Implementing Novel IT Products in Small Size Organizations
Technology-driven Requirements Engineering

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Abstract: The growing popularity of new mobile information technology products influences enterprises to buy them without an appropriate evaluation of their usability. This situation is relatively new and conventional usage-driven requirements engineering approaches are not well suitable. The objective of our work is to propose a technology-driven requirements engineering approach where requirements are discovered not only from business needs but also from product features and properties. In particular we take into consideration small size organizations with a small number of business roles and activities.

1 INTRODUCTION

Today's enterprises demonstrate a constantly growing interest in new mobile information technology (IT) products that they consider as innovative and modern support for their business activities. This popularity is mainly justified by their multifunctional capabilities, intuitive usage facilities and mobility. Smartphones and tablet computers are being used as personal and professional tools at the same time. Moreover, executives bring their personal devices at their workplace and use them instead of their office computers. This growing trend arises multiple issues for the company: data backup and recovery, material and data security, information monitoring and so on. In order to keep control on this situation, more and more companies are buying those IT products and set them up before giving them to their employees (Jern, 2012; Lai, 2012; Narisi, 2012; Pettey and Van der Meulen, 2012). Similarly, high education institutions are distributing tablets for their students (Martinez, 2011) for education purposes and paper saving. As big companies and schools are starting to acquire thousands of tablets or smartphones, smaller ones are tempted to follow the trend sometimes without considering the real need and the applicability of these IT products in the enterprise business context.

It seems that traditional requirements engineering (RE) approaches (e.g. goal-driven, scenarios, use cases) are not sufficiently helpful in this new situation because they are based on business objectives and stakeholders' problem and/or needs analysis. The situation discussed in this paper is slightly different – the main RE driver is not a problem or a need for an IT product but the product itself. The main question is how the product fits its potential users' activities and how it could facilitate and/or improve their realization.

In this paper we consider the challenge of introducing new mobile IT products/devices into small and medium size organizations. In particular, we propose an approach for technology-driven requirements engineering where the purchase of a particular IT product is influenced by the market and current trend rather than by the enterprise activity-based necessity. We aim to help enterprise decision makers and project managers to determine the benefit of those IT products for their enterprise and its employees and to identify the most appropriate usage of their capabilities. The approach aims to cover the RE process starting from the analysis of product features and potential needs, going through the implementation requirements specification and ending with the decision taking on product acquisition. In particular, we take into consideration the situation of small and medium size organizations with a narrow scope of activity and small number of organizational roles.

The approach has been initiated and tested on a small non-profit organization called "Unions Chrétiennes de Genève" willing to acquire tablet

computers for its executives. The study has been conducted during a Master internship in this organization. The obtained results demonstrate the utility of the approach and highlight its limits and potential evolutions.

The paper is organized as follows: in the next section we describe the research context and objectives. Then, we present our approach for technology-driven requirements engineering and illustrate its application in a small organization. Finally, we conclude the paper with the discussion about potential extension of the approach and future research perspectives.

2 RESEARCH CONTEXT AND OBJECTIVES

By definition a requirement designates "some capability that somebody needs or wants" (Robertson, 2001), or "a condition or capability needed by a user to solve a problem of achieve an objective" (IEEE Std610.12-1990). Most of the RE approaches consider requirements as descriptions of how a product or service should behave, what functionalities and qualities it should offer, what constraints it should respect and all other relevant specifications it should have (Alexander and Beus-Dukic, 2009; Kotonya and Sommerville, 1998; Pohl, 2010; Robertson and Roberston, 2012). Various information sources such as information on existing systems, stakeholders' needs, organizational standards, regulations and domain information are used to discover and specify information system or IT artifact requirements. We name these approaches *Usage-driven RE*. They follow a general schema:

- Identification of business goals and project stakeholders.
- Discovery and specification of stakeholders' requirements towards the IT product by using different requirements elicitation techniques.
- IT Product selection and/or design according to the specified requirements.

