Managing Non-Technical Requirements in COTS Components Selection

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Abstract

The selection of COTS components is made not only by an analysis of their technical quality but also (and sometimes mostly) by considering how they fulfill those non-technical requirements considered relevant, which refer to licensing, reputation, and similar issues. In this paper we present an approach for managing non-technical requirements during COTS selection. The proposal is based on extending the ISO/IEC 9126-1 catalogue of quality factors by adding factors related to non-technical issues, obtaining a cohesive and comprehensive framework for managing requirements during selection.

1. Introduction

The increasing use of Commercial Off-The-Shelf (COTS) components in both public and private companies has brought several new challenges to the software engineering community. Among them, the selection of COTS components (hereafter, COTS selection) remains particularly challenging. COTS selection embraces several activities [1]: the elicitation of the appropriated requirements; the localization and understanding of available components; and the assessment of the quality of those components in relation to the requirements.

Although non-technical requirements have been considered relevant in the establishment of the basic criteria for COTS component evaluation [2, 3, 17], most of the work in relation to COTS selection has focused in the technical aspects of quality, and not to non-technical issues [4]. Thus, the analysis of non-technical aspects of COTS components, their category-zation and their representation is more than justified.

In this paper we tackle this issue. Our proposal is based on the belief that technical and non-technical aspects shall be dealt similarly during COTS selection. Therefore, we propose to extend the ISO/IEC 9126-1 catalogue of quality factors [5] with non-technical factors following the same layout as in this standard.

Our research has combined action-research through different industrial experiences (see table 1) with literature survey.

2. Extending the ISO/IEC 9126-1 Framework with Non-Technical Factors

The main idea behind the ISO/IEC 9126-1 standard is to use quality models, composed of three types of quality factors (characteristics, subcharacteristics and attributes), as a framework for software evaluation. The standard fixes a set of six technical characteristics (functionality, reliability, usability, efficiency, maintainability and portability) decomposed into a first level of subcharacteristics (such as security, portability, etc). All these quality factors are intended for the evaluation of the technical quality of software, without mention or support the evaluation of non-technical quality aspects.

In our proposal we arrange non-technical attributes in an ISO/IEC 9126-1 tree-like structure, thus the catalogues that we use for COTS selection include high-level characteristics and subcharacteristics, and also lower-level attributes.

We distinguish 3 different catalogues (see figure 1):
1) *NT-ISO/IEC catalogue*. Defines the two highest levels of the hierarchy. This catalogue is equivalent to the ISO/IEC catalogue for non-technical quality factors.
2) *Extended NT-ISO/IEC catalogue*. It is an intermediate, highly reusable catalogue that includes non-technical subcharacteristics and attributes that are common in most COTS selection processes. This catalogue is the counterpart of the catalogue we proposed for technical factors [6] that we call *extended ISO/IEC catalogue* which adds 60 quality factors to the ISO/IEC 9126-1 standard.
3) *Customized NT-ISO/IEC catalogue.* It is a refinement of the previous catalogue to be used in a particular selection project. Usually, it decomposes some factors into others, adds new ones, and hides others that are not relevant for the problem at hand.

The design principles used for building these catalogues may be found at [12]. Also, the 6-step method presented in [7, 8] for building quality models has been adopted whenever possible.

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Domain	No. Cases	Description	Size of QM	Participation
Mail Servers [7,8]	2	**CASE 1:** ► Organization Type: Public - Government ► Expected Users: 50000 Local ► Main Project Budget: N/A ► Objective: Improve internal communication and support to citizens **CASE 2:** ► Organization Type: Private-ISP ► Expected Users: ≈2000 World Wide ► Main Project Budget: 5000 Eur. ► Objective: Provide e-mail services and discussion list to registered users	► 410 QF ► 5 Levels ► 1 QM	► Type of participation: Off-line ► Timing: Post mortem ► Objective: Validation of the process ► Role: Observation ► Type of participation: On-line ► Timing: Project live ► Objective: Provide evaluation criteria ► Role: Observation
Requirement Management Tools [9]	1	► Organization Type: Public - Education ► Expected Users: 2-5 members of project team ► Main Project Budget: 6'000.000 Eur. ► Objective: Manage project requirements	► 329 QF ► 6 Levels ► 1 QM	► Type of Participation: On-line ► Timing: Project kick-off ► Objective: Select more suitable component ► Role: Decision making
Workflow [10]	1	► Organization Type: Public - Education ► Expected Users: 100-1000 Administrative staff, campus wide, cross-campus. ► Main Project Budget: 6'000.000 Eur ► Objective: Improve management of medium and long lasting processes (regulations approval, curricula)	► 102 QF ► 3 Levels ► 1 QM	► Type of Participation: On-line ► Timing: Project development ► Objective: Select more suitable component ► Role: Decision making
Document Management Tools [10]	1	► Organization Type: Public - Education ► Expected Users: 25000 ► Main Project Budget: 6'000.000 Euro ► Objective: Improve management of internal documents, students registration and records, teachers-students interaction etc.	► 298 QF ► 5 Levels ► 1 QM	► Type of Participation: On-line ► Timing: Project development ► Objective: Identify real organizational needs ► Role: Provide criteria for decisions
Academic Records Management System	1	► Organization Type: Public - Education ► Expected Users: 25000. ► Main Project Budget: 6'000.000 Eur. ► Objective: Improve management of internal documents, students registration and records, teachers-students interaction etc.	► 120 QF (Functional only) ► 5 Levels ► 1 QM	► Type of Participation: On-line ► Timing: Project wrap-up ► Objective: Documentation of final product ► Role: Describe functional aspects of the resulting system
IP Telephony System [11]	1	► Organization Type: Public - Telecommunication ► Expected Users: 100000. ► Main Project Budget: USD $ 10'000.000 ► Objective: Provide public and domestic telephony services	► 1832 QF ► 4 Levels ► 5 QM	► Type of Participation: On-line (ongoing) ► Timing: Project life ► Objective: Selection of more suitable components ► Role: Decision making

