# 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 the 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. We show how we can use this catalogue for eliciting non-technical requirements, and how the metrics included in the catalogue may be used to define fit criteria for requirements. We illustrate our approach with an industrial experience that took place in the telecommunications field.*


## 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 [FSR96]: 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 the evaluation of COTS components [Kon96][WJ02], most of the work in relation to COTS selection has focused in the technical aspects of quality, paying less attention to the analysis and categorization of non-technical issues [Kun03].

Non-technical quality features are relevant for several activities that take place during COTS-based systems development:

- In an early stage they can be useful to establish the estimated project budget, the reliability of COTS suppliers and their capacity to address the required project, the preliminary architecture of the system, the effort required for COTS components adoption and integration, and thus the project schedule.
- During negotiation they provide the basis to set the project scope, and to establish responsibility of the involved parties, contractual constraints and warranties, and the services to be provided by the suppliers, among others.
- In relation to the previous bullet, if well stated and structured, they can be useful during project development to clarify eventual disputes based on the agreed contract (if it has been issued based on the attribute values provided by the suppliers and includes some compromise from them). Also in this stage, they can be useful to support several aspects as: general progress and fulfillment of project targets, the application of the proposed methodology and the accomplishment of the appointed services.
- At project wrap-up, they can be useful not only to measure the degree of accomplishment, but also as the basis to negotiate the future relationship with suppliers, including services to be offered, licensing and recurring fees, and management and deployment of new versions.

Because of this, the analysis of non-technical aspects of COTS components, their categorization and representation is more than well 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. To achieve this goal, we propose to extend the

ISO/IEC 9126-1 catalogue of quality factors [ISO01] with non-technical factors following the same layout than in this standard. In particular, as done in the standard, we fix just the two higher levels of the hierarchy, avoiding excessive prescription of the proposal. We call this catalogue the *non-technical extension of the ISO/IEC catalogue* (NT-ISO/IEC catalogue for short) to distinguish it from the previous one. An extension of this catalogue built from our industrial experiences, academic experiments and literature survey can be found at [CFQ06].

In the paper we also show how to use this catalogue to drive the whole selection process. Our approach is based on using a Request for Information form which is no more than a template with the NT-ISO/IEC catalogue customized to the particular experience. Suppliers fill this form and send it back to the interested organization which combines the results and makes the final decision, probably after a negotiation process. We illustrate both the catalogue and its procedure of use with an industrial experience that takes place in the telecommunications field.

The rest of the paper is structured as follows. Section 2 details the research method followed. Section 3 introduces related work. Section 4 briefly summarizes the ISO/IEC 9126-1 quality framework. Section 5 gives the details of the non-technical catalogue, whilst section 6 proposes a procedure for driving COTS selection based on this catalogue. Section 7 presents the case study, and section 8 provides the conclusions.

## 2. Research Method

The research carried out to formulate the proposal has combined action-research through different industrial experiences (see table 1) combined with literature survey. We focus in the first aspect. We may divide the research performed into three phases:

*Phase I. Detection of the problem.* In previous work [FC02][FC03] we used the IQMC method to extend ISO/IEC-9126-1-based quality models and use them to support requirements elicitation and validation during the process of selecting a single COTS component. We soon discovered that non-technical requirements were crucial in the selection of coarse-grained COTS components and especially in Enterprise Applications such as ERP systems, CRM tool, etc. As two short examples of this situation from our experiences (table 1): in the Document Management Tools case, the only two candidates to be selected were chosen because they had a special license agreement with the University; in the Requirements Management Tools case, there was a non-negotiable requirement for the suppliers to have a site in Spain.

*Phase II. Formulation of a solution.* We decided to tackle the problem as mentioned in the introduction. We were building the catalogue and refining its procedure of use whilst we conducted some of our experiences (see table 1, rows 2 to 5).

*Phase III. Validation of the solution.* Our last industrial experience (see table 1, row 6) is a very large-scale one. As expected, the catalogue was customized to the particular experience, as will virtually always happen. The project is still under development, but the COTS selection phase has successfully finished. We remark the size of the project and the corresponding artifacts, as well as the fact that it was an on-line participation: the proposal presented in this paper has been really used throughout the project and decision-making was done in the basis of its outcome.