In our case, we need an approach, which would be IT product driven with the focus on its integration into the organization. We need to find the adequacy between the functions and properties of the IT product and the potential users' needs. Therefore, in our case, the starting point of the analysis is not a group of stakeholders with their needs but the IT product itself, for the simple reason that it is known at the beginning of the project. Of course, one can ask how an IT project can start without business

goals and justifications for the required budget. However, the professional literature, web survey (Jern, 2012; Lai, 2012; Martinez, 2011; Narisi, 2012; Pettey and Van der Meulen, 2012) and our own experience reveal that such situation is not rare, because the technology and innovation trend has more and more influence on enterprise managers. Certainly, the evaluation of the IT product adequacy to the organization and its potential contribution to the business activities and their innovation is necessary in order to justify the purchase. The main objective of this analysis is to determine if the main functions of the product/device match the activities of the end-users, and to help enterprise mangers to take the decision to acquire this product or not. In case of a positive decision, the requirements related to the product implementation in the organization have to be specified. We name this approach *Technology-driven RE*. Its general process can be summarized like this:

- Selection of the desired IT product. Identification and appreciation of its main qualities, properties and functions.
- Identification of potential product users and evaluation of the adequacy between the product features and users' activities and profiles.
- Specification of requirements for the product configuration and implementation.

3 AN APPROACH FOR *Technology-driven* RE

The construction of our *Technology-driven RE* approach is based on the following assumptions:

- The approach applies to a relatively small and medium size organization that has a project to acquire a new IT product for its employees.
- The product to be deployed is known at the beginning of the research, but different versions or additional options may be subject to further analysis.
- The usage and the adaptability of the product to the enterprise business have to be discovered and evaluated.
- The technical integration of the product does not constitute a major obstacle for the implementation but precise requirements have to be specified.

To represent our approach we use an intention-driven and multi-strategy process modeling formalism named Map (Rolland et al., 1999),
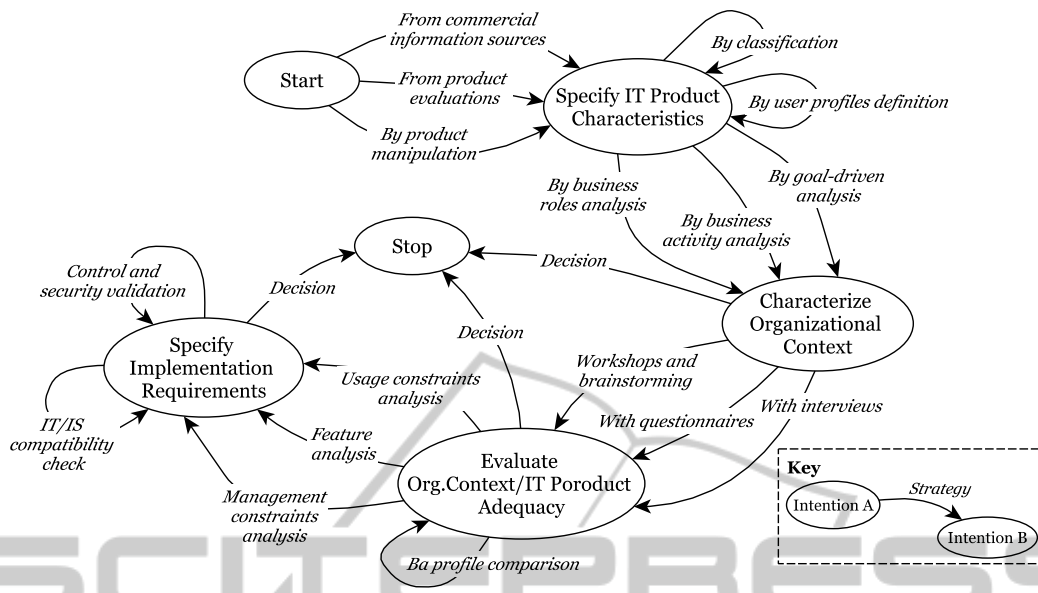
Figure 1: Process Model for Technology-Driven Requirements Engineering.

which allows to express process models in intentional terms instead of fixed steps and activities. In a map, a process is represented as a labeled directed graph where nodes define process intentions and edges designate different strategies to achieve the intentions. Each strategy represents a particular technique to achieve the target intention.

