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Requirement specification in Government IT Procurement

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Abstract

IT procurement represents a business process of importance, including the ability to articulate requirements that the procurement deals with. Furthermore, specifying requirements is of importance for both procurer, and potential supplier as it functions as central contractual element between the two. The purpose of the article is to show *how functional and non-functional requirements are represented in current call for bids for the procurement of IT*. 11 ‘call for bids’ were examined from a Swedish national procurement database. From the analysis of the bids, it can be concluded that the call for bids displays fuzziness in making a clear distinction between functional and non-functional requirements. From the discussion on this, a tentative procurement framework is suggested, aiming on increasing the logical transparency for the procurement of IT.

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1. Introduction

For firms and public administration, procurement represents a business process of importance. Regarding the role of Information Technology (IT), it may be used as a *tool* to increase an organizations’ procurement capability [1,2] and IT may also be the *subject* of the procurement. In this paper we are interested in the latter

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and in particular the case of the European Union-wide legislation of “Government procurement in the European Union”. Put shortly, the legislation stipulates – and in line with the ambitions of the common market – that an individual Government procurement exceeding a certain monetary threshold value needs to be published in open competition. The act applies to all services and goods that government bodies procure, including the procurement of IT.

From an academic point of view, procurement in a broad sense has previously been covered extensively [3]. Less interest has been given to procurement of IT. In the majority of call for bids, financial value of the bid is not specified by the procurer, because the supplier is required to submit a *proposal* of the financial value. However, in Sweden 2009 the part of call for bids that pre-specified value of procurement of IT amounted to 63 million Euro. Further illustrating this trend towards increased importance of procurement is the increased amount of job postings explicitly demanding purchasing competence surrounding procurement of IT. Also, Swedish trade press has on numerous occasions reported on challenges associated with procurement legislation. Rådmark [4] reports on the CIO of Växjö Municipality having to resign as a result of not complying with Government procurement in the European Union and Eriksson [5, 6] comments upon on procurement challenges when procuring vaccine for the Health sector and procuring services with Swedish Civil aviation is literally described as being a “nightmare”. We believe it is important to address procurement of IT not only because of the significant financial value that it represents, but also to address the reported challenges regarding compliance.

The ability to specify requirements is another important area for firms and public administration when they aim at equipping themselves with IT-based resources. This implies the need to specify requirements for future software to a satisfactory degree. Furthermore, being able to specify requirements becomes increasingly important since organizations increasingly buy the software as either standardized software package or buy the software development as a consultancy service rather than develop them in-house.

Pivotal to any activity of system development analysis and design is the *process of specifying requirements* [7]. Also, as stated above, requirement specification process applies to instances of both in-house development as well as instances of procuring IT from external suppliers.

Consequently, we argue that requirements may be used as an anchor to analyze a procurement situation. Using call for bids, the purpose of our paper is to problematize and discuss the theoretical distinction between *functional* and *non-functional* requirements, and further propose an alternative conceptualization to requirements. In order to reach the purpose, the following question was initially asked: How are functional and non-functional requirements represented in current call for bids for the procurement of IT?

The rest of the paper is organized as follows: we first present some descriptions and problematic issues with systems development and requirements focusing specifically on software requirements specifications. The section thereafter presents our research method, how empirical data were collected and analyzed. In the penultimate section we then present our findings which we then discuss and draw some conclusions on presented in the final section.

2. Systems Development and Requirements

Software developer’s makes a high-level distinction between functional and non-functional requirements (cf. RUP, software engineering). Functional requirements represent the type of operations that connects the user and problem domain with the representation of the problem domain [8]. More specifically, functional requirements may be divided into four major categories of operations: calculation, signaling, update and write. According to Stellman and Greene [9] non-functional requirements represent requirements beyond the above mentioned, for example usability, computing efficiency, reliability, scalability, reusability, portability etc. In tandem with specified requirements, use cases define interaction with a suggested system from an

actor's point of view. In all of the above mentioned categories, the requirements need to be specified, clarified and documented in some way. The result of this exercise often ends in a software requirements specification (SRS).