## 3. Related Work

There are other works that also address non-technical quality features. In some of them the aim is different to our. In [BTV03] authors explore some commercial COTS vendors web pages and identify some non-technical features with the objective to evaluate the quality of the information provided by COTS suppliers in relation to technical ones. Also in [TJS+02] authors identify and categorize a set of non-technical features, to provide a framework for the classification of COTS components.

Other works propose lists of non-technical features for the evaluation of COTS components. In [KB00] a list of 12 attributes classified in 3 categories (Business issues, Marketplace variables, and Vendor issues) is deduced and classified from interviews with 7 organizations. In this work the idea behind the study was to identify the factors that are relevant in the selection of software products, in order to reuse the list of attributes in selection processes. In [PVL97] a framework for the evaluation of software tools is proposed, and it is applied to the domain of the tools that give support to component based software development. In one of the activities proposed, they use a checklist of evaluation criteria, in which there are general criteria independent of the domain and that include 32 non-technical attributes classified into 6 categories (business, external reference, vendor support, financial, emplacement and tool lifespan issues).

From the process perspective, the use of Request For Information forms is usual in the context of tendering processes [Lau04]. Which is not so usual is using predefined catalogues to drive the construction of these forms. An approach which tackles reusability of knowledge in this context has been proposed in [KBD04]. In this work, used in an industrial setting, it is proposed to conduct tendering by sending questions derived from a software requirements specification to potential supplier companies. In order to improve the process they work with software requirements specification templates. At the time being, the templates are not categorized nor classified as our ISO/IEC-based catalogue making their use ad-hoc.

| Domain | No. Cases | Description | Size of QM | Participation | Ref. |
|---|---|---|---|---|---|
| Mail Servers | 2 | **CASE 1:**<br>► Organization Type: Public - Government<br>► Expected Users: 50000 Local<br>► Main Project Budget: N/A<br>► Objective: Improve internal communication and support to citizens | ► 410 QF<br>► 5 Levels<br>► 1 QM | ► Type of participation: Off-line<br>► Timing: Post mortem<br>► Objective: Validation of the process<br>► Role: Observation | [FC02]<br>[FC03] |
| | | **CASE 2:**<br>► Organization Type: Private-ISP<br>► Expected Users: ≈2000 World Wide<br>► Main Project Budget: 5000 Eur.<br>► Objective: Provide e-mail services and discussion list to registered users | | ► Type of participation: On-line<br>► Timing: Project live<br>► Objective: Provide evaluation criteria<br>► Role: Observation | |
| Requirement Management Tools | 1 | ► Organization Type: Public - Education<br>► Expected Users: 2-5 members of project team<br>► Main Project Budget: 6'000.000 Eur.<br>► Objective: Manage project requirements | ► 329 QF<br>► 6 Levels<br>► 1 QM | ► Type of Participation: On-line<br>► Timing: Project kick-off<br>► Objective: Select more suitable component<br>► Role: Decision making | [CFQ05] |
| Workflow | 1 | ► Organization Type: Public - Education<br>► Expected Users: 100-1000 Administrative staff, campus wide, cross-campus.<br>► Main Project Budget: 6'000.000 Eur<br>► Objective: Improve management of medium and long lasting processes (regulations approval, curricula | ► 102 QF<br>► 3 Levels<br>► 1 QM | ► Type of Participation: On-line<br>► Timing: Project development<br>► Objective: Select more suitable component<br>► Role: Decision making | [CFQR04] |
| Document Management Tools | 1 | ► Organization Type: Public - Education<br>► Expected Users: 25000<br>► Main Project Budget: 6'000.000 Euro<br>► Objective: Improve management of internal documents, students registration and records, teachers-students interaction etc. | ► 298 QF<br>► 5 Levels<br>► 1 QM | ► Type of Participation: On-line<br>► Timing: Project development<br>► Objective: Identify real organizational needs<br>► Role: Provide criteria for decisions | |
| Academic Records Management System | 1 | ► Organization Type: Public - Education<br>► Expected Users: 25000.<br>► Main Project Budget: 6'000.000 Eur.<br>► Objective: Improve management of internal documents, students registration and records, teachers-students interaction etc. | ► 120 QF (Functional only)<br>► 5 Levels<br>► 1 QM | ► Type of Participation: On-line<br>► Timing: Project wrap-up<br>► Objective: Documentation of final product<br>► Role: Describe functional aspects of the resulting system | NYP |
| IP Telephony System | 1 | ► Organization Type: Public - Telecommunication<br>► Expected Users: 100000.<br>► Main Project Budget: USD $ 10'000.000<br>► Objective: Provide public and domestic telephony services | ► 1832 QF<br>► 4 Levels<br>► 5 QM | ► Type of Participation: On-line (ongoing)<br>► Timing: Project life<br>► Objective: Selection of more suitable components<br>► Role: Decision making | [Car06] |

