Software Analytics for Planning Product Evolution

Farnaz Fotrousi[1,2(✉)] and Samuel A. Fricker[1,2]

[1] SERL-Sweden, Blekinge Institute of Technology, 371 79 Karlskrona, Sweden
{farnaz.fotrousi, samuel.fricker}@bth.se
[2] i4Ds Centre for Requirements Engineering, FHNW, 5210 Windisch, Switzerland
{farnaz.fotrousi, samuel.fricker}@fhnw.ch

Abstract. Evolution of a software product is inevitable as product context changes and the product gradually becomes less useful if it is not adapted. Planning is a basis to evolve a software product. The product manager, who carries responsibilities of planning, requires but does not always have access to high-quality information for making the best possible planning decisions. The current study aims to understand whether and when analytics are valuable for product planning and how they can be interpreted to a software product plan. The study was designed with an interview-based survey methodology approach through 17 in-depth semi-structured interviews with product managers. Based on results from qualitative analysis of the interviews, we defined an analytics-based model. The model shows that analytics have potentials to support the interpretation of product goals while is constrained by both product characteristics and product goals. The model implies how to use analytics for a good support of product planning evolution.

1 Introduction

Software products are evolved throughout their life cycle through extension and adaptation of functionality and quality [1]. Such evolution is inevitable as product context changes and a software gradually becomes less useful if it is not adapted [2]. The flexibility of service-oriented approaches enables such evolution thinking [3]. Early release of a minimal viable product followed by evolution is beneficial for the product organization because it allows increasing return on investment when compared with a late release of a near-perfect product [4, 5]. Also, early release of a product allows learning about actual customer wants and needs; and the use of such market information in later product evolution is determinant for product success [6].

Mature companies plan how they intend to achieve their strategic objectives and satisfy market needs [7, 8]. Planning concerns the product portfolio, the long-term roadmap of each product, and the short-term release plans [9]. Portfolio management is about the strategic choice of which markets, products, and technologies the product organization addresses and, consequently, how it intends to spend its scarce resources on marketing, engineering, and research [10]. Roadmapping supports strategic and long-range planning for exploring evolving markets, products, and technologies and for

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coordinating the actions of the product organization to address opportunities and threats [11]. Release planning, finally, addresses the short-term time horizon by selecting an optimum set of features to be delivered in a release so that competing stakeholder demands, benefits for the product organization, and available resources are balanced [12]. The impact of product planning, in comparison to the absence of such planning, are shorter projects, fewer delays, and improved quality [13].

Product plans are based on information about company goals, market trends, product requirements, and stakeholder priorities [9]. That information is collected and the resulting plans validated by consulting company-external stakeholders such as customers, partners, and consultants that monitor the market and company-internal stakeholders such as marketing, sales, research, development, support, sales, and company board representatives. Many techniques exist for such consultation of stakeholders, including workshops [14], focus groups [15], and surveys [16]. Stakeholder consultation is essential for achieving clarity, support, and stability of the product vision and the plans that refine it [17].

Even-though stakeholder consultation is widely established and considered good practice; the value of information obtained by this approach is limited, especially in a context with many users and customers. The consulted representatives are intermediaries to the real stakeholders. Non-probabilistic sampling, especially convenience sampling, tends to produce biased input [18]. Even if a representative set of stakeholders is identified, it is questionable whether their expressed opinion corresponds to the actual interest. An expressed customer wish does not necessarily translate to a buying decision [19]. Finally, dependency on stakeholders exposes the product manager to power and politics. Stakeholders exert their power by telling the product manager what to do and by creating a reality in which the product manager has to act according to these instructions [20]. The resulting political decisions risk benefiting the most powerful of these stakeholders, but not necessarily the product.

This paper proposes the use of software analytics [21] as a new source of information for product planning evolution. Analytics are the quantitative measures of an entity [22], which provide insight and actionable information [21] for a data-driven decision making [23, 24]. Analytics have the potential to become useful decision-support for software made available to customers and users, but still is undergoing evolution. In contrast to stakeholder consultation, measurement of product use and quality provides evidence that is representative, unbiased, and free from power and politics.

