Market Operations (MOs) for gathering information and promoting strategies. The PST also communicates with Customer Support and Product Development.

At the time of writing there are eight MOs representing six geographically segmented markets in

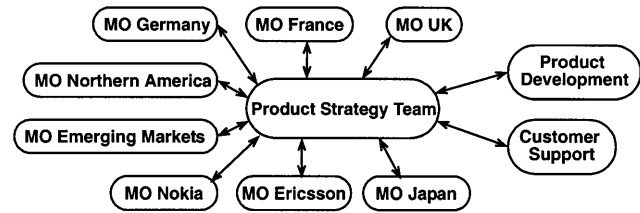


Fig. 1. The Product Strategy Team communicates with a number of stakeholders representing valuable information sources on market opportunities, user expectations and technology trends.

North America, Germany, France, the United Kingdom, Japan, Emerging Markets, and also two markets segmented by key corporations in the telecom industry. The centralised Customer Support Department has, based on support issues, valuable information regarding what customers desire. Similarly, the centralised Product Development Department has valuable information on where technology is heading. Hence, there are in total 10 stakeholders from which the PST gathers information on requirements priorities, before making strategic decisions regarding products. These strategies are applied in every-day requirements decisions, made by the Requirements Management Group. (More information on the role of this group can be found in [6].)

In the efforts of further improving RE at Telelogic, a baseline sub-process for strategic prioritisation of high-level requirements was formulated where each stakeholder can contribute with their particular priorities. This process is the object of the presented pilot case study, which started in October 1999 (see further Section 3). The sequencing of tasks in the process is illustrated in Fig. 2.

- *Step 1:* The PST starts the process by making a candidate list of strategic high-level requirements. The requirements on the candidate list are divided into two abstraction levels. At the high level, the items are feature groups, and at the next level the items are individual features.
- *Step 2:* The candidate list is distributed to the different stakeholders around the world. Each stakeholder in

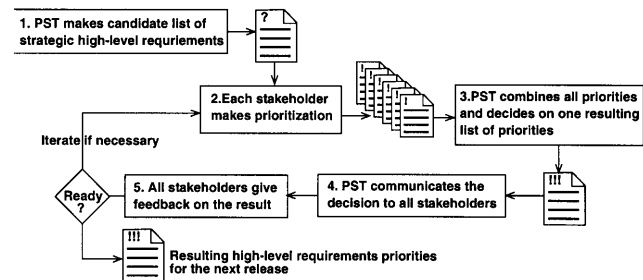


Fig. 2. A distributed prioritisation process for gathering information from all stakeholders on high-level requirements importance.

Table 1. Number of features per feature group

Feature group	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	Total
Number of features	10	0	4	2	3	4	0	2	2	3	2	6	4	7	2	4	3	58

parallel makes a prioritisation of the requirements on the candidate list. It is also possible for each stakeholder to add new features or feature groups to the list.

- *Step 3:* Based on the separate priorities of each stakeholder, the PST decides on a combined list, including an aggregation of the individual priorities.
- *Step 4:* The decision is communicated to all stakeholders.
- *Step 5:* The stakeholders give feedback on the impact of the decision to the PST. If the PST finds it necessary, another iteration may be started. Otherwise, the process results in a decision on high-level requirements priorities for the next release. This list is then used as a guidance when making trade-offs between value and cost of more detailed requirements (see [6] for further description on the use of must- and wish-lists).

When the PST aggregates the priorities of the individual stakeholders into a combined decision, there are a number of criteria for adjusting the influence of each stakeholder. This aggregation can be carried out by weighting the market segments based on one or several *weighting criteria*, for example:

- revenue last release;
- profit last release;
- number of sold licences last release;
- predictions of the above criteria for the coming release;
- number of contracts lost to competitors;
- number of potential customers with nil licences to date;
- size of total market segment.

Which weighting criteria to use depends on which general strategy that the top-level management perceives best fits with the current market phase [12].

3. Case Study Planning and Operation

During the summer of 1999, the case study was planned with the objective of obtaining feedback on the distributed prioritisation process shown in Fig. 2. The case study was conducted during the fall of 1999, and comprised one iteration of the process.