Software requirements specifications (SRSs) are important documents, used by different groups of people for communicative purposes; by customers, to know what to expect; by the software developers, to know what to build and how; by test groups, to test and evaluate the system [10-12]. The SRS act as a channel of communication between developers and customers and help to ensure that the system satisfies customer needs [13]. Moreover, it creates a baseline upon which sub-sequent systems development activities are based [14].

It is clear that an SRS is one part of the overall systems requirements determination process which in its turn is part of the entire systems development process. An SRS is described by Eriksson [15] as a document produced when a system is built from scratch, or if there are major changes being made to an existing system. Wiktorin [16] on the other hand states that "a requirements specification consists of several parts.". Another description, also rather short, is given by Duggan and Thachenkary [17]: "Requirements specification: representing the results [of the previous steps in the SRD process] in a document".

One explanation of the contents of an SRS is given by Wieringa [18], who states the following: "A requirements specification consists of a specification of product objectives and a specification of required product behavior". In other words, an SRS shows the purpose of the system, and how it is supposed to behave – its functionality, which is described by Carvalho *et al.* [19] in the following way: an SRS should describe the "what" of a system, not the "how". Wiegers [10] states that since the SRS is important for the following activities in systems development, it needs to have a detailed description of system behavior. Smith et al [20] state that the SRS should describe essential system requirements of the software and its external interfaces, such as functions, performance, constraints and quality attributes. To sum up, a SRS is a document created when a system is built or rebuilt, containing purpose and behavior of the system as well as descriptions of the system and its desired functions. However, in the context of this research we view the 'call for bids' as a sort of initial formalization of a SRS.

3. Data Collection and Collected Data

11 current call for bids concerning the procurement of IT were reviewed, see Table 1. The approach meant that we attempted to generate observations, primarily based on a data-driven approach to problematize our theoretical understanding. The 11 cases were hard-copy printed in completeness in two sets. Supplied with post-it notes, it was decided that we (the two authors of the paper) independently from each other read through the call for bids looking for theoretical gaps in terms of functional and non-functional requirements. The two sets of post-it notes were then compared and discussed. This exercise ended in some findings and the analytically most promising were selected for future analysis. The selection was made from the question asked: *How are functional and non-functional requirements represented in current call for bids for the procurement of IT?*

More specifically, we were interested in assessing both *use*, as well as the *usefulness* in relation to how the 'call for bids' were formulated. The selected call for bids were collected from e-Avrop, which is Sweden's biggest free database for procurement.

4. The Findings

In this section we present findings from the analysis of the call for bids. The first finding discussed is the different precision between hardware and software requirements. Next finding discussed is the demand for a track record of the bidders from the procurer and how that is related to low specificity of requirements. This

finding is closely related to the third finding discussed which discusses how low specificity restricts or gives opportunities for suppliers. The last finding discussed is the inherent tension existing between functional/non-functional requirements on the one hand and hardware/software on the other hand. From the discussion on these four findings we present a procurement framework which we suggest could act as a starting point for developing a strategy for the procurement of IT.

Table 1. Description of the 11 call for bids cases

| Case | Subject of procurement | Categorization of the subject in the database e-Avrop |
|---------------------------|---|--|
| Örnsköldsvik Municipality | New external webpage | Production of a new external webpage for the municipality in accordance with pre-specified graphical profile program |
| Östra Göinge Municipality | Procurement of surf pads | 120-130 units of tablet computers. |
| Eskilstuna Municipality | Web-based support system for relatives of patients | Web-based turn-key support system for relatives of patients |
| Umeå University | Video conferencing system | Video conferencing hardware |
| Sigtuna Municipality | IT consultants | IT implementation expertise for renewal of public admin supporting IT |
| Sundsvall Municipality | Unspecified IT | Experience output-specified |
| Courts of Sweden | Service and support for a video conferencing system | Service and support for video conferencing system |
| Flen Municipality | Creative Media | IT-based education on creative media main focus. |
| Sundsvall Municipality | Apple-products | Pre-procurement of tablet computers |
| Örnsköldsvik Municipality | Surf pads | 24 units of tablet computers. |
| Skellefteå Municipality | SMS platform | Meta-integration of disparate SMS-systems delivered as Software as a Service |