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

## 4. The ISO/IEC 9126-1 Quality Standard

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

The standard is not precise at some points, as for example if multilevel hierarchies of subcharacteristics or attributes are allowed. For this reason we have felt compelled to take some decisions about which should be the organization of an ISO/IEC-based quality model [BBC+04]. We enumerate the most interesting ones:

- Characteristics are non-measurable quality features used to classify the rest of entities of the model.
- Subcharacteristics are quality features that may be decomposed into other subcharacteristics or alternatively into attributes. Subcharacteristics are also used for classification purposes.
- Hierarchies of subcharacteristics and attributes are allowed with no restrictions about number of levels.
- Attributes can be derived or basic. Basic attributes are directly measurable quality features which can be objectively measured.
- Derived attributes are non-directly measurable quality features. Metrics can be objective or subjective.
- Overlapping of quality attributes is allowed.
- Quality attributes belonging to more than one subcharacteristic can be measured with different metrics for each case.


**Figure 1:** The different catalogues found.

## 5. Extending the ISO/IEC 9126 Framework with Non-Technical Quality Features

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. To follow the ISO/IEC guidelines, we distinguish two differentiate issues: 1) the definition of the NT-ISO/IEC catalogue which defines just the two higher levels of the hierarchy; 2) the extension of this catalogue in particular experiences, which means decomposing the defined subcharacteristics into attributes. In both cases, we find convenient to adhere to some design principles to enhance the quality of the resulting models. Fig. 1 provides the overall picture which is detailed in 5.2 and 5.3. We remark the homogeneous treatment of technical and non-technical aspects which is one of the key points of our approach.

### 5.1 Some Design Principles

In order to have guidelines for building a good catalogue, we decided to follow some of the existing approaches for designing models. In particular, we found Reingruber and Gregory's for ER models quality [RG94] especially well-suited, probably because ER models and quality models may be both considered basically as two kinds of data models. We analysed the principles and guidelines proposed in this book, and for that purpose we found useful to associate the ER notion of entity to that of characteristic and subcharacteristic in the ISO/IEC standard, whilst entity attribute in ER was matched with quality attribute in ISO/IEC. As a result, the most useful principles and guidelines in the book for our purpose are:

- *Quality factor identification.* A quality factor represents a single concept, about which enterprises want to have information.
- *Quality factor naming.* A quality factor must be labelled with a unique, descriptive name that follows an established set of conventions that may be:
  - Syntactical conventions: minimum set of words, singular noun (optionally described with modifiers), meeting naming convention requirements and limitations (e.g., about length, minimizing special characters, etc.), avoiding ad-hoc acronyms.
  - Semantic conventions: meaningful, self-explanatory, abstract, avoiding homonyms, resolving synonyms.
- *Quality factor definition.* Each quality factor must be described with a definition, description or statement of purpose, which aligns with the name (but it must add information to the name) and adheres to some guidelines: mostly self-contained (avoiding links to other sources of information), with a statement about its importance to the COTS selection activity, written clearly (e.g., no jargon) and sparingly.
- *Domain-related issues.* Besides some basic guidelines (e.g., every attribute must have a domain that consists of at least two values), the most crucial one has been the *Split Domains* rule, which requires not to split single logical domains of enumerated values into multiple attributes (usually, boolean ones).