Figure 1 represents the process model of our approach formalized in terms of four main intentions, named *Specify Product Characteristics*, *Characterize Organizational Context*, *Evaluate Organizational Context/Product Adequacy* and *Specify Implementation Requirements* and several strategies providing different complementary and/or alternative means to reach these intentions. The flexibility offered by the Map formalism enables an iterative selection of the process strategies and their underlying techniques. We explain below the four intentions and the strategies to reach them.

3.1 Specifying IT Product Characteristics

The first step consists in selecting and dissecting the IT product to be implemented to highlight the main benefits that it could bring to the organization. This analysis is obviously easier if we can get the product in hand to test its functionalities; we call this strategy *by product manipulation*. Otherwise, the information has to be collected *from diverse commercial sources* like product documentation, product vendors and their websites, media and blogs, other companies or institutions that already adopted

this product, and *from public product evaluations* made by other users. Data collected is then *classified* – analyzed and compiled into a list of functions and qualities considered as essential, those features that characterize the product and could bring a real added value to the activities of the potential users.

The combination of features and qualities chosen allows the creation of one or more generic user profiles (formalized as *user profiles definition* strategy) characterizing typical users of the product. These profiles are later compared with the potential user profiles in order to identify similarities and provide purchase recommendations.

3.2 Characterizing the Organizational Context

The objective of the second step is to evaluate if the selected IT product fits enterprise activities, roles and business rules. The results of this step should allow the decision makers to pronounce their initial judgment: to buy this product or not. It consists in specifying the application domain in which the product should be introduced and involves the following complementary activities:

- Identification of the general objectives justifying the product acquisition project by using *goal-driven analysis* techniques;
- Identification of the main organization activities that could benefit from the product acquisition with respect to the business rules

by following *business activity analysis* strategy, and

▪ Identification of the main organizational roles as potential users of the product under consideration by following *business roles analysis* strategy.

The data can be retrieved either from the available documentation (organization charts, business reports, job descriptions, website, etc.) and/or from the discussions with project initiators and potential users. Goal-driven approaches (Dardenne et al., 1993; van Lamsweerde, 2001) can be used to create a clear view of different stakeholders' goals related to the product usage in the organization. At this moment, it is not necessary to specify in detail the responsibilities of each potential user, but their important and recurring tasks have to be known. Also, decision-makers, i.e. people who will make the final decision concerning the acquisition of the product, must be identified in order to keep them informed throughout the process.

3.3 Evaluating Organizational Context vs. IT Product Adequacy

This step gives a more active role to the project stakeholders, in particular to the decision-makers and the potential product users identified during the organizational context analysis. They should be now questioned about their daily activities and responsibilities in order to relate them to the product capabilities defined beforehand.

The traditional and most common way to discover requirements is *interviewing* (Alexander and Beus-Dukic, 2009). Interviews can be closed or open (Kotonya and Sommerville, 1998), standardized, exploratory, or unstructured (Oppenheim, 2000), individual or group ones (Pohl, 2010). Stakeholders have to be interrogated about their activities, responsibilities, recurring and occasional tasks, and the tools they use. It is also important to let them express their opinion about the product and investigate what they would like to improve in their job. We recommend to begin the analysis *with a questionnaire* that allows to capture some general information about stakeholders' activities and work contexts. Starting with questionnaires instead of direct interviews has a few benefits. First of all, it allows quickly eliminating some candidates for whom the product is clearly useless and a complete interview would be a waste of time. Then, the obtained answers permit to refine the respondent's profile and therefore make the main

interview more adapted to the person through the development of complementary and targeted questions. Finally, the mere fact to inform the respondent about the product and some of its functions makes him/her aware of its existence and lets him/her to imagine possible applications later in his/her daily work and express them during the interviews.

The results of interviews and questionnaires allow to define personal users' profiles that are then compared with the generic profiles defined beforehand. This strategy for evaluating the product adequacy is named *by profile comparison*. If the potential user's profile is close enough to one of the standard profiles then we can assume that the product will bring a sufficiently significant benefit and the purchase will be recommended.

Group techniques like *workshops and/or brainstorming sessions* sometimes can be more effective than personal interviews. They allow to generate many new ideas and to discover unconscious requirements (Robertson, 2001).