First, the PST decided on a list of requirements. The requirements were represented on two levels of abstraction. The lower level consisted of features, which in turn were grouped into high-level feature groups. This grouping was natural, according to the product manager, as there were related feature requirements which easily formed coherent groups. In this study there were 17 feature groups (denoted A–Q in the analysis). The feature groups A–P each consist of up to 10 closely related features as shown in Table 1. Feature group Q consists of remaining features with no natural relation to other features. Feature groups B and G contained no specified features, and were only prioritised on the group level. In total there were 58 features. The total number of objects given to stakeholders for prioritisation was thus $17 + 58 = 75$, as the stakeholders were asked to prioritise both the feature groups and the features.

Each feature group and each feature were represented by a short but informative name together with a natural language description comprising a couple of sentences. Examples of requirements at feature group level were ‘External tool integration’ and ‘Support for deployment and partitioning on target level’. The former feature group included features such as ‘Integrate SDL Suite with DOORS’ and ‘Improved integration with Clearcase’.¹

All requirements were described in a spreadsheet and sent out via email to the 10 stakeholders. Each stakeholder made two prioritisations: one for the feature groups and one for the individual features. Each prioritisation was carried out through the distribution of a predefined amount of fictitious money (\$100,000) over the items to be prioritised. During the prioritisation, the stakeholders were given the possibility to add new items, both feature groups (denoted group Z in the analysis) and features. Each stakeholder was represented by a number of persons, ranging from one to six. Each group of representatives delivered one set of priorities for the $17 + 1$ feature groups A–Z and one set of priorities for the 58 (plus added) features. These

¹The requirements in this study are strictly confidential, but the few carefully selected examples above were allowed to be revealed in order to give a flavour of their abstraction level, as long as they cannot be explicitly related to the anonymous data given in the paper.

priorities represent the stakeholder representatives' agreed-upon views on the importance of the requirements.

After the individual stakeholder prioritisation, a questionnaire was sent out to each stakeholder, with the objective of receiving feedback on the distributed prioritisation process. The results from the analysis of the questionnaire answers are summarised in Section 4. The outcome of the prioritisation is presented in Section 5, together with a number of charts for visualising the data from distributed prioritisation.

4. Results from Questionnaires

We received responses from eight participants (one response each from six stakeholders and two responses from one stakeholder). The questions and answers can be found in Table 2. Some stakeholders gave additional information to question numbers 10, 14 and 16. This additional information, together with an interpretation of the results, is presented in the following.

The first questions were aimed at relating the time spent on the prioritisation to the other answers. Unfortunately, there seem to have been different interpretations of the questions, which makes the answers to questions 2 and 4 unreliable. As a result we cannot draw any conclusions from questions 3 and 5 either.

As indicated by the answers to questions 15 and 17, the stakeholders seem to have good confidence in the usefulness of distributed prioritisation of requirements using the selected method. One quarter of the stakeholders thought the distributed prioritisation was very useful. The rest of the stakeholders thought it was rather useful.

According to the answers to questions 6 and 7, the stakeholders also thought that it was easy or very easy to understand what to do and not difficult at all to carry out the prioritisation. The answers to question 12 possibly indicate that there were some difficulties in interpreting the requirements description, although most stakeholders did not come up against any problems. Also, the answers to question 13 show that the stakeholders were not very confident that the other stakeholders would have the same interpretation of the requirements. The quality of requirements descriptions may influence the participants' opinion about the method. The requirements descriptions can, however, be improved regardless of the method used and possibly improve confidence in the interpretation.

The answers to question 8 also support the usefulness and simplicity of the method. The stakeholders found that the result closely reflected their 'gut feeling' of what

was important. This positive outcome naturally influences the opinion of the method but it is also important in order to avoid further iteration in the prioritisation process.

All the stakeholders used the same order of prioritisation, starting with the high-level requirements and then proceeding with the low-level requirements. This is not very surprising, as the method description indirectly suggested this order. The majority of the stakeholders also used the same strategy when distributing the money and started with the requirements they found most important. Only one stakeholder started from the top of the list. The rest of the stakeholders used variants of the 'most important' strategy. Stakeholder number 8 emphasised that they started with the requirements that were important for the whole company, not only for them. Another stakeholder used a simple algorithm to distribute the money and started investing \$ N on the most important requirements. Then, the stakeholder invested \$ $N/2$ on the next important ones, \$ $N/4$ on the next important ones after that, and so on until all wanted investments were made. N was then adjusted so that the sum became \$100,000.