In addition, we considered as overall design principles:

- *Uniformity*. Easy integration of our catalogue of non-technical factors with the ISO/IEC 9216 hierarchy.
- *Leverage.* The model should maintain a balanced degree of abstraction at each level of the hierarchy.

### 5.2 The NT-ISO/IEC Catalogue

The top-level of the hierarchy has been structured into 3 characteristics: *Supplier*, *Costs*, and *Product*. These three characteristics group non-technical quality features required to measure the supplier capacity to address and support the project, the implementation costs and the out-of-the-box quality and effort required to get the component running. These non-technical quality characteristics correspond to the main non-technical aspects often cited in the literature [Kon96][KB00] and we have checked that they really group all the relevant non-technical issues that have appeared in our experiences.

These three top-level characteristics have been further decomposed into 15 subcharacteristics (see table 2). Similarly to non-technical characteristics, some of the subcharacteristics have been identified in the literature (e.g. the *Supplier/Reputation* subcharacteristic which corresponds to the *Vendor Issues/ Vendor Reputation* factor included in [KB00]), whiles other where included in our approach to leverage the hierarchy required to embrace some of the lower-level attributes acknowledged.

| Charact./ Subcharact. | Definition |
|---|---|
| **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 | Capability of the supplier 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. |
| **Cost** | |
| Licensing Schema | Description of the COTS component licensing options. |
| 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** | |
| Stability | Detail of the aspects that stand for the out-of–the-box stability of the product. |
| Ownership | Description of the aspects in relation to the intellectual property rights. |
| Deliverables | Detail of the out-of-the-box and expected post-implementation deliverables. |
| Parameterization and Customization | Description of the initial effort required for the product to operate. |
| Guarantees | Detail of the guarantees provided over the product. |

**Table 2.** NT-ISO/IEC catalogue.

## 5.3 Using the NT-ISO/IEC Catalogue for Selection

As done with the technical part, we propose to extend this catalogue following the 6-step method presented in [FC02, FC03]. In fact, the extension is divided into two (see fig. 1): creating an intermediate, highly-reusable catalogue, and customizing it to a particular experience.

### 5.3.1. The Extended NT-ISO/IEC Catalogue

In [BBC+04] we have shown the possibility of extending the ISO/IEC 9126-1 catalogue with up to 60 new subcharacteristics and attributes that arise virtually always in COTS selection. This *extended ISO/IEC catalogue* makes the selection process more efficient since more quality features are available from the very beginning.

We have used the same idea for the NT-ISO/IEC catalogue obtaining thus the *extended NT-ISO/IEC catalogue* which adds 126 non-technical quality features to the 18 starting ones. As in the technical catalogue case, we have checked that these quality features are applicable to most selection processes.

In the extended NT-ISO/IEC catalogue, some subcharacteristics have been decomposed into others, whenever this was required for structuring or leveraging purposes. This is the case of the *Organizational Structure* subcharacteristic belonging to *Supplier*, which has been decomposed into the *Internal Organization*, *External Organization* and *External Consulting Team* subcharacteristics.

Next, we have refined into non-technical attributes which can be of two kinds: basic attributes, which are objectively measurable quality features (e.g. the *Total Number of Employees* attribute categorized under the *Internal Organization* subcharacteristic); and derived attributes, which require to be additionally decomposed into other attributes (e.g. the *Sales Budget* attribute, categorized under the *Supplier/Positioning and Strength* subcharacteristic, which has been decomposed into the *General Budget*, *Hardware Sales Budget*, *Software Sales Budget* and *Services Sales Budget* attributes among others).