To sum up, the final decision will depend, above all, on the adequacy between the features offered by the IT product and the requirements induced by the activities of each user. The result, however, must be qualified by various elements collected during the analysis, such as the possibilities for future applications, users' opinions and open-mindedness and, of course, the price. At the end of this step, the results are presented to the decision-makers and recommendations are made concerning the purchase as well as the choice of product versions and/or eventual alternatives. If the acquisition is not validated and no alternative is considered, the process ends here.

3.4 Specifying Implementation Requirements

The acquisition of a new IT product requires adequate measures to ensure its successful integration within the organization. The main strategy to achieve this intention is named *feature analysis*; it consists in the identification, selection and/or configuration of functional product features according to the user's profile and activities. It can be done by using feature models from software product line engineering (Kang et al., 2002), goal models like AND/OR graphs (Dardenne et al, 1993) or even use case techniques (Jacobson et al., 1992). In addition, requirements related to the product usage have to be identified and specified. In particular, rules related to the product exploitation

(e.g. data storage) and rules concerning product management (e.g. product updates) must be defined in agreement with the management staff. Respectively, these two strategies are named *usage constraints analysis* and *management constraints analysis*. The product/tool being provided by the employer, the question of responsibility arises and must be settled quickly and transparently with each user. One of the ways to proceed would be to define a charter specifying the limits of the product exploitation and the consequences in case of its loss or deterioration.

Compatibility with the existing IT/IS system (*IT/IS compatibility check* strategy) as well as *control and security validation* issues must be addressed and resolved prior to the product implementation. Especially, if the product requires a certain level of monitoring (security, control, maintenance), it may be necessary to create a new position within the organization dedicated to its management or to add a new responsibility to the existing IT Manager role. If the specified requirements appear to be too "expensive" (e.g. maintenance, new roles to be created), the decision still can be to abandon the acquisition of the product.

4 APPLICATION OF THE APPROACH

As mentioned in the introduction of this paper, the design and application of the methodology proposed above was realized during a six-month internship in a non-profit organization named Unions Chrétiennes de Genève (UCG). UCG offers training, leisure and social activities to foster personal development in a community environment (see Table 1). UCG is willing to be a modern organization and the introduction of tablet computers, representing a relatively avant-gardist technology for the association, is a part of its innovation process. The project to acquire iPads for some UGC executives was launched by the President of UCG. The main objective of our work was to provide arguments allowing the UCG Management Committee to take this decision.

Following our approach (see Figure 1), the first step consisted in evaluating the selected IT product (iPad in our case) itself and to select its main features and characteristics. The analysis was based on multiple information sources available on Internet, such as commercial data and users' evaluations, and it was completed by the manipulation of the product itself. The results of this

Table 1: Activities of UCG.

Activity	Description
Administra-tion	Administration of the association: management, maintenance, office supply, accounting, etc.
Villas YoYo	Free spaces open every day after school hours where children (4 to 12 years) benefit from school support and various activities, animations and summer camps.
@do	A space offering young people (10 - 15 years) school support, social and cultural activities, and an annual summer camp.
Web Seniors	Offers various IT courses to seniors: office tools, internet, webcam, skype, e-mail, digital photos handling, etc.
Foyer George Williams	Offers to people (18 to 35 years) a possibility to rent rooms for living and organizing parties or other activities.
Fitness	Management of subscriptions.
Meeting room	The association rents a meeting room with a capacity of up to 50 people.
Rehabilita-tion	Professional and social reintegration support for employees in difficulty.

step are summarized in Table 2, which also includes a general user profile description established with regards to the selected product characteristics.

The next step consisted in defining the organizational context, i.e. identifying project decision-makers and their main objectives, listing the main business activities and describing organizational roles considered as potential product users. Information collecting has been greatly facilitated by the multiplicity of information sources: association's website presenting the organizational chart, activity reports, funding sources and of course its activities, several available documents such as statutes, archives and the book tracing the association's history. Furthermore, it was easy to engage in informal discussions with associations' members to glean the information regarding their tasks and responsibilities. Goal-driven strategy was applied to identify only very general project objectives allowing to justify the product purchase in general but not yet for each particular user. The results of this step are summarized in Table 3. In total, eleven people were selected as potential users and considered as stakeholders for the rest of the study.

