Extending the ISO/IEC 9126-1 Quality Model with Non-Technical Factors for COTS Components Selection

Juan Pablo Carvallo
ETAPATELECOM
Calle Larga y Ave. Huayna Capac, edif. Banco Central del Ecuador, 1ra. Planta alta,
Cuenca, Ecuador
jpcarvallo@etapatelecom.net

Xavier Franch
Dept. LSI - UPC
c/Jordi Girona 1-3
08034 Barcelona (Catalunya, Spain)
+34 9341 37891
franch@lsi.upc.edu

ABSTRACT
The selection of Commercial Off-The-Shelf (COTS) components is currently a central activity in the development of information systems. Criteria for selecting COTS components include both technical and non-technical issues. Whilst many catalogues of technical quality factors exist, it is not the case for non-technical ones. In this paper, we propose an extension of the ISO/IEC 9126-1 catalogue with non-technical factors. The extension is designed to be integrated smoothly in the departing catalogue, therefore we keep the hierarchy-oriented structure and we distinguish the three abstraction levels of the ISO/IEC standard. We provide some evidence of the adequacy of the catalogue by reporting on its use in some recent COTS selection experiences carried out in the context of the ETAPATELECOM company (Ecuador).

Categories and Subject Descriptors
D.2.13 [**Software Engineering**]: Reusable Software.

General Terms
Measurement, Documentation, Standardization.

Keywords
COTS, non-technical factors, quality models, ISO/IEC 9126.

1. INTRODUCTION
Quality assurance is currently an extended practice in many software engineering activities. One of these activities is Commercial Off-The-Shelf (COTS) components selection [Kon96][MN98]. Assessing the quality of the COTS components which are candidates for selection is a crucial issue that has devoted the attention of both practitioners and researchers.

One of the approaches that have been used to analyse the quality of components is the definition of quality models [ISO01] for representing the factors that impact on this quality, such as performance, integrity and interoperability. Following this idea, a catalogue of quality factors is defined, either from the scratch or by refinement of a predefined one, and then the different COTS candidates are evaluated with respect to this catalogue. Some examples of this process may be found in the literature [BB03][Ols99][FC03][PTK04].

Evaluation of candidates from a technical quality point of view is necessary, but in fact experiences in COTS selection show that there is another kind of requirements that must be taken into account and in fact, sometimes are even more important than the others: requirements related to non-technical factors, i.e. related to licensing, supplier characteristics, etc. These requirements are traditionally not integrated with the technical factors and therefore are managed in a different way, usually as an unstructured list. Having technical and non-technical issues separated hampers COTS selection processes since selection-related activities must take into account the different nature of their representation.

In this work, we propose to use a unified framework for describing technical and non-technical factors. We focus on the case of using quality models for describing technical factors, therefore we propose to enlarge quality models to accommodate non-technical factors in a uniform way. We have chosen the ISO/IEC 9126 quality standard, although the main ideas of our proposal could be used for other quality frameworks.

The rest of the paper is structured as follows. In section 2 we provide some background about non-technical requirements used in COTS selection and the ISO/IEC 9126 quality standard. In section 3 we present our proposal which puts together both issues to build an integrated framework. In section 4 we present some empirical results on the use of our framework which serves as a preliminary validation. Finally, in section 5 we mention some related work and in section 6 we provide the conclusions.

2. BACKGROUND
We present the two main streamlines that influence our work.

2.1 Non-technical Requirements
Non-technical requirements are those that do not refer directly to the intrinsic quality of software, but to the context of the system under analysis. They include economic, political and managerial issues. In the case of COTS selection, supplier-related requirements are of great value for discriminating among candidates, as well as non-technical requirements on the components themselves.

To illustrate their importance, we just enumerate here some non-technical requirements that were of highest priority in some of the experiences in which we have participated or had access:

WOSQ'06, May 21, 2006, Shanghai, China.

- In the selection of a mail server system for the public administration, on-line support characteristics were considered as important as performance and security issues.
- In the selection of a workflow system [CFQR04], licensing characteristics were crucial since the selection took place in the context of a University which already had some general agreements with major companies. In fact, this criterion restricted the set of candidates to just two products.
- In the selection of a requirements management tool [CFQ05], the final decision was greatly influenced by the client support characteristics of the candidates. In fact, this was a key factor to select a Spanish product.
- In the selection of the ERP system for a private company, the project budget and, the structure and experience of the supplier's consulting team, were prioritized over technical characteristics of the candidates, restricting once again the number of candidates and their possible providers.