In order to measure the attributes, metrics are required. We have used the general theory of software measurement presented in [FP97][Zus97], and the framework presented in [BBC+04] to clarify their usage in the ISO/IEC 9126 standard, as the conceptual basis to define the metrics for non-technical quality features. Metrics 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 a subjective metrics are required. Some examples of metrics defined in our approach are shown in table 3.

| Non-Technical Attribute | Metric | Example Value |
|---|---|---|
| Time of Product in the Market | Time: Ratio;<br>Time = Float[Years] | 5 years |
| Versions Currently in the Market | Versions: List (<Version: Ordinal, Time: Ratio>);<br>Version = (Unknown),<br>Time = Float[Months] | V1, 15 months<br>V2, 9 months<br>V3, 3 months |
| Own Manufactured Product | Own: Nominal;<br>Own = Label(Yes, Not) | Yes |

**Table 3.** Sample non-technical attribute metrics.

Some quality features depend on others, for instance the *Product Availability* attribute belonging to the *Positioning and Strength* subcharacteristic is influenced by the *Vertical Market Orientation* attribute, categorized under the same subcharacteristic. At its turn, this last attribute constrains the attributes *Services Offered/System Tailoring-Adaptation* and *Parameterization and Customization/Type of Modification Required.* Elaborated types of relationships among quality features and also intensities of these relationships may be built, as done in [CNYM00]. Advices given in [EG04] should be followed for not obtaining too many of these relationships. The relationships found may be depicted by means of a tabular representation as proposed in that work.

Finally it is worth to remark that some non-technical quality attributes are suitable for the evaluation of several non-technical (or in some case technical) quality subcharacteristics, thus overlapping is also supported in the approach. As an example we quote the *Time in Market* attribute of the *Stability* non-technical subcharacteristic which influences the *Maturity* technical subcharacteristic of the original ISO/IEC 9126-1 quality standard. Table 4 presents an excerpt of the resulting catalogue (see [CFQ06] for the complete version).

| | | | |
|---|---|---|---|
| Positioning and Strength | | | |
| | Availability and Orientation | | |
| | | Market Segments | |
| | | Clients for Segment | |
| | Sales Forecast | | |
| | Incomes | | |
| | | Worldwide Incomes | |
| | | National Incomes | |
| | | Incomes Composition | |
| | | | Hardware Incomes |
| | | | Software Incomes |
| | | | Services Incomes |

**Table 4.** An excerpt of the proposed non-technical quality features catalogue.

#### 5.3.2. Customising the Extended NT-ISO/IEC Catalogue

To sum up, selection processes have up to 144 non-technical factors available to start with. From this departing extended NT-ISO/IEC catalogue, more refinement may be needed for customizing to particular experiences. Since the catalogue is very complete, little information will generally be needed. An extension to the piece of catalogue shown above that appears in the case study of section 7 was to add a new attribute for the *Incomes* subcharacteristic to represent the incomes in South America.

## 6. COTS Selection using NT-ISO/IEC-based Catalogues

COTS selection processes in public companies are most frequently driven by call for tenders. In this process, the interested organization issues a wish-list which may take the form of a system requirements document or a summary of the features to be considered, sometimes with weights attached. In this context, writing a call for tenders document to be issued may be time-consuming and cumbersome. Furthermore, the document must be complete enough to ensure that no single important requirement is left out.

On the other hand, the document basically invites potential suppliers to submit answers in relation to the stated needs. Although the answers are usually useful, the information provided is usually difficult to handle; answers are presented in heavy volumes with hundreds of pages, with little structure and several brochures with to general information which is useless in most of the cases. Complexity of writing call for tender documents, and filtering and aligning the obtained information demands systematic approaches.

We propose to use the NT-ISO/IEC for generating the information about non-technical issues. The catalogue is used to create a particular kind of call for tenders document that we call Request For Information forms (RFI). Requirements in a RFI are are stated in the form of constraints over the attributes included in the catalogue (technical and non-technical), using the metrics defined for them (in a similar way that the examples shown in table 3). Also suppliers are asked to handle their answers as values resulting from the application of these metrics. In this way, quality models become a general framework to state requirements over the required domains, and to describe COTS components capabilities in a uniform way [FC02, FC03]. The resulting descriptions are used to support the negotiation process, making easier the identification of mismatches among components characteristics and the stated requirements (see figure 2). The next section details some of the advantages found when managing the process in this way by means of a case study.