4.1. Hardware Precision and Software Vagueness

Three of the cases concerned procurement of tablet computers. Sundsvall and Örnsköldsvik Municipality are pure hardware purchases, while the procurement of Östra Göinge Municipality stipulates tablet computers to be used in pre-school and compulsory school. Consequently, the suggested user group can be assumed being pupils in the age span 6-16 years. Usability requirements are also included in the call for bids.

The requirement specification of Östra Göinge Municipality shows a high level of precision regarding hardware and product specification and less in terms of detailed software performance. The high level of hardware and product specification is illustrated by the following three examples:

*“The pad must have a built-in battery providing at least 8 hours of battery time. [...] The pad must be delivered with a minimum of 16 Gb primary memory. [...] The pad must have a minimum screen of 9,5” allowing for 1024*768 resolution.”* (Östra Göinge Municipality, 2011a)

As is common in call for bids, the overarching evaluation criterion are given weights, and in this case price quality is given 5/10 of evaluation importance, “usability” is given 4/10 of importance and insurance solution is given 1/10 of importance. As the call for bids is formulated, hardware aspects are included in the usability definition (see point 8 below) and the generic minimum performance level of software is not covered in any detail. According to Östra Göinge Municipality (2011b, p. 4), usability will be assessed based on the quality of the following aspects: 1) Protective cover, 2) File management, 3) Application management (purchasing, installation and remove), 4) Administrative tools, 5) Security back-up, 6) Boot-up time, 7) Experience of performance (lagging, efficiency in switching between windows), and 8) Hardware.

Besides the hardware requirements previously mentioned before, the criterion ranging from 1-7 are not expressed in any measurable minimum metrics. Due to context-dependent quality of usability, it has been suggested [21-23] that usability should be expressed in measurable context-specific metrics. For example, boot-up time may be specified in seconds. In the Östra Göinge case the criteria is supposed to be evaluated subjectively by the procurement staff. Further improvement would have allowed for evaluation to be made by stakeholders that are supposed to use the pads, if not, any objective measurement such as seconds could be used.

This is a call for a more coherent use of non-functional requirements. It can also be stated from the findings of the Östra Göinge case that there exists possibilities for procurers to be more precise when describing how the evaluation is planned to be done as well as what evaluation criteria that is supposed to be used. The benefits for being more precise would be two folded; first the bidders would be able to more clearly evaluate their products and thereby prevent errors as well as being able to give a more accurate price, second, the procurers evaluation of specific proposals would be much more easy to conduct.

4.2. The Objects Looking for a Subject or the Requirements Looking for a Supplier

In procurement processes we have identified numerous instances of explicit demand by the procurer for the supplier to prove a track-record of previous deliveries. This illustrates the importance of the subject, meaning the supplier. In the process of requirement specification, which could be seen as the object of the activity, the screened ‘call for bids’ clearly states the qualities the suppliers need to have. We can only speculate on implications of this, it could be used as a screening-mechanism of supplier, guaranteeing that the supplier has been able to deliver in the past. However, the obvious risk is that more competitive suppliers are excluded from the bidding process.