Of course, many non-technical requirements have some implications in software quality, which may be more or less evident. For instance, a requirement on the budget available for I+D is implicitly a requirement on the technical quality of the component: the more money is available for I+D, the more quality is achieved. However, as happens with this example, it is not easy to discern the exact relationship from one requirement to another, and that's why non-technical requirements cannot be removed.

2.2 The ISO/IEC 9126 Quality Standard

The ISO/IEC 9126 software quality standard is one of the most, if not the most, widespread quality standard available in the software engineering community. It proposes quality models as the artefacts that keep track of the quality factors that are of interest in a particular context, i.e. for a software domain of interest. From the 4 parts that compose it, we focus here on the 9216-1 part [ISO01], which presents a catalogue of quality factors.

The ISO/IEC 9126-1 standard fixes 6 top level characteristics: functionality, reliability, usability, efficiency, maintainability and portability. It also fixes their further refinement into 27 subcharacteristics but does not elaborate the quality model below this level, making thus the model flexible. In fact,, under some circumstances, this flexibility may damage its use, but in our experiences in the context of COTS components selection it is a crucial point for tailoring the quality model to the concrete needs that each software domain may have. Subcharacteristics are in turn decomposed into attributes, which represent the properties that the software products belonging to the domain of interest exhibit. Intermediate hierarchies of subcharacteristics and attributes may appear making thus the model highly structured.

When the domain of interest is complex, building ISO/IEC 9126-based quality models may be tough. We have defined elsewhere [FC03] the IQMC methodology for **I**SO/IEC 9126-based **Q**uality **M**odel **C**onstruction.

3. THE EXTENDED ISO/IEC 9126

3.1 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] specially 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 enough, 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.
- Abstraction. The model should maintain a balanced degree of abstraction at each level of the hierarchy.

3.2 The proposal

In our proposal we have arranged non-technical attributes in an ISO/IEC 9126-1 tree-like structure, thus the resulting catalogue includes high-level quality characteristics and subcharacteristics, and also lower-level quality attributes. To build the hierarchy we followed the 6 step method presented in [FC02, FC03].

Charact./ Subcharacteristics	Definition
Supplier	
Organizational structure	Description of the organizational structure of the supplier company.
Positioning and Strength	Description of the position 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	Detail of the costs for the different licensing options
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 cost for network operation.
Product	
Stability	Attributes of the product that bear on the stability of the product.
Ownership	Attributes in relation to the intellectual property rights.
Deliverables	Detail of the out of the box and post-implementation deliverables.
Parameterization / Customization	Attributes in relation to the initial effort required for the product to operate.
Guarantees	Detail of the guarantees provided over the product.

Table 1. Non-technical quality features upper-level hierarchy.

The departing top-level of the hierarchy has been structured with 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][TJS+02]. The three top-level characteristics have been decomposed into 15 subcharacteristics (see table 1). Some of them have been decomposed into other subcharacteristics, whenever they were required for structuring or leveling purposes. This is the case of the *Supplier/Organization Structure* subcharacteristic which has been decomposed into the *Internal Organization*, *External Organization* and *External Consulting Team* subcharacteristics.

Following the construction approach, subcharacteristics have been further decomposed into over 200 non-technical quality attributes. Non-technical quality attributes 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 Structure* 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* basic attributes among other).

In order to measure the attributes, metrics are required. We have used the general theory of software measurement presented in [FP97], and the framework to clarify their usage in the ISO/IEC 9126 standard, presented in [BBC+04], as conceptual basis to define the metrics for non-technical quality features. Metrics can be objective or subjective and 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 2.

Non-Technical Attribute	Metric	Example Value
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[Years]	V1, 1 year V2, 2 Years V3, 1 Year
Own Manufacture Product	Own: Nominal; Own = Label(Yes, Not)	Yes

Table 2. 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 of the same subcharacteristic; this last one constrains the attributes *Services Provided/System Tailoring-Adaptation* and *Facility to Start Operation/Type of Modification Required.* Elaborated types of relationships among quality features and also intensities of these relationships may be built, as done in [CNYM00]. The relationships found may be depicted by means of a tabular representation as proposed in that work.