## 7. A Case Study

ETAPATELECOM is a private but public-founded telecommunications company, based in Cuenca, Ecuador, established in 2002. Currently, ETAPATELECOM provides internet access and data carrying services in several locations of the country. However, the main purpose for its creation is not to focus on these services, but to develop the strategy and perform the deployment of the services included in the objectives of the concession contract (nationwide, public and domiciliary fixed telephone services).

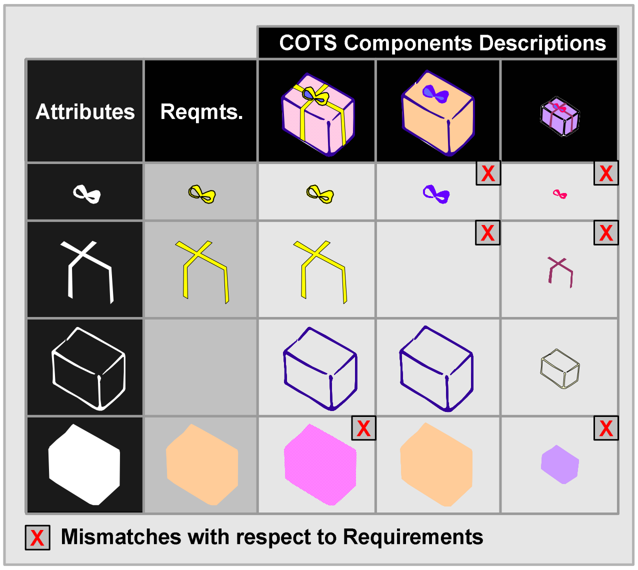


**Figure 2:** Statement of requirements and RFI answers with respect to an attributes catalogue.

To fulfill its deployment strategy ETAPATELECOM has to face the selection and adoption of several technologies, including several COTS components, required for its operation. A selection process for these COTS components was initiated in 2005. The first step was to write an appropriate RFI in order to gather initial information from the potential suppliers. The method described in section 6 was then applied, using the catalogues presented in section 5.

### 7.1 A COTS-based System Architecture for ETAPATELECOM

To identify the required COTS components we used the first two activities of the COSTUME (*COTS-based SysTem qUality Model dEvelopment*) method presented in [CFGQ04]. Using this approach, six COTS components domains were identified to be included in the COTS-based systems architecture projected in ETAPATELCOM (see figure 3): *Mediation* components (required to interact with telephone switching devices, softswitchs, AAA servers or other telecommunications management equipment); a *Telecommunications Billing* component; an *Enterprise Resource Planning* (ERP) component; a *Customer Relationships Management* (CRM) component; a *Balanced Score Card* (BSC) component; and a *Call Center* management component.

Although the original idea was to purchase all of the components, a strategic analysis performed by the senior management resulted in the decision to develop in-house the *Billing* and *CRM* components. These components were considered too business-specific, and the ability to fully tailor them to the very dynamic requirements of this kind of organization (commercial plans and offers, new services, combined services packages, etc.), could give a competitive advantage respect to its competitors.

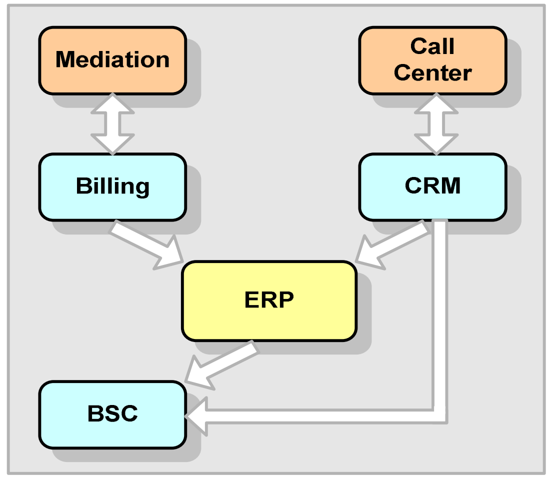


**Figure 3:** COTS-based system architecture proposed for ETAPATELECOM

### 7.2 Issuing the Request for Information

Once the main components of the architecture were identified, the focus of the attention was the project viability. The availability of the required components, the existence of local suppliers with enough experience and capacity to support the required project, the estimated budget and the time schedule, became the major concerns. The issue of RFIs to drive the selection process was a strategic decision.