The answers to question 14 reveal the most influential criteria used by the stakeholders when deciding what was important. We can see that increasing sales was a highly influential criterion for most of the stakeholders. Other important criteria were to find new customers, to reduce support effort and to beat competitors. Stakeholder 2 provided other criteria and stated that using company skills to the best and technology push was rather important. Stakeholder 3 thought it was important to create complete functions and a truly usable product. Stakeholder 7 wanted to satisfy a key customer.

In this study, the stakeholders were asked to distribute a total of \$100,000 on all requirements across groups. As question 11 suggests, another way would be to give \$100,000 for each group of low-level requirements and distribute them only within the group. This second suggested way to distribute the money was supported by half of the stakeholders, although they had not tried it. Only two, as the answers would indicate, were convinced that the used distribution method was the best. The rest had difficulties to decide which was the best approach.

The priority information that the method collected was enough for half of the stakeholders. The other half wanted to provide additional priority information and brought up several interesting and important aspects. Stakeholder 1 thought it was necessary to discuss the impact of new features: if they open new markets, increase sales to existing customers, and keep existing customers pleased. Stakeholder 3 found that 'after the collection of requirements it was clear that some top

Table 2. The results of the questionnaire used to evaluate the prioritisation method

Question	Answer format	1	2	3	4	5	6	7	8
1 Number of people involved in prioritisation		1	1	4	6	1	5	2	6
2 Time spent on high-level requirements prioritisation	Person minutes	10	60	110	300	30	60	180	180
3 Was the time spent enough?	1–More than enough 2–Enough 3–Too short	2	2	2	3	3	2	2	2
4 Time spent on low-level requirements prioritization	Person minutes	20	60	200	30	30	20	80	540
5 Was the time spent enough?	1–More than enough 2–Enough 3–Too short	2	2	3	3	3	–	2	2
6 How easy was it to understand what to do based on the method description?	1–Very Easy 2–Easy 3–Neither easy nor difficult 4–Difficult 5–Very difficult	2	1	2	1	2	1	2	2
7 How easy was it to carry out the prioritisation of requirements?	1–Very easy 2–Easy 3–Neither easy nor difficult 4–Difficult 5–Very difficult	3	2	3	3	2	2	2	2
8 When finished with prioritisation, did invested money reflect the 'gut feeling' of what was important?	1–The result was exactly correct 2–The result was almost correct 3–The result was not very correct	2	2	2	2	1	2	2	–
9 Order of prioritisation	1–High-level, then low-level 2–Low-level, then high-level 3–Iterated between levels	1	1	1	1	1	1	1	1
10 Strategy when distributing the money	1–Started with the important 2–Started from top of list 3–Other	1	3*	2	1	1	1	1	3*
11 Best way to distribute the money?	1–Consider all low-level requirements as a whole and distribute one sum of money on all of them 2–Have one sum of money for each group, so that we can consider them separately 3–Equally good to distribute money on all or per group 4–Don't know	1	4	1	4	2	2	2	2
12 How easy was it to interpret the requirements descriptions?	1–Very easy 2–Easy 3–Neither easy nor difficult 4–Difficult 5–Very difficult	2	2	3	2	2	2	4	2
13 Do you think you have the same interpretation of requirements as others?	1–Exactly 2–Almost exactly 3–Partly the same 4–Not very similar 5–Completely different	2	4	3	2	3	2	3	2
14 Most influential criterion/criteria when deciding what was important	1–Increasing sales 2–Increasing profit 3–Finding new customers 4–Reducing support efforts 5–Beating competitors 6–Other	1 3 4	5 6* 3	4 6* –	1	1	1 5 4	3 1 6*	1 2 4
15 Usefulness of the method with monopoly money	1–Very useful 2–Rather useful 3–Not useful 4–Waste of time	1	2	2	2	1	1	2	2
16 Is the priority information you provide enough, or should you have had opportunity to provide more?	1–The method collects necessary information from us 2–It is not enough. We want to provide additional information	2*	1	2*	1	1	1	2*	2*
17 Usefulness of prioritisation in general, by collecting information from different sources	1–Very useful 2–Rather useful 3–Not useful 4–Waste of time	1	2	2	2	1	2	2	2
18 Agreement with the resulting list of priorities made by the product manager	1–Agreed completely 2–Agreed to most of it 3–Agreed to some of it 4–Disagreed in most cases 5–Did not agree at all	1	2	2	3	2	2	3	3

*Additional information on marked numbers can be found in the text.