Based on a review of existing literature on software product planning and analytics, the paper introduces a conceptual model that connects measurements of the software product to product planning decisions. The study explores the connection by discussing it in interviews with 17 software product managers. The Inductive content analysis method [25] was used to identify how the measurements would be interpreted and used for product planning decision-support. The results provide insights for method and tool engineering [26] and for research targeted at simplifying product planning and improving the reliability product planning decisions.

This paper extends an earlier paper that presented the statistical analysis performed to understand product manager preferences for analytics [27]. The present paper gives an in-depth analysis whether and when analytics are valuable for product planning and

how the interviewed product managers would use analytics for obtaining product planning decision-support for evolution.

The remainder of the paper is structured as follows. Section 2 reviews existing work in software analytics and introduces a conceptual model that describes how software analytics provide decision-support for product planning. Section 3 describes the research design used in the study. Section 4 presents the empirical results and analyze the collected data. Section 5 discusses the results and their implications on practice and research. Section 6 summarizes and concludes the paper.

2 Background

Software product analytics are the quantitative measures, collected during product use, giving actionable insight [21] for deciding about product evolution [23]. The actionable insight characteristics of analytics differentiate it from measures or metrics terms, which are used interchangeably in literature (e.g. ISO-9126 used the term *metrics* but replaced by *measures* in ISO 15393). Some literature refers to analytics as the process of developing actionable insight [28]. However, our definition emphasizes analytics as quantitative measures.

In product planning context, analytics measures a product, feature, or quality attribute. A product consists of features [29] and each feature is composed of a set of functional and non-functional requirements [30]. A product manager should deal with decision-making about creation, change, deletion, prioritization or allocation concerning product, features or requirements. Table 1 gives an overview of decisions that can be made during the planning of a software product. The decisions are distributed based on the practice areas including portfolio management, roadmapping, and release planning.

Table 1. Taxonomy of product planning decisions

Practice area	Decision object	Decision alternatives						
Portfolio Management	Products in the company's portfolio	Create	Enhance, Change	Prioritize	Remove	Allocate Resource	Allocate to Release	Confirm Technology
Product Roadmapping	Features of a product							
Release Planning	Requirement in a feature selected for release							

The decisions of product planning have a strong relationship with software product delivery. The trend of changing the software delivery from packaged product to SaaS (Software as a Service) delivery model [31] implies faster and smaller release of new features [4], ease of developing more features upon request [4] in addition to facilitating data collection to support planning decisions. SaaS delivery model enables monitoring of software use and provides first hand information about market, attractiveness of software and its features.

Table 2 illustrates a taxonomy of the measurement attributes in SasS based products. For such products, the measurement attributes belong to entities such as a product, feature/content or GUI requirement that can be mapped to entities of a website, page or GUI element in a general web application. Product managers conceptualize a web application as a product that consists of features instead of pages. Page is the definable unit of content. A feature can be one page, part of a page or distributed among pages. A request for the feature can be defined as a page request. Similar to a feature, a page can be conceptualized as a content, since it provides an additional information resource for the feature contributing to the end user knowledge. In a SaaS-based product, functional requirements may belong to graphical elements of a feature (i.e. page) measurable for a GUI requirement entity.

Table 2. Taxonomy of measurements for SaaS-based applications

Mapped entities to product	Entities	Attributes		
		Health	Usage	Context
Product	Website	Errors, Downtime, Response time, Throughput, Attacks	Use, Time between uses, Duration of use.	Users, New users, Returning users, Referrers, Location/ISP per use, Search engines and keywords, Campaigns, Browsers, Operating systems, Languages, Plugins, Screen resolutions.
Feature/content	Page	Errors, Response time	Use, Time between uses, Duration of use, Entrance, Click activity, Depth of use, Click stream/path, Exit, Bounce.	Users, Search engines and keywords, Campaigns
GUI Requirement	GUI Element	–	Use, Time between uses, Click activity, Click stream/path.	–

The second part of the taxonomy presented in Table 2 categorizes the corresponding measurement attributes based on the measurement purpose for products' *health*, *usage* and *context*. The attributes corresponding to *health* of entities inform technical quality of services [32]. The category of *usage* measurement attributes specifies the key data for understanding a traffic behavior of users [33] from the entity-use perspective. Context measurement attributes address the circumstances of users or sources in which entities' requests are issued from [34].