The use of the NT-ISO/IEC extended catalogue proved to be useful in the practice. When stating requirements the catalogue was easy to handle and requirements were easy to state in relation to the included non-technical attributes. Several situations aroused, most of them in relation to the cases identified in [FC02] [FC03]:

- *Identification of intrinsic requirements:* The existence of the catalogue allowed for the direct statement of requirements over the included attributes. In some way the catalogue acts as a non-technical requirements template, with the advantage that requirements are parametric (given the metrics values), thus can be reused in several processes (e.g. the *National Presence* attribute categorised under the *Support/Support Channel Location* subcharacteristics, can be given the requirement value {yes, Ecuador}, {yes, USA} or any other country depending of the required location where the process takes place).
- *Elimination of abstract requirements:* Because requirements have to be stated in terms of the non-

technical attributes values, there is not room for abstract requirements. For instance let's consider the requirement "Supplier shall be in charge of the implementation", stated prior the use of the catalogue. This requirement was mapped to several non-technical attributes to define the scope of the required service. The metrics of the *Organizational Analysis and Alignment*, *Organizational Change Management* and, *Parametrization and Adaptation* attributes, among others, where set to the YES value in order to constrain the required services.

- *Elimination of incorrectly stated requirements*: Non-technical quality features categorized under the NT ISO/IEC extended catalogue can be used to reformulate incorrectly stated requirements. For instance the cost of a given component was confused with its Total Cost of Ownership (TCO), by people with lack of experience in the adoption of COTS components. A requirement stated as "the cost of the product shall not exceed XXX dollars", was later detailed in terms of the non-technical attributes categorized under the *Licensing Costs*, *Platform Cost*, *Implementation Cost* and *Network Cost* subcharacteristics. Not only that requirements become more refined, but in this way the doors were open to perform a more complete financial analysis in order to obtain a more approximate TCO.
- *Implicit extension of requirements:* With the use of the catalogue and the stated relationships among quality features, requirements can be implicitly extended. For instance, the *Technology Transfer and Training Cost* non-technical attribute, categorised under the *Implementation Cost* subcharacteristic, is in relation to the *Languages and Compilers* non-technical attribute categorised under the *Platform Cost/Development Tools*. Thus in order to grant technological transfer at least a requirement in relation to the number licences of the languages and compilers required has to be stated.

Finally it is worth to remark that requirements stated in the proposed framework, are measurable, thus more precise and easy to evaluate. The next section analyses the implication of this fact in relation to the answers provided by the suppliers.

## 7.3 Obtaining Answers from Suppliers

Eleven COTS suppliers were invited to present answers to the RFIs in relation to four components; 5 answers were presented in relation to the ERP, 3 in relation to the CRM (although the decision to in-house develop this component was already taken, managers wanted to validate this decision gathering information from available components), and 1 in relation to the BSC and the Call Center Management components. Some of the invited suppliers presented RFIs in relation to more than one component.

Once the answers from the suppliers were available, they were placed in a single matrix, to make easier their management and comparison. The resulting matrix of non-technical quality features and supplier answers was the basis to support several activities:

- ***To make easy the identification of mismatches***. The answers included in the matrix were described in a uniform way, using the same metrics. This made easy the identification of differences and mismatches among the different proposals and with respect to the stated requirements (e.g. the size of the organization, the vertical market orientation, the provided services, the type of product ownership, etc.). Evaluators focused only in this reduced set of non-technical quality features, instead of the whole set, prioritizing the concepts that could make a difference among the products, their total cost of ownership or the proficiency of their suppliers to successfully complete the implementation process. A subset of 30 non-technical attributes where mismatches existed was used for this analysis.
- ***To identify potential risks***. The answers to some of the non-technical attributes proved to be useful to identify potential risks (e.g., suppliers with a reduced consulting team addressing several projects at the time, suppliers excessively relaying in third party support and services, suppliers of two competing products at the time, or the lack of participants providing some required services).
- ***To define a prospective budget.*** Cost related attributes include not only licensing fees but costs in relation to the platform (hardware and software), consulting services and development tools, as well as recurring fees. These allowed for the definition of a complete budget and the total cost of ownership at the short, medium and long time.
- ***To propose an initial schedule***. Part of the non-technical quality features in the catalogue are in relation to the methodology to be applied, the estimated number of hours to perform each of the required services and the effort required to get the component running, based on past similar experiences. This allowed the definition of an initial schedule including the main activities to be performed, the estimated time for their conclusion and the resources (people and money) required.
- ***To analyze the viability of the project.*** There can be several problems hampering the viability of the project: Some of the components may not be available in the market; some of them are due to work only in proprietary platforms; some of them are not designed to interoperate with other components; etc. In addition, the adoption of the components may not align with the organizational goals, schedule or budget, making the project not feasible to be conducted in the practice. Although some of the features to perform this analysis are technical ones, some non- technical attributes are also well suited to support