–The dash indicates that no answer was given.

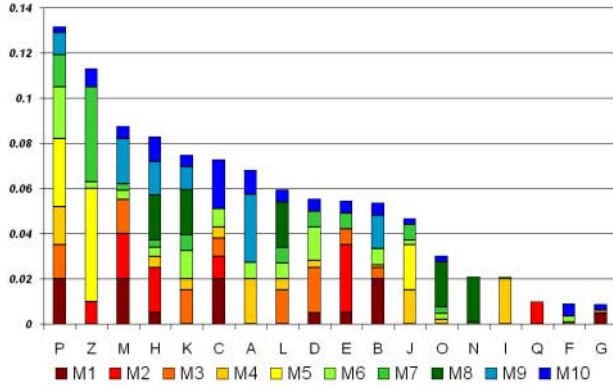


Fig. 3. *Distribution Chart* with equal market influence. The chart is best viewed in colour (available at <http://www.telecom.lth.se/Personal/bjornr/fig3.pdf>).

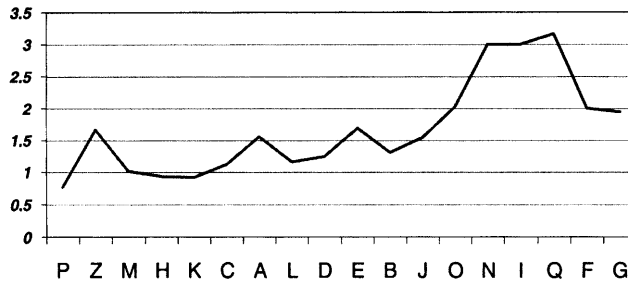


Fig. 4. *Disagreement Chart* visualising the dispersion of priorities among stakeholders.

- *Disagreement Chart* for showing the size of variation between stakeholder priorities for each requirement.
- *Satisfaction Chart* for showing how well the resulting priority ranking corresponds to the priorities of each individual stakeholder.
- *Influence Chart* for showing how much influence each market is given on the resulting priority.

These diagrams are explained in the following, and exemplified with real data from the industrial case study.²

The resulting priority denoted p_i for each requirement i is calculated as the weighted average of the priorities over stakeholders using a weight denoted w_j , where the sum of all w_j equals 1. The weights w_j are used to adjust the influence on the resulting priorities for each stakeholder. If all stakeholders have equal influence, then all $w_j = 1/m$, and the unweighted resulting priorities correspond to the ordinary average.

²Unfortunately, the timing of the decision making in the PST hindered the use of these diagrams in the actual release plan decision meetings, but they were examined by the PST afterwards. Hence, the PST did not build their decision on the diagrams, although the PST felt that the charts would have been valuable as an integral part of the prioritisation process.

Figure 3 shows an unweighted Distribution Chart, where the priority distribution is visualised using a stacked Pareto bar chart. The requirements are sorted based on the resulting priorities, starting with the requirement with the highest total priority. Each

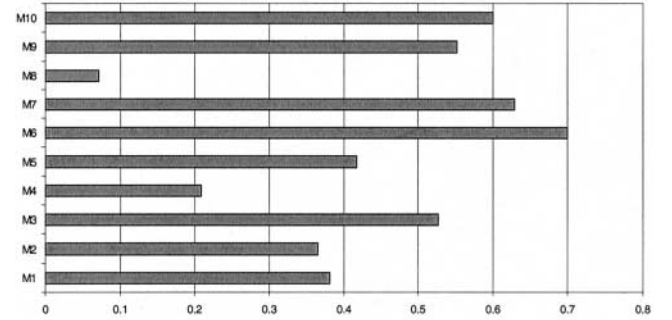


Fig. 5. *Satisfaction Chart* visualising the correlation of each stakeholder's priorities with the resulting priorities.

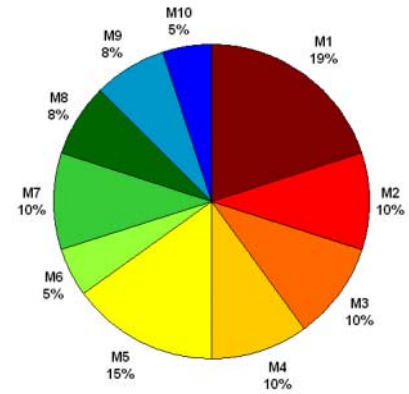


Fig. 6. *Influence Chart* visualising the weighting of stakeholder influence (the chart is available in colour at <http://www.telecom.lth.se/Personal/bjornr/fig6.pdf>).