The taxonomy in Table 2 introduces the measurement attributes belong to web analytics context [35]. The taxonomy excludes other attributes such as those discussed in business analytics [36], which support broader aspect than customer centric application. Business analytics provide better insights particularly from operational data stored in transactional systems to inform sales, marketing, price optimization and workforce analysis [35]. The data are usually collected offline by the executive staff in a company [37] or an e-commerce platform [35].

This section confirms the usage of software analytics for product planning, but that it is yet to be understood how the measurements would be used for product planning evolution. These are the aims of the current study.

3 Research Design

To achieve the discussed aims, we designed an inductive study based on product managers' interpretations of analytics for product planning. We explored the following research question:

RQ: How are analytics used for planning product evolution?

To answer the research question, we conducted an interview-based survey with the purpose of identifying the relation between analytics and decisions of product planning. We performed data collection using semi-structured phone interviews. For the interviews, we initially designed the questionnaires, but we also asked the interviewees about their motivations for the provided answers. To avoid disadvantages of telephone survey related to lack of visual material and avoid complexity, the screen of the interviewer's computer that presents the questionnaire was shared with interviewees through web-based screen sharing applications.

Samples: We asked a well-established consultancy company in software product management to introduce experienced SaaS product managers in a wide variety of SaaS contexts. We selected 17 product managers from 3 micro, 4 small, 7 medium, and 3 large companies. The product managers managed 7 new respectively 10 already existing software products. All interviews were structured alike. The similarity of questions, homogeneity of interviewees and number of interviews could make the saturation of the interview results [38].

Designing the Instrument: We designed a questionnaire in which the taxonomy of measurement attributes discussed in Sect. 2 was a base for asking product managers how they would use analytics. The questionnaire was started with questions about context facets of the product, organization (company size and development team size) and people (role and experience). Questions about product planning formed the core of the interview,

in two parts: "Planning Decisions" and "Analytics". In the first set of questions, the interviewees were asked to select a product that they have planned and are most satisfied with. Then questions were asked about the planning decisions that the interviewees usually take for the selected product. Later on, the interviewees were asked to rate the importance level of measurement-categories and measurement-attributes for taking the decisions and provide comments for their reasons behind the selections.

Interviews were piloted by two product managers and two students having product planning knowledge. After initial testing and several refinements, the interviews with the product managers were scheduled.

Selecting and Presenting the Results: We recorded the interviews by getting permissions from interviewees for the sake of future reference and transcribed for qualitative analysis of their argumentations. From the selected applications, 4 were "Business oriented", 7 were "Consumer-oriented" software and 5 were "information display and transaction entry". 41.2 % of the products were new products, and 58.8 % of the responses were evolutionary products. The distribution of interviews among different application magnifies the difference of product characteristics on interview results.

Analysis Method: We used inductive content analysis approach [25] for analyzing and coding the argumentations of the interviewees. In the first step of the analysis, we selected a unit of arguments, tagged with the headings describing the argumentations' concepts for the role of analytics, and repeated the process for all arguments. In the next steps, we grouped the headings in two rounds to reduce the number of similar categories in each round. The categorization provided a mean of interpreting the phenomenon, increasing understandability, and facilitating decision making ability [25]. At the end of the content analysis, we performed abstraction, which led to general descriptions and further discussions based on the categories. During the process, initial codes were gradually improved to form the final codes.

4 Analysis and Results

4.1 A Model for Analytics-Based Product Planning

By the analysis of interviewees' argumentations, we could conclude that product managers use *analytics to interpret the product goals while the analytics are constrained by both product characteristics and product goals.* This relation has been illustrated in Fig. 1.