In addition to the product qualities listed in Table 2, two major constraints had to be taken into account: the price of the product and its reliability. Both were evaluation as acceptable and satisfactory.

Table 2: Selected Product Characteristics and Generic User Profile.

Quality Requirement	Facet	Attributes
High mobility	Autonomy	High capacity of the battery - a full working day. No need to connect to any peripheral (e.g. screen, keyboard, mouse) to work.
	Portability	Appropriate size and weight. No need for additional peripheral.
	Connectivity	Wireless and 3G connection. Availability of connectors to different peripherals (monitor, beamer, keyboard).
Multi-functionality	Multiplicity and variety of functions and applications	The device is functional immediately because of several basic functions such as, web browser, e-mail, notes, calendar, capture of photos and videos. More than 650'000 applications for infinite purposes are available on the App Store.
	Performance	Rapid processor, while maintaining low consumption. Adequate storage memory.
Reduced paper usage	Paper substitution	The width of the screen is close to the A4 format. Easy reading of the majority of standard documents. Facilities to adapt the font size. The portability of the tablet makes it easy to read documents at any place.
Simplicity and accessibility	Facility of usage	The screen size close to the one of a small laptop computer. Easy installation and manipulation of the applications. Quick and intuitive access to the applications.
	Intuitive interface	Application-based operating system. The touchscreen interface is intuitive and learning is much quicker than on a computer. People frustrated by the complexity of computers may finally receive a viable and user-friendly alternative.
Generic User Profile		
The tablet user regularly needs an electronic support when moving inside or outside the main workplace. The tablet user utilizes the device as a multifunctional support (agenda, documents, presentations, web, mails, photos, video, etc.). The tablet user is open to new technologies, at least as long as they are accessible to him/her.		

Table 3: Results of the Organizational Context Definition.

Context Elements	Organizational Context Specification
Decision-makers	The Management Committee including the President, the Associate Director and the Main Director makes the final decision regarding the acquisition of tablets.
Main objectives	The main goal – Improve work efficiency – is refined into the following sub-goals: facilitate mobility of managers, offer a multi-functional device supporting managers' tasks, ensure simplicity of the product usage and reduce paper usage.
Potential users	The following organizational roles were identified as potential beneficiaries of the tablets: Associate Director, Main Director, Administrative Officer, Web Seniors Manager, Administrative Assistant, Accountant, Head of Maintenance, @do Manager and three managers of the villas YoYo.
Activities	See Table 1.

The next step in the decision-making phase consisted in evaluating the adequacy between the potential users profiles and activities on one hand, and the product characteristics on the other hand. Semi-open interviews, based on a list of generic predefined questions, were used in this study. The results of the questionnaire and the transcription of interviews are available in (Biggel, 2012). The study revealed that the roles of *Accountant*, *Administrative Assistant* and *Head of Maintenance* were matching by very far the standard profile, due to the little mobility and the low potential for transferability of the tasks already performed on a computer. It was therefore not recommended to acquire tablets for these three roles. In the contrary, the profile of the *Associate Director* was considered very similar to the generic tablet user's one. She moves regularly outside her office and uses her smartphone for some tasks that would gain in comfort with a tablet for taking notes in meetings, consulting e-mails and editing presentations and documents. Therefore, the recommendation to acquire a tablet was positive. Concerning the *Administration Officer*, the result was more nuanced: little mobility but an interesting potential for the multifunctional aspect of the tablet. The profiles of the *Main Director* and the *Manager of Web Seniors* did not match the standard profile due to their low computing needs and also because of their difficulties in understanding and using new technologies in general. Therefore, the recommendation was negative. Similarly, the *@do Manager* has a distant profile from the standard one. Even if some of his activities take place regularly outside the workplace, a computing support in these cases is not needed. Already existing computers in his main workplace fully meet his professional needs. Finally, the three *Managers* of the villas YoYo have quite similar tasks but they work and operate differently, with a different material and their respective profiles are not identical. However, two of them are close to the standard profile and show some enthusiasm and interest for the tablet; they received positive recommendation.