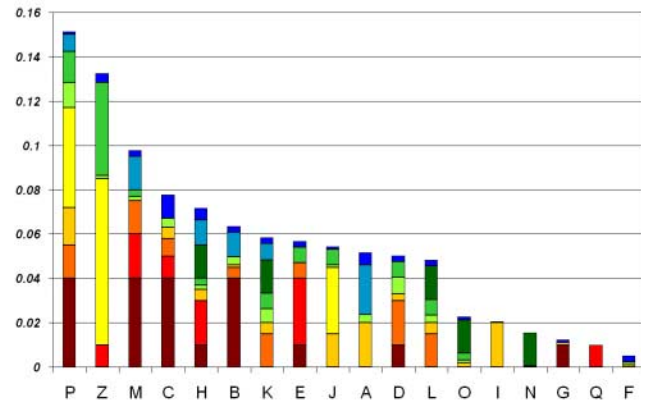


Fig. 7. *Priority Distribution Chart* with weighted market influence. The chart is best viewed in colour (available at <http://www.telecom.lth.se/Personal/bjornr/fig7.pdf>).

stakeholder is distinguished with a specific colour. We can see that many stakeholders have given high priority to requirement P, whereas requirement N, for example, although important for stakeholder M8, is given a low total priority.

As a disagreement measure denoted d_i for each requirement i , the variation coefficient was used. The variation coefficient is calculated for each requirement as the standard deviation of the weighted priorities divided by the average of the priorities over the m stakeholders. The variation coefficient is a commonly used statistical measure of dispersion, and it can be argued that large disagreement means precisely that there is a large variation between the priorities of the stakeholders.

Figure 4 shows an unweighted (i.e., all w_j equals $1/m$) Disagreement Chart that displays the disagreement measure d_i for each requirement. The chart makes it clear that there is more consensus on, for example, the priority of P compared to N. We also see that, although C and A have almost the same total priority in the Distribution Chart, there is more disagreement over A than over C.

Another result from the case study is the visualisation of stakeholder satisfaction with the resulting priority order decided by the PST. This is accomplished by correlating the ranks of the total priorities with each stakeholder's original priority ranks using the Spearman rank-order correlation coefficient [13], denoted r_j for each stakeholder j . The use of the Spearman rank-order correlation coefficient is motivated by the intuitive notion of satisfaction as how well the resulting priority order corresponds to the original priority order of each stakeholder. The Satisfaction Chart, shown in Fig. 5, reveals that stakeholder M6 is most satisfied and that stakeholder M8 is least satisfied with the resulting unweighted priorities.

In the case study, the different stakeholders were prioritised by the Product Manager according to a subset of the criteria mentioned in Section 2. This revealed, for example, that two stakeholders representing special markets were considered more important than the others (M1 and M5) and that four stakeholders were to be given low priority (M6, M10, M8 and M9). Figure 6 shows an Influence Chart, which displays the decision by the Product Manager on the market influence in terms of the weights w_j for each stakeholder. Given these weights, recalculations of p_i , d_i and r_j are made, and the charts are redrawn.

Figure 7 displays the Distribution Chart after weighting by market influence using the weights of Fig. 6. It can be seen that the priorities of M1 and M5 are

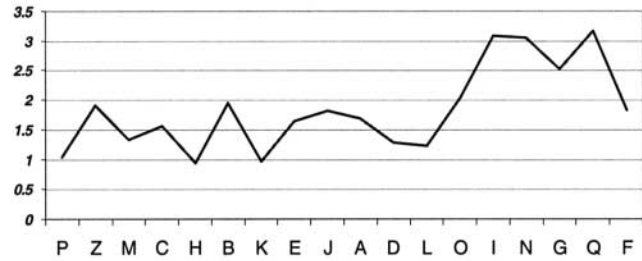


Fig. 8. Disagreement Chart with weighted market influence.