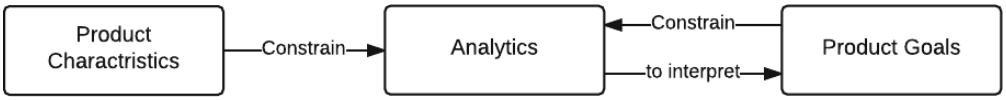

Fig. 1. A model for analytics-based product planning

For building and evolution of a product, product managers define product goals aligned with the companies' business goals. The essential goal of a product is to ensure that a product is built to deliver business values to a specific set of customers and meet important business goals of companies.

The analysis of interviewees' argumentations showed that product managers did not recognize some analytics useful for specific characteristics of a software product. In another word, product characteristics limit the scope of using analytics. Table 3 in Appendix provides a list of product characteristics and corresponding supportive quotes about constraining analytics. As an example, the application type filters and constrains the applicable measurements:

> "*For our specific product, error and response time could be used, but others healthiness measurements did not have a role in our intranet-based product.*"

Coding the argumentations clarified that analytics can be used to interpret products' goal in terms of assisting product manager to evaluate how far product goals are achieved. These products' goals might also constrain the analytics. Table 4 in Appendix outlines the interviewees' interpretation of analytics for product planning. The extracted codes for product goal characteristics (i.e. the left column of Table 4) reveal that product managers mostly addressed a dimension of product quality as a goal. "User satisfaction", "customer satisfaction", and "freedom from risk" are quality in use attributes in ISO/IEC 25010. The usability, functional suitability, maintainability, reliability, and performance efficiency codes are static and dynamic properties of software products in the quality model of ISO/IEC 25010. Such analytics support product evolution decisions from the technical perspectives.

Also, extracted code "market positioning" for product goal characteristics (i.e. the left column of Table 4), introduces a business goal [39], to be interpreted by analytics. Such goals complement the technical evaluation of the product to give 360-degree view to the product manager for taking decisions [40].

Product managers define product goals alongside with business goals considering inputs from stakeholders. So analytics can point out to the level that a product goal has been achieved. On the other hand, the product goals can constrain analytics and specify which measurements have more or less value to achieve the desired level of the goals:

> *"For referral source measures, if I can find out in what segment the user belongs to, and then it is very important. If from the measures, I can find out from which country they use it, it is mostly less important."*

The example indicates that extracting statistics about user's segment from referral source attributes is valuable and can be interpreted toward a product goal, while other statistics of referral sources might not be valuable for this case. For all codes, although interviewees' argumentations were not available to support both interpretations and constraints, the logical relations between interpreting product goals and constraining analytics can cover the argumentation shortage:

> *"Click steam is important to see the sequence of clicking to track the usage and see do the users follow the pattern in a right way or not."*

The example illustrates that high level of click streams might interpret a good level of user satisfaction for the feature and can strengthen the quality of the feature. Logically it is evident that achieving user satisfaction wishes to have information about click streams, which strengthen the constrained relations.

4.2 Validation of the Model

The model in Fig. 1 was validated by examples of product managers' experiences. We mapped argumentations of product managers (i.e. interviewees) for different groups of products to the model. The mapping helped us to check whether the chains of arguments can support the model. The products that interviewees selected during the interviews belonged to three product types: "Consumer-oriented software", "Business oriented" and "Information display and transaction entry". For each product type, one interview was selected to show how the shifting from constraining the analytics to interpretation of the product goal is performed. Table 5 in Appendix presents three examples of different products. The following example shows how argumentations of an interview (first row in Table 5) can support the proposed model.

Based on the characteristics of a mobile application, "*referral source is not important [analytics] because users are from all over the world*". "*Dos and worm attacks are not important [analytics] in an IPhone application*" but when the product is mature, the other "*product healthiness statistics are extremely important because having errors and bad usability makes it hard [for users] to understand a feature*". By collecting data about product healthiness "*The errors* [analytics] *can be seen very quickly and repaired in each month release*". So product manager will monitor analytics to find out error and take an action toward a healthy product. Having a healthy product will facilitate the customer benefit goal.

In this example "mobile application" is the product with specific characteristics, "referral source, Dos attacks and worm attacks" are analytics and "customer benefit goal" is the product goal. The relations between product characteristics, analytics, and product goals could confirm the relations defined in Fig. 1. Similarly, the other argumentations can also confirm the defined relations in the model.