Of course, we are conscious that this type of analysis has some risks, in particular, triggering some frustration of people who were discarded from the project since the beginning or after the

evaluation of their profiles and their needs towards the product. One can argue that in such situation the company should simply buy the product to all employees in order to avoid envy and conflicts. However, our study, and in particular the final interviews, revealed that some employees were not interested in having a tablet computer for their job and were convinced that such a purchase would be a waste of money and energy.

Finally, the requirements for the tablet implementation in the organizational context and general rules for its usage were specified. The final decision was to buy 4 iPad tablets and test their usage in practice before acquiring more devices.

5 FURTHER EVOLUTION OF THE APPROACH

Usually, requirements engineering is realized at the beginning of an IT product acquisition/engineering process. However, it is well known that users' needs evolve during the product usage in practice. Moreover, new ways of using the product could be discovered with the aim to innovate the enterprise business model and activities. Therefore, we see that logical continuation of our approach would be considering requirements evolution management during the product lifecycle. That would include capturing user feedback and exploring the potential business innovations enabled by the product usage. Both steps would lead to the revision of the requirements specification and the product update.

5.1 Capturing and Analyzing Users' Feedback

The main objective of this step consists in evaluating the product in use and identifying the problems faced by its users, the changes made in their daily activities, and the desired improvements. One way to make this assessment would be a permanent monitoring where users would be asked to report the encountered problems, to explain what functions they use the most, and to evoke the possible applications. Of course, this method implies that a regular contact with each of the users is possible.

Another possibility would be to conduct planned interviews after several weeks of product usage under the real work conditions. The major risk of this technique is that people can forget about some interesting situations implying the tool.

Feedback prioritization and organization can be necessary in case of multiple users reports in order to detect commonalities and discrepancies in them and to extract the most relevant information. We recommend to use techniques dedicated to explore customer/user feedback collected in the form of reviews, comments and surveys (Oelke et al., 2009). The results obtained during the product assessment may entail a return to the stage of requirements specification where feedback reports are used to identify new requirements concerning the product implementation.

5.2 Exploration and Innovation

The objective of this step would be to explore the prospects offered by the acquired IT product. The aim of this analysis is to go beyond the mere satisfaction of stakeholders' needs and to imagine what innovations it could bring to the users' activities based on the product capabilities. This step makes sense if the initial feedback reports are favorable and the lifecycle of the product is considered as relatively long.

In order to stimulate ideas and to discover new ways to use the product, we recommend applying creativity techniques used in requirements engineering (Karlsen et al., 2009; Maiden et al., 2010). Gathering some members of the organization together in a brainstorming session or other creativity workshop and leveraging the potential of group thinking seems to be a great way to discover unexpected applications or different ways to use the product.

Once the ideas for future product applications have been discussed and validated, the approach would bring us back to the requirements specification phase. For example, it can be required to change the network infrastructure, to add new features (applications), to accompany product users to make changes in their work or even to change assignments and tasks related to their position.

6 CONCLUSION

In this paper we propose an approach for handling the implementation of new IT products in small and medium size organizations. The construction of this approach was instigated by a real project and the need to evaluate an IT product acquisition in a small non-profit association. The approach is mainly adapted to the evaluation of multifunctional devices like tablets and smartphones and is based on the

evaluation of the adequacy between the features offered by the product and the business activities, responsibilities and work context of its users. Further investigations should be done in order to broaden its scope to more general technology-driven projects exploring business innovation with the help of new technologies and IT artifacts.

We recognize that the comparison of user profiles during the product adequacy evaluation step needs further elaboration – introduction of quantitative and/or qualitative criteria in order make the assessment of profiles similarity more precise and better adapted for bigger organizations.

We also imagine the extension of our approach for managing requirements evolution and finding possible business innovations with the help of the IT product. We believe that fostering creative thinking throughout the entire RE process is a great way to combine fun and efficiency. We suggest trying some creativity workshops in the early steps of the analysis process in order to test social interactions between different organizational roles and their capacity to generate original ideas.

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