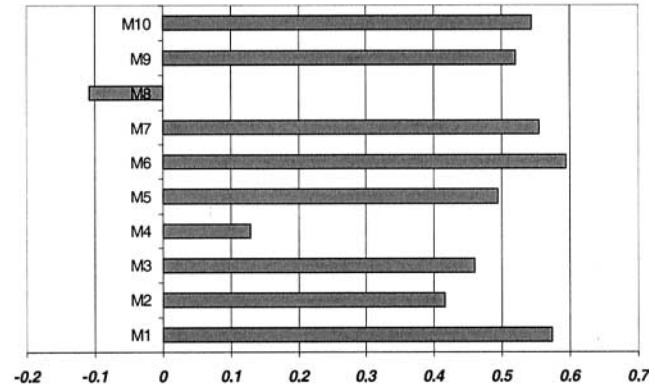


Fig. 9. Satisfaction Chart visualising the correlation of each stakeholder's priorities with the total priorities with weighted market influence.

boosted. This in turn has altered the priority order, causing, for example, C and B to move up, and A and L to move down.

The Disagreement Chart in Fig. 8 reveals an increase in disagreement for requirement C and B, while the disagreement over requirement A and L is only slightly affected. In the Satisfaction Chart in Fig. 9 we can see that stakeholder M8 is least satisfied with the weighted priority order. The negative value of the satisfaction means that the resulting priority order has a tendency to be the opposite of the individual priority order, meaning that high priorities of M8 are given low priorities in the result and vice versa. Also, both stakeholders M1 and M5 are more satisfied compared to the unweighted case.

6. Conclusions and Further Work

The presented work is aimed at making similarities and differences in priorities among market segments explicit. This is valuable as a decision support in market-driven software development, when strategic high-level requirements are to be selected for the

coming release of a software package. The presented charts for visualisation of requirements priority distribution, disagreement and satisfaction have been developed based on data from an industrial case study. The main objective of the case study was to study how distributed prioritisation can be used in the connection between everyday requirements management and a high-level product strategy. The case study included real requirements and real stakeholders.

The presented case study was evaluated qualitatively through questionnaires answered by stakeholders and by interviews with product and quality management. The general conclusions from the case study are (1) that distributed prioritisation is useful, and (2) that the visualisation charts are valuable decision support.

When comparing the sum of priorities from all stakeholders to the management's original view of the priorities from before the case study, the management was able to identify three interesting groups of requirements:

- *Confirmed priorities*: Some requirements were prioritised in a way that corresponded to the views before the case study, and thus confirmed the strategic value of these requirements. This information was valuable, as it strengthened the PST in the belief that many of the requirements previously in focus were still right.
- *Elevated priorities*: Some requirements were given surprisingly high priorities, compared to what was anticipated. This information was valuable, as it gave the opportunity to adjust the strategies to focus on new opportunities that might otherwise have been missed.
- *Cancelled priorities*: Some requirements were given surprisingly low priorities. This information was valuable, as it helped to avoid implementing requirements that may be of little success on the market.

Based on the analysis and visualisation of the data from the case study, the following major findings were made:

- *Differences among stakeholders*: The colour-coded Priority Distribution Chart shows that there were large differences among the stakeholders regarding requirements priorities. The Disagreement Chart shows that for some of the requirements the stakeholders agreed more on their priorities compared to other requirements. The Satisfaction Chart shows that there were large differences in the stakeholders' satisfaction with the resulting total.
- *Impact of influence weights*: When some stakeholders were given a higher influence than others on the

resulting total, the Satisfaction Chart shows that some stakeholders' priorities were very far from the resulting total, while others were relatively close.

- *Stakeholder tactics*: The stakeholders had different tactics when assigning absolute priority values to the requirements. Some stakeholders concentrated on a few requirements and gave them high priorities, while other requirements were given zero. Some stakeholders made a more even distribution of their priorities.

The main challenges with the proposed approach include the following:

- *Difficulties with absolute assessment*: The individual prioritisation was carried out by placing an absolute amount of fictitious money on each requirement in accordance to its perceived importance. The assessment of priorities through assignment of absolute numerical values is inherently difficult, and there are strong indications that relative judgements through *pairwise comparison* rather than assigning absolute values is easier for humans and also more accurate [10].
- *Assessment of prioritisation quality*: The quality of the priorities given by stakeholders is a major issue. The stakeholders are representatives from marketing and may not know how a particular requirement should be interpreted or how important it is for the potential customers of their market. Furthermore, all stakeholders gave the same priority to many requirements, especially the ones with low priorities. This makes it more difficult to discriminate requirements. If pairwise comparison [10] is introduced, the stakeholders are forced to take a stand for every requirement. When using pairwise comparison it is possible to calculate a consistency index [10], which may indicate if requirements are interpreted inconsistently, e.g. due to poor knowledge or ambiguous descriptions.
- *Sensitivity to 'shrewd tactics'*: It is difficult to know if some stakeholders, for example, gave an extra-low priority to requirements they knew other stakeholders would give high priorities, just in order to influence the total result to fit their aims. Such tactics would compromise the quality of the result in that it would not truly correspond to the importance to the different market segments represented by the stakeholders. It is difficult to avoid this type of obstruction in general. However, if pairwise comparison [10] is introduced, obstructive tactics may be more difficult to carry through in a consistent way.