5 Discussions

In this paper, we contribute to creating a model for understanding how analytics are used for planning of a software product. The study introduces a new perspective for product planning by applying analytics. Analytics are filtered based on product characteristics and product goals. The analytics are interpreted to evaluate the level of product goals' fulfillments. The evaluation enhances a product manager's intuitions to help to find out the rationales for his decisions. Deviation from the product goal requires an action that reflects a new decision in the product plan [8].

The results have implications for research on understanding the relations between product characteristics, analytics and product goals for supporting product evolution. The results have also implications for product managers of software vendors on interpreting analytics to use data science as a basis for decision supports of product planning. In Fig. 2, we propose a product manager to carry out a chain of activities to take planning decisions for product evolution by the supports of analytics.

In step 1, the product manager prepares a list of goals corresponding to the candidate product. The study showed in a SaaS-based product, most of the product managers set quality goals with the focus on quality-in-use (ISO/IEC 25010). In this

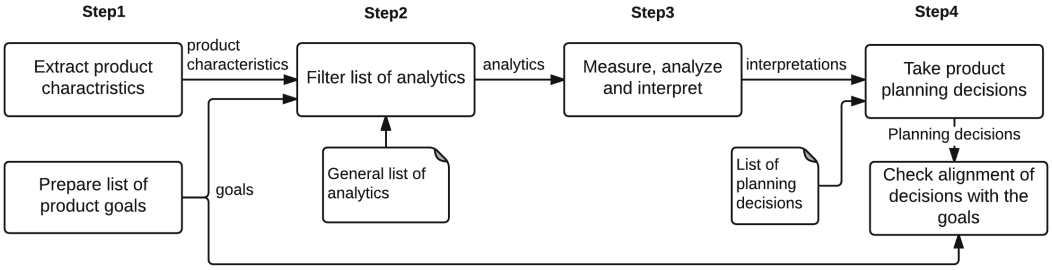

Fig. 2. Suggested activities for product managers to support planning decisions and product evolution by analytics

study product managers looked for acceptable perceived experience of use (efficiency), acceptable perceived results of use (effectiveness), acceptable perceived consequences of use (Freedom from risks) and the customer's satisfaction in a particular context of use [41]. Quality of services and marketing goals were also on the list of goals, with lower priority than the quality-in-use goals.

In step 2, from the general list of analytics (i.e. created using a general list of measurement attributes such as Table 2), the product manager excludes those with less importance based on the defined product characteristics and goals. The study showed some of the factors that constrain the analytics for product planning. Product characteristics such as product's context, features, users, platform, network type and maturity constrain the analytics for product planning. Also, product goals such as managing the quality of product, managing market positioning and organization grows can constrain the analytics. Although few goals were discussed by the interviewees, it is not a big deal to generalize to different goals such as growth and continuity of the organization, meeting financial, personal objectives, and etc. [39].

In step 3, the included analytics are measured, analyzed, and interpreted to provide required information and inform the product managers' decisions. The alignment of the decisions with the product goals is investigated in step 4. Argumentations of interviews showed, product managers usually benefit from analytics about product and feature usages, which supports goals corresponding to functional suitability and usability. Product healthiness analytics support performance efficiency, reliability and security goals. The result is in the same direction with the study that recognized feature use, product use, response time, users, error and downtime as the most preferred measurements for planning, despite planning decisions' types [27]. To create, remove, or enhance a feature, the data trends provide a broad view of requirements or feature desirability in the current or even future time and clarify how these changes can impact the product's goal. Comparing the corresponding measurements' impacts on the defined goals can prioritize features. This impact can support both reactive and proactive planning for an evolution of the product.

The chains of interrelated activities explained in step 3 are mapped to the measurement information model defined in ISO 15939. We propose to enhance the model by adding a box for product goals with two outgoing arrows: One to *constrain* measurement attributes and one to *support* the information needs. The enhancement would adapt the ISO 15939 to support product evolution using analytics.