Table 1: Summary of industrial experiences in COTS selection (QF: quality factor; QM: quality model).

2.1 The NT-ISO/IEC Catalogue

The non-technical quality characteristics that we have included in the NT-ISO/IEC catalogue correspond to the main non-technical aspects often cited in the literature [2, 13].

These characteristics are three: *Supplier, Business, and Product*, and they group non-technical quality factors required to measure respectively: the supplier capability to address and support the project; the aspects related with the acquisition of the COTS component; and the out-of-the-box quality and effort required to get the component running.

In the second level we have included 15 subcharacteristics (see table 2). Some of them have also been identified in the literature (e.g. the *Supplier/ Reputation* subcharacteristic which corresponds to the *Vendor Issues/ Vendor Reputation* factor included in [13]), while others have been included to leverage the hierarchy grouping related lower-level attributes found. One subcharacteristic is decomposed later in the paper.

2.2 The Extended NT-ISO/IEC Catalogue

The extended NT-ISO/IEC catalogue [6] adds 126 non-technical quality factors to the 18 starting ones. In the following we explain situations that have occurred during the construction related to each type of element in the quality models.

Subcharacteristics. We have decomposed some subcharacteristics into others for structuring or leveraging purposes. This is the case of the *Supplier/Organizational Structure* subcharacteristic, which has been decomposed into *Internal Structure* and *External Structure*.

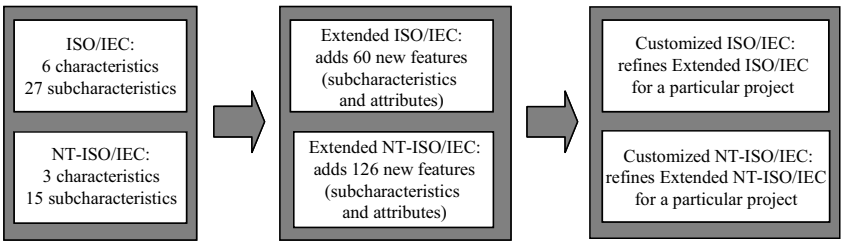

Figure 1: Three types of ISO/IEC-9126-1-based technical and non-technical catalogues.

Supplier		
	Organizational structure	Description of the organizational structure of the supplier company.
	Positioning and Strength	Description of the position and orientation of the supplier company in the market.
	Reputation	Supplier's capability to perform similar projects based on past experiences and certifications.
	Services Offered	Description of the services offered by the supplier.
	Support	Description of the support mechanisms offered by the supplier.
Business		
	Licensing Schema	Description of the COTS component licensing options.
	Ownership	Description of the aspects in relation to the intellectual property rights.
	Guarantees	Detail of the guarantees provided over the product.
	Licensing Costs	Description of the total cost of ownership for the different licensing options available
	Platform Cost	Estimation of the cost for the required production platform
	Implementation Cost	Estimation of implementation costs based on similar past experiences.
	Network Cost	Estimation of additional costs for network operation.
Product		
	History	Aspects related with the evolution of the product since it has been offered to the clients.
	Deliverables	Detail of the out-of-the-box and expected post-implementation deliverables.
	Parameterization/ Customization	Description of the initial effort required for the product to operate.

Table 2. NT-ISO/IEC catalogue.

Attributes. We have refined subcharacteristics into basic attributes, which are objectively measurable quality factors. One of them is the *Total Number of Employees* attribute categorized under the *Internal Organization* subcharacteristic mentioned above. We have also found derived attributes, which require to be additionally decomposed into other attributes. Among them we mention the *Supplier/Positioning and Strength*/*Sales Forecast* attribute. Among others its subattributes are *Software Sales Forecast* and *Services Sales Forecast*.