There are several candidate techniques involving relative judgement through pairwise comparison [14], and one of the most promising techniques is the Analytical

Hierarchy Process (AHP) [15]. This technique, however, is not adapted to distributed prioritisation with multiple stakeholders in its original form. Furthermore, this technique may require specialised tools for the matrix calculations required. An interesting question for further research is how to incorporate relative judgement through pairwise comparison in the presented distributed prioritisation process, including the usage of an Internet-based tool for gathering pairwise comparison data in a global organisation. It is also interesting to evaluate the utility of the charts for visualisation of distribution, disagreement and satisfaction, when applied to prioritisation data from pairwise comparison.

Other work in the area has focused on arriving at a consensus between stakeholders. Boehm and Ross [16] propose Theory-W, which is concerned with how to negotiate between many stakeholders with conflicting win-conditions. Kotonya and Sommerville [17] propose a viewpoint-oriented approach with explicit planning for conflict resolution. The approach presented in this paper is not focused on creating consensus among stakeholders, but rather on revealing the differences between stakeholder priorities in order to make an informed decision about which stakeholders to prioritise in relation to foreseen market opportunities. The business strategy governing the selection of requirements to implement in the next release of a packaged software product may very well have the result that some stakeholders representing a market segment with a lower priority will not get what is considered important for those particular stakeholders.

The process proposed in Section 2 is general and Steps 2 and 3 can be carried out using many different methods. Based on the above conclusions, one of the most promising methods to investigate in further studies is pairwise comparison. Another industrial case study, similar to the one presented here, but with pairwise comparison instead of absolute priority assignment, would give the interesting opportunity of comparing methods and further improve distributed requirements prioritisation in global software development organisations. It would also be interesting to investigate if the stakeholders whose ratings differ significantly from the final decision are more inclined to accept this decision due to the increased transparency of the prioritisation process.

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Appendix: Raw Data from Prioritisation

Table 4. Raw data from prioritisation of high-level feature groups

Req.	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10
A	0	0	0	20000	0	7250	0	0	30	10000
B	20000	0	5000	1000	0	7250	0	0	15	5000
C	20000	10000	8000	5000	0	8000	0	0	0	20000
D	5000	0	20000	3000	0	15000	7000	0	0	5000
E	5000	30000	7000	0	0	0	7000	0	0	5000
F	0	0	0	1000	0	2500	0	0	0	5000
G	5000	0	0	1000	0	0	0	0	0	2500
H	5000	20000	0	5000	0	4000	3000	20	15	10000
I	0	0	0	20000	0	1000	0	0	0	0
J	0	0	0	15000	20000	2000	7000	0	0	2500
K	0	0	15000	5000	0	12500	7000	20	10	5000
L	0	0	15000	5000	0	7000	7000	20	0	5000
M	20000	20000	15000	0	0	4000	3000	0	20	5000
N	0	0	0	0	0	1000	0	20	0	0
O	0	0	0	2000	0	2500	3000	20	0	2500
P	20000	0	15000	17000	30000	23000	14000	0	10	2500
Q	0	10000	0	0	0	0	0	0	0	0
Z	0	100000	0	0	50000	3000	42000	0	0	7500
Total	100000	100000	100000	100000	100000	100000	100000	100	100	92500