The proposed model in Fig. 1 is not specific to product planning of a traditional software development, but the model may support planning of products using modern development approaches [42] such as an agile development, continuous integration, and continuous deployment. In such approaches instead of listing the product goals in the beginning (i.e. refer to step1), sub-goals of the corresponding iteration are identified instead. However, for the iterations that do not release a software product or prototype, analytics approach is not applicable. Because the prerequisite for using runtime analytics for product planning is to have a software prototype or product.

The study was limited to 17 answers of product managers experienced in SaaS-based products. However, the stratified sampling ensured the results are from the variety of product managers. Although the study focused on analytics of SaaS-based products, the model in Fig. 1 could be generalized to the other application domains, by considering that meaningful analytics may vary in different categories of products. For example, *Throughput* measurement does only make sense in networked-based applications. Furthermore, another limitation was due to the choice of product managers for focusing on roadmapping decisions. More detailed study of portfolio management and release planning decisions may reveal other constraints on analytics in future. It is also valuable for researchers to know which measurements support each product goal and how the product manager may prioritize the measures, which we propose as future work.

6 Conclusions

Products are the artifacts to satisfy the customers' needs, and hence product managers require bringing the voice of market and customer to the product planning processes, where this happens effectively through a data-driven endeavor of sensing and understanding the requirements. Different types of analytics assist a product manager in product planning, where each might be gathered through a different channel and process. SaaS-based product delivery facilitates gathering a new range of detailed, usable and real-time product-use data. Measuring and analyzing the data to support product-planning decisions are targeted by analytics.

This study introduced two taxonomies as inputs for the other parts of the study: A taxonomy of SaaS-based measurements in categories of two dimensions: "Product", "Feature/content", "GUI Elements" in the first dimension, and "healthiness", "usage", and "context" in the second dimension. The second taxonomy was related to planning decisions taken in portfolio management, roadmapping and release planning.

To present how analytics assist product managers and contribute to product planning, an interview-based survey was conducted with professionals in the product management area by focusing on roadmapping decisions since the interviewees were experienced more. Through the interview-based survey, the justifications of interviewees for assigning a value to a measurement show that both product characteristics and product goals constrain analytics, while it is interpreted to product goals. In the other word, product characteristics and product goals specify which analytics can assist product managers in achieving the product goals.

The findings helped us to propose an analytics-based model. Some parameters such as product maturity, users, network type, context, and technology change the scope of

analytics usefulness for product planning. Analytics can be motivators for product managers to achieve goals for market positioning, meeting quality-in-use (i.e. customer and user satisfaction) and improving product quality (usability, functional suitability, maintainability, reliability and performance efficiency). Therefore, even limited list of analytics will be helpful to gain good support for taking planning decisions aligned with the product goals. In the case that analytics shows any deviation from the product goal, the product manager takes a constructive decision to prevent its occurrence or, at least, decrease negative effects. The analytics-based model can be used in various application domains rather than SaaS, when collecting the customized analytics for a particular domain is applicable.

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Appendix: Tables of Qualitative Analysis

Table 3. Constraining analytics[a]

Product characteristics	Constraints
Product maturity	*"When you are creating an immature product, it is hard to base your decision based on these kinds of statistics. Instead of analytics for creating decision for an immature product, we create a prototype and test the prototype. But for tuning functionality and enhancing, these statistics can have benefits."* *"From a second release to third release, definitely analytics can be helpful. Product-use [measurement] affects their allocation of feature in third release. But not from first release to second, because first release is mainly about how to build a product."*
Product users	*"Referral source attribute is not important because our users are from all over the world as they use their mobile phone."* *"End users are within some specific organizations so statistics about referral sources are not important."* *"Statistics about new user are not important because we are dealing with available users, not new users."*
Being Web based	*"Technology and channel [measurement] is very important because the product is a web-based tool."* *"Technology and channel data is less important. We need to support all browsers and cover related technology as it is a web based product."*
Network type	*"For our specific product, error and response time could be used, and others [other healthiness measurements] did not have a role in the intranet-based product."*
Product context	*"Dos and worm attacks are not important in an IPhone application."*

(*Continued*)

Table 3. (*Continued*)

Product characteristics	Constraints
Product technology	*"Technology and channel data are less important. We have to support all browsers and cover related technology as it is a web based product." "Inside our organization it is clear which OS or browsers the product has to work with, so we did not have too many challenges about it [Technology and channels measurement attributes]"*
Product features	*"Language attribute is not important. Our product only supports English language, and there is no different to know what languages have the users."*

[a]Words given in the brackets (i.e. []) have not been directly mentioned in the quotes, and were added to make the interviewees quotes more clear.