Metrics. In order to measure the attributes, metrics are required. They can be as simple as integer or boolean values or more complex as lists, records or functions. For derived attributes, sometimes it is not possible to find an objective metric to derive its value in terms of the attributes in which it is decomposed. In these cases subjective metrics are required. Some examples of metrics are shown in table 3.

Attribute	Metric	Example
Time of Product in the Market	Time: Ratio; Time = Float[Years]	5 years
Versions Currently in the Market	Versions: List (<Version: Ordinal, Time: Ratio>); Version = (Unknown), Time = Float[Months]	V1, 8 months V2, 9 months V3, 3 months
Own Manu-factured Product	Own: Nominal; Own = Label(Yes, Not)	Yes

Table 3. Sample non-technical attribute metrics.

Dependencies. Some quality factors depend on others, for instance the factor *Supplier/Reputation* is influenced by the factors *Supplier/Positioning and Strength/ Incomes* and *Supplier/Support.* The relationships found may be depicted by means of a tabular representation as proposed in [8].

Overlapping. Finally it is worth to remark that some non-technical quality attributes are suitable for the evaluation of other factors (either technical or not), thus overlapping is also supported in the approach. As an example we have that the *Time of Product in the Market* attribute decomposes the *History* non-technical subcharacteristic and this subcharacteristic decomposes the *Maturity* technical subcharacteristic of the original ISO/IEC 9126-1 quality standard.

An excerpt of the catalogue is included in Table 4.

Reputation	Recognition of the capability of the supplier to perform similar projects based on past experiences and certifications.		
	Supplier Company Existence	Years of the supplier company in the market from its foundation.	
	Quality Process Certification	Certifications of the quality of the process followed by the supplier company given by recognized certification authorities.	Qualification: (Good, Correct, Suitable) Derived attribute
		CMM Level	Capability Maturity Model Level granted to the supplier company
		ISO 9000	ISO 9000 Certificate granted to the supplier company.
		Other Certificates	Other quality process certificates
	Client Recommendations	References and recommendations of the supplier company that other clients have given.	

Table 4. Excerpt of the extended NT-ISO/IEC catalogue (grey: subcharacteristics; white: attributes).

2.3 Customized NT-ISO/IEC Catalogues

Since the extended NT-ISO/IEC catalogue is quite comprehensive (144 non-technical factors), we have needed just a few additions to tailor it to our experiences. On the other hand, it is more likely that some factors belonging to the catalogue are not interesting, or need a slight redefinition (e.g., a particular metrics is required). For example, in the experience reported in [11], the metrics of the attribute Direct Support was redefined in order to know not just if it is provided and its description, but also the list of channels of direct support provided by the supplier (mail, phone, messenger, ...).

3. Using Catalogues in COTS Selection

COTS selection in public companies is often driven by call for tenders processes. In these processes the company elaborates a document that consists on a wish-list about the COTS to select, which is sent to

potential suppliers inviting them to submit their products for their consideration during the selection.

Our catalogues may be used to facilitate the writing of complete enough call for tenders documents (named Request for Information Forms, RFI), to make easier the analysis of the answers of the potential suppliers, and to support the negotiation process.

RFI contents are requirements stated as constraints on the attributes included in the customized ISO/IEC and customized NT-ISO/IEC catalogues. Answers of suppliers consist of values (or interval of values) given to the attributes for the COTS proposed, using the stated metrics. Once the company obtains the answers from the clients, the common framework offered by the catalogues makes easier the identification of mismatches among COTS components characteristics and the stated requirements.

4. Conclusions

In this paper we have presented an approach for dealing with non-technical issues during COTS selection processes. We have aligned technical and non-technical information during COTS selection by using the ISO/IEC 9126-1 catalogue as common framework. This is a crucial benefit since both categories can be assimilated: technical and non-technical quality factors are diverse but they share some fundamental properties. We have proposed a 3-level catalogue of non-technical information, corresponding to three abstraction levels.

Concerning comparison with other works that include a catalogue of non-technical factors [13, 14, 15, 16], the main difference is the number on non-technical quality factors that we have identified in the NT-ISO/IEC extended model, the way in which they have been organized, and the provision of metrics for evaluating each factor. Our extended NT-ISO/IEC catalogue is much richer than others we know about; it encompasses near 150 non-technical quality factors (including the ones identified in the reviewed approaches) which are arranged in a hierarchical tree-like structure, similar to the one proposed in the well known ISO/IEC 9126-1 software quality standard, outlining a uniform framework well-suited for the evaluation of both technical and non-technical quality factors. Also, the way we have presented of integrating technical and non-technical issues is not as explicit as ours. Other works also address the importance non-technical factors. Among them we remark [17]. The aim of that work is much wider; it provides a complete and comprehensive framework for software process improvement, including support for the elicitation of requirements and the selection of COTS suppliers and components. However, it does not provide a catalogue of non-technical quality factors, it just mentions some relevant categories and examples of them, thus it can be supported by / complemented with our proposal.

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