The qualification of a supplier is given in a rather superficial way. One example of this could be found in the bid from Örnsköldsvik Municipality in which it is stated “The provider shall have required experience and competence to deliver and be a provider that has delivered similar services before”. The implications from this requirement could mean difficulties both from suppliers’ perspective as well as from buyers’ perspective. For the suppliers it means that they have to make a statement on its experience and competence, which could be hard if recently established. It also means that the providers need track-records that are positive and to have those they probably need to have been in the business for some time. For the buyer it could be seen as strictly positive to get references from earlier customers to the provider and it is probably easier to evaluate a provider if the provider could present a track record of successful deliveries. However, for both the supplier and the buyer, this requires a satisfactory level of articulation of both experience and competence.

The theoretical implication following from this is that the model of functional and non-functional requirements does not adequately address the issue of “who”, suggesting that further research activities needs

to be focused on including qualities of the supplier into the existing models. Considering the importance given in investigated call for bids, it is clear that more consideration needs to be taken to include qualities of the suppliers to have a useful framework for procurement of IT.

4.3. Vagueness as a Supplier Opportunity

From theoretical point of view the call for bids are fuzzy in terms of precision on the absolute-haves. In the case of Eskilstuna Municipality under “Requirements for the service”, of the presented six bullets regarding requirements relating to the service in itself were five fuzzy in terms of how to evaluate them. The sixth requirement, “being able to link externally” to the service we find redundant since external linking to web service in most cases always are possible. Under the same headline there are numerous of shall requirements, however, the evaluation of all these requests are handed over to the supplier. The suppliers are asked to state if each and every of the requirements are fulfilled by giving a yes or no answer on the direct question “is the requirement fulfilled?” Potential suppliers are also asked to make comments on each answer. This may be a satisfactory way of having a supplier to make the first evaluation of the bid. However, it demands clear and precise requirements, as well as a clear description of what the procurers wants to have. In the Eskilstuna case the call for bids is fuzzy in the description of what is asked for, which makes that potential suppliers have an opportunity to also be fuzzy in their bids. Thereby rendering the supplier an opportunity to clearly state that they fulfill the requirements.

Another case that epitomizes vagueness as a supplier opportunity is the Sundsvall Municipality case on “unspecified IT”. The case presents Sundsvalls Municipality’s vision about their new building at the big square and asks the supplier to deliver something that makes visitors to be so extremely surprised that it creates an “Oh, shit”-feeling (literal translation) among the procuring party. This call for bids is a clear example on how an organization uses suppliers to help them create innovative solutions. However, it also is a clear example on how suppliers could use the vagueness to try out some innovations and at the same time give them a possibility to get a “big project” if they want that. The call for bids is relatively thin and it does not say anything about the level or scope – in the form of needed or available resources - of the project, which also indicates suppliers’ opportunity.

4.4. Procurement Framework – Strategy for the Procurement of IT

In the studied cases we have observed a lack of explanation of what “product” that was asked for, how the “product” should be used, as well as who should use the “product”. This could be improved by using cases when specifying requirements in the procurement of IT. Furthermore, non-functional requirements include a multitude of possible use qualities that may be connected to software, hardware and also requirements beyond the scope of hardware and software.

In the circumstance of IT procurement, we argue for more purposeful representations of IT to assist procurement staff in organizing requirements. In line with this, it is necessary to address the inherent tension existing between functional/non-functional requirements on the one hand and hardware/software on the other hand. Several of the studied cases conflate hardware/software requirements with functional and non-functional requirements, creating logical inconsistencies since the realization or delivery of non-functional requirements needs to consider the interactive nature between hardware and software. In concrete, a call for bid which specifies hardware to restrictive might negatively impact the realization of functional and non-functional requirements.

From the findings above, we argue that there exist limitations when only considering requirements in terms of functional and non-functional requirements due to wide scope of what may be included under the umbrella

term of non-functional requirements. In addition, from the call for bids we have shown that from a user point of view - the separation between functional and non-functional requirements is problematic.