Table 5. Raw data from prioritisation of individual features

Req.	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10
A1	0	10000	3000	3000	0	800	0	200	0	1250
A2	0	10000	0	25000	0	800	0	400	0	7500
A3	0	0	0	20000	0	400	0	0	0	1250
A4	5000	10000	0	2000	0	400	0	400	20	2500
A5	0	0	0	1000	0	0	0	0	0	0
A6	0	0	0	10000	0	0	0	0	0	0
A7	0	10000	0	14000	0	1400	1200	200	0	2500
A8	5000	0	0	14000	0	400	0	200	0	0
A9	0	0	4000	11000	0	400	0	0	0	2500
A10	0	0	0	0	0	1400	0	100	0	2500
A99	54000	5000	0	0	0	0	0	0	0	5000
C1	10000	0	6000	0	0	1800	0	0	10	10000
C2	0	0	1000	0	0	4200	0	400	0	10000
C3	0	0	4000	0	0	400	0	500	0	0
C4	0	0	0	0	0	0	8400	300	0	0
C99	0	0	16000	0	0	0	0	0	0	12500
D1	0	0	0	0	0	6600	0	0	0	0
D2	5000	0	8000	0	0	5400	0	400	20	2500
D99	0	0	0	0	0	10800	18000	0	0	0
E1	2000	0	0	0	0	0	0	0	0	0
E2	2000	0	0	0	0	800	0	0	0	0
E3	2000	10000	3000	0	0	1800	0	300	0	0
E99	0	0	0	0	0	0	8400	0	0	0
F1	0	0	1000	0	0	0	0	200	0	2500
F2	3000	0	0	0	0	0	0	200	0	0
F3	0	0	1000	0	0	0	0	0	0	1250
F4	0	0	0	0	0	0	1200	0	0	0
F99	0	0	4000	0	20000	2600	1200	0	0	0
H1	2000	0	5000	0	0	800	0	400	10	2500
H2	0	0	3000	0	0	400	0	400	0	2500
H99	0	0	0	0	0	0	0	0	0	0

(continued over)

Table 5. Continued

Req.	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10
I1	0	0	0	0	0	0	0	0	0	0
I2	0	0	0	0	0	0	0	0	0	0
I99	0	0	0	0	0	0	0	0	0	0
J1	0	10000	0	0	0	2000	0	200	0	0
J2	2000	0	0	0	0	2800	0	200	0	5000
J3	0	0	0	0	0	0	0	400	0	0
J99	0	0	0	0	30000	0	19200	0	0	0
K1	0	0	0	0	0	800	1200	300	20	2500
K2	0	0	0	0	0	1400	1200	300	0	2500
K99	0	0	0	0	0	9000	0	0	0	0
L1	4000	0	3000	0	5000	1800	1200	300	0	5000
L2	0	0	3000	0	5000	1000	1200	300	0	0
L3	0	0	0	0	0	0	0	300	0	2500
L4	0	0	0	0	0	0	0	0	0	1250
L5	0	0	5000	0	0	1800	0	200	0	0
L6	0	5000	0	0	0	0	0	100	0	1250
L99	0	0	0	0	0	0	0	0	0	0
M1	0	0	0	0	0	0	0	50	10	0
M2	0	0	0	0	0	0	0	0	0	0
M3	0	5000	2000	0	0	400	0	100	0	0
M4	0	5000	0	0	0	2800	0	0	10	1250
M99	0	5000	8000	0	5000	600	0	0	0	0
N1	4000	0	0	0	0	800	0	0	0	2500
N2	0	0	2000	0	0	0	0	200	0	0
N3	0	0	0	0	0	800	0	200	0	1250
N4	0	0	0	0	0	1400	0	300	0	0
N5	0	0	3000	0	0	0	0	200	0	0
N6	0	0	0	0	0	0	4000	0	0	0
N7	0	0	0	0	0	0	0	0	0	0
N99	0	0	5000	0	0	0	18000	0	0	0
O1	0	0	0	0	5000	0	0	500	0	0
O2	0	5000	0	0	0	1000	0	0	0	0
O99	0	0	0	0	0	1000	1200	0	0	1250
P1	0	0	0	0	0	6000	4000	300	0	0
P2	0	0	8000	0	10000	12000	4000	200	0	2500
P3	0	0	0	0	10000	2400	4000	50	0	0
P4	0	0	0	0	10000	1800	0	400	0	0
P99	0	0	0	0	0	6000	2400	0	0	0
Q1	0	10000	2000	0	0	400	0	300	0	0
Q2	0	0	0	0	0	0	0	0	0	0
Q3	0	0	0	0	0	400	0	0	0	2500
Q99	0	0	0	0	0	0	0	0	0	0
Total	100000	100000	100000	100000	100000	100000	100000	10000	100	100000