Table 4. Examples of Analytics Interpretation for product goals and the constraints that a product goal provides for analytics

Product goal characteristics	Interpretation	Constraint
Market positioning	*"Statistics about campaign are important because they show how efficient various marketing campaigns are in bringing visitors to be customers." "Referral source measurements can be interesting as we can learn about the structure of the market and then they can map it to the feature use, by that make it an input for prioritizing features for further development. So in combination with other studies of a market, it is important but alone and in isolated manner." "Our goal is to increase web users, if product use is not too many then action should be taken to find the reason.."*	*"For referral source measures, if I can find out in what segment the user belongs to then it is very important. If from the measure I find out from which country they use it, it is mostly less important." "Referral source is not importance since we sell product to an organization not end users. So they do not care where the customers are coming from."*
Customer Satisfaction	*"Our main role is to create customer benefit to the product and give them functionality that is useful. For example by analytics, finding errors can be seen very quickly and repaired in each month release."*	*"In our product, it is good to create more customer benefit which are got from an interview with customers and customer feedback from their service organizations. If we agree on prioritizing feature, the statistics are not useful for them."*

(*Continued*)

Table 4. (*Continued*)

Product goal characteristics	Interpretation	Constraint
Functional Suitability	*"Referral source measure attributes are important because you can help to adapt User Interfaces." "Statistics in Technology and channels are important because we do not want to support all versions and will support technologies that are used more." "Technology and channels statistics are very important- Depending on which mobile they have accessed from they have to provide a service according to that."*	*"Technology is a tricky category, what do you mean by technology? Technology that used for development, or technology that is related to users. They are different with each other. For development part the analytics is not important, although for user side that plays important role."*
Reliability	*"Product healthiness [analytics] is very important. If we cannot achieve desire reliability and performance we can go home."*	*"All healthiness measures are important, especially error, people do not accept faulty product and error."*

Table 5. Examples of shifting from constraining analytics use to interpretation of analytics for product planning

Product characteristics	Constrain (by product characteristics)	Interpretation	Product goal	Constraint (by product goal)
Social ERP (Business oriented product)	*"Exit and entrance feature is mostly good to know when you have a product like a website. For other product it might be different entrances and exits, and might not so differ to each other." "Referral source measurements are not so interesting. I think they are mostly useful for websites, like online shopping to know the source of customers. For us, the current users location is clear."*	*"Quality adds value to the product. If not, you [i.e. your products] are definitely dead. Faulty product ends in no user satisfaction. So It's good to know before lose all users." "Feature measurements Provide a good picture of interesting features"*	*"Planning a high quality product is that makes users satisfied is important."*	*"Product user is very important to monitor the popularity level of product during time period."*

(*Continued*)

Table 5. (*Continued*)

Product characteristics	Constrain (by product characteristics)	Interpretation	Product goal	Constraint (by product goal)
SaaS-based Knowledge Management (Information display and transaction entry product type)	*"End users are inside some specific organizations, so referral source measurements are not important for us. Also inside each organization it is clear which OS or browser are available so we do not have too much challenges about it."*	*"Lead users have special roles in patterns related to gathering tacit knowledge in the organizations. So it is important to understand who are the lead users to target specific users. So user classification based on their activities on the product is useful."* *"Depth of use analytic helps us to understand that users are involved with the product and do not have random visiting."*	*"The product suppose to grab tacit knowledge in the organization so it was important that adequate number of users would engaged in different parts of the system."*	*"Feature use is very important because it shows which parts of the system the users are engaged."*

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