One way forward to resolve some of the above mentioned problems could be to introduce the product model suggested by Kotler and Keller [24]. In our view this model represents an alternative way of separating functional and non-functional requirements, but also to clarify both functional as well as non-functional requirements. In particular, we hypothesize that merging requirement terminology with the product layers suggested by Kotler and Keller [24] is a more useful way to specify requirements under practical procurement activities. Separating the instance of IT being procured into core product (the essential problem-solving side of a product), basic product (the actual product, e.g. SW and HW), expected product (what the customer expect the product to include), augmented product (attributes beyond the scope of the actual product, e.g. insurance, guarantees and deliver times) and potential product (the qualities important for the future use of the product) assists procurers to make increasingly sense of the separation between functional and non-functional requirements. In particular this holds true for non-functional requirements, due to unclear scope of what quality attributes to include as non-functional requirements.

Placing the different product layers alongside the requirement terminology (Table 2) contextualizes the requirements into a wider business-driven framework more useful for procurement activities.

Table 2. Matching product levels with requirement terminology

| Kotler and Keller (2009) | Suggested requirement specification equivalent | Comments |
|--------------------------|--|---|
| Potential product | Scalability, Flexibility, Reusability, “Nice to have in the future” | The requirements dealing with dynamic requirements that changes over time, for example increased users. |
| Augmented product | Guarantees, service and maintenance contracts, “small extras”. Non-functional requirements, e.g. availability, portability, integrity, reliability, reusability, robustness. | Augmented product overlaps mostly with non-functional requirements, e.g. availability, portability, integrity, reliability, robustness. Performance is considered a non-functional requirements, but is included in the scope of usability efficiency (cf. Joshi, Sarda, & Tripathi, 2010; Olson & Olson, 2003; Shackel, 1991.) |
| Expected product | System objectives expressed in terms of assumed improvement organizational benefits, i.e. the business-realizing of requirements | In order to cover the business-side of requirements in the framework, and to fulfill the customer needs (cf. Femi, Schubert, Sudzina & Johansson, 2010), the expected products should be expressed as technology-neutral desired <i>outputs</i> |
| Basic product | Use cases, usability | Use cases in combination with usability considerations provide a language to address the theoretically desired quality of what rather than how (cf. Wieringa 1996; Carvalho et al, 2010). |
| Core benefit | Customer/citizen utility | Essentially the choice of the procurers; and politicians, ultimately, in the case of government procurement |
| Potential product | Scalability, Flexibility, Reusability, “Nice to have | The requirements dealing with dynamic requirements that changes over time, |

 in the future”

 for example increased users.

5. Overarching Conclusions

From the analysis of the call for bids it can be concluded that non-functional requirements do not sufficiently separate between the business-side and HW/SW-side of the “product” that the municipalities demand in their bids. This conclusion made us search for other ways of specifying requirements in call for bids. One solution on the problematic issue of specifying and separating functional and non-functional requirements could be to use the Kotler and Keller [24] product model.

Furthermore, the analysis suggests that dividing requirements into functional and non-functional requirements results in low precision of requirements as well as limitations in applicability. It is also found that supplier qualities, or the question of “whom”, is empirically important in the bids.

Procurers claim to require “functionality” and “usability”, however these requirements are rarely expressed in any meaningful level of detail. While this relationship may enable for mutual discussion on what is the most purposeful solution, there is also a financial risk that the procurer takes by the imprecision that can be used both on the margin-side as well as proprietary opportunities side by the bidders. This supports the conclusion that there needs to be a balance between precision and impreciseness, in the call for bids.

Finally, the analysis of the findings of hardware precision and software vagueness it can be concluded that there is a need for an increased coherency of non-functional requirements. It can also be concluded that that procurers have a possibility to be even more precise in the evaluation criteria by for instance working with measurable metrics. In turn, this would potentially make evaluation increasingly efficient, and possibly improve the result of the procurement. The main conclusion of the analysis of the call for bids is that another focus on how to specify requirements is needed. We suggest that a framework building on Kotler and Keller [24] product model could have the potential, however, more research in the direction of designing such framework and evaluate it, is needed before making more normative predictions.

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