this purpose, not only cost related ones, but also others such as product market orientation, the initial effort required to get the component to work, or even the lack of suppliers providing answers in relation to a particular component.

## 8. Conclusions

In this paper we have presented an approach for dealing with non-technical issues during COTS selection processes. We have articulated the proposal by defining a catalogue with the same layout as proposed in the ISO/IEC 9126-1 standard. We have shown how this catalogue may be effectively used for issuing Requests For Information to help gathering and comparing information about COTS products and suppliers.

The main contributions of our approach are:

- We have proposed a 3-level catalogue of non-technical information. The first level just provides the most abstract non-technical features which remain immutable throughout every single COTS selection process. The second level embraces those features that are considered to appear in most selection processes facilitating identification of applicable features. The third level is devoted to individual selection processes. The size of the catalogues we talk about (e.g. near 150 quality features in the second level) makes our approach particularly appealing. The catalogue has been validated through several industrial cases and literature survey.
- We have aligned technical and non-technical information during COTS selection. We think this is a crucial benefit since both categories can be assimilated: technical and non-technical quality features are diverse but they share some fundamental properties, e.g. they may be organized hierarchically, they may be measured using the same domains and scales, etc.
- We have defined a method that is to be applied in selection processes rules by tendering, in which we exploit the existence of the catalogue. We have shown how this method supports: 1) writing Request For Information (RFI) documents effectively and efficiently; 2) gathering and comparing data for those RFI in a systematic way; 3) managing mismatches, estimating risks, etc.; 4) refining, completing or discarding requirements from the organization.
- We have found that our proposed catalogue is complete enough to be used in very dissimilar experiences. As a matter of fact, all of the quality features included in the NT-ISO/IEC catalogue have been used in the evaluation of the four COTS components required in the case study presented in section 7. Thus the hierarchical decompositions of each of the non-technical subcharacteristics included in the catalogue can be used as attribute patterns, in the evaluation of other COTS components and their suppliers.

It is worth remark two additional observations of our case study. Both are in relation with some concerns about how RFI could work with software engineers in ETAPATELECOM and suppliers. On the one hand, because of the nature of the non-technical quality attributes included in the extended NT-ISO/IEC catalogue, our approach was perceived by the personnel involved in the process as the perfect asset to format the RFIs: it was good to structure the information provided by the suppliers, to unify the answers provide by them, to state requirements in relation to non-technical attributes, and in general to easy the management of the process. On the other hand, contrary to the concerns that some of the members of the internal staff of ETAPATELECOM had, the non-technical quality features catalogue was easily handled by the suppliers, and the metrics were well understood and complete enough to describe the answers provided by them.

Concerning comparison with related work presented in section 3, first of all we do not know of any approach which addresses jointly the definition of a non-technical catalogue and its impact in selection processes. Also, the way we have presented of integrating technical and non-technical issues is not as explicit as ours.

Focusing on the catalogue of non-technical features, the main difference is the number on non-technical quality features 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 feature. Our catalogue is much richer than others we know about; it encompasses near 150 non-technical quality features (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 features.

As a last distinctive issue, in the introduction we have enumerated a series of applications for which non-technical attributes are useful during the COTS components selection and implementation lifecycle. Some of these applications have already been validated in industrial cases, whilst others remain under study to asses their practical applicability.

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