Finally we remark that some non-technical quality attributes can influence several non-technical (or even technical) quality subcharacteristics, thus hierarchic overlapping is also supported in the approach, by considering the hierarchy as a graph. An example is the *Time in Market* attribute of the *Stability* non-technical subcharacteristic also categorized under the *Maturity* technical subcharacteristic of the original ISO/IEC 9126-1 quality standard.

4. VALIDATION

In the last few years we have conducted several experiences in the field of COTS components selection and evaluation, both academic and industrial. To support all of these experiences we have built and used ISO/IEC 9126-1-based COTS components quality models. Once constructed, quality models became the framework to state requirements over the required domains and to describe COTS components capabilities in a uniform way [FC02, FC03]. The resulting descriptions were used to support the negotiation process, making easier the identification of mismatches among components characteristics and the stated requirements. The first industrial experiences (see table 3 for a summary), helped us to understand the importance that non-technical requirements have in this kind of process and also to structure a catalogue of over 200 non-technical quality features, some of them previously reported in the literature and other emerging from our own experience.

Although some of these non-technical attributes were structured in an ISO/IEC 9126-1-like structure and used to support these first experiences, it is just recently that the complete catalogue has been used in the *Request For Information* (RFI) issued by ETAPATELECOM, a new-entrant telecommunications company based in Ecuador, and in the ongoing selection process of four of the COTS components required to support its operation.

Using the two first activities of the method presented in [CFGQ04], ETAPATELECOM has identified the six components included in the architecture presented in figure 1: *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; *Balanced Score Card* (BSC) component; and a Call Center management component. Although the original idea was to purchase all of the components, an strategic analysis performed by the senior management resulted in the decision to make in-house the Billing and CRM components which are 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.), can make big difference with respect to the competitors.

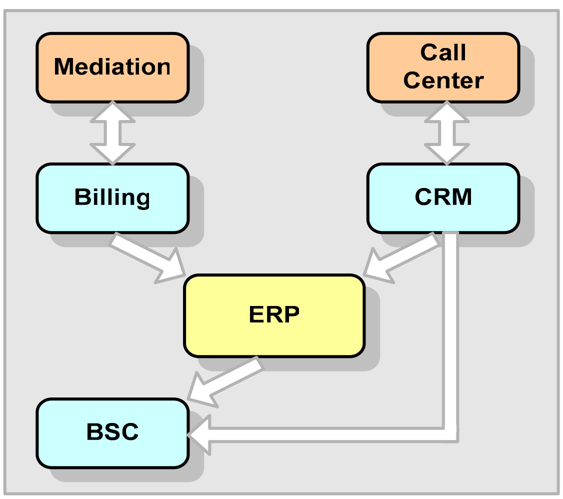

Figure 1: COTS-based sytem architecture proposed for Etapatelecom

Eleven COTS suppliers were invited to present the RFI in relation to these components; 5 answers were presented in relation to the ERP, 3 in relation to the CRM, and 1 in relation to the BSC and the Call Center components. Some of the invited suppliers presented RFIs in relation to more than one component. Although the RFI included the full catalogue of non-technical quality features, in these cases only the areas of the catalogue in relation to the *Cost* and *Product* characteristics were required to be completed for each component. This is due to the fact that the *Supplier* characteristic encompasses non-technical quality features general enough to be reusable for all the components that a particular COTS components supplier can provide.

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.

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 support 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, 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***. It 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-

Domain	No. Cases	Description	Size of QM	Participation	Ref.
Mail Servers	2	**CASE 1:** ► Organization Type: Public - Government ► Expected Users: 50000 Local ► Main Project Budget: N/A ► Objective: Improve internal communication and support to citizens	► 410 QF ► 5 Levels ► 1 QM	► Type of participation: Off-line ► Timing: Post mortem ► Objective: Validation of the process ► Role: Observation	[FC02] [FC03] [CF02]
		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		► Type of participation: On-line ► Timing: Project live ► Objective: Provide evaluation criteria ► Role: Observation	
Requirement Management Tools	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	[CFQ04]
Workflow	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	[CFQR04]
Document Management Tools	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	[CFQR04]
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	NYP
IP Telephony System	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 live ► Objective: Selection of more suitable components ► Role: Decision making	[Car06]

Table 3: Summary of industrial experiences in COTS components selection and evaluation.

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.

In Etapatelecom we are currently working in the construction of quality models for the evaluation of the identified COTS components. They are being built using the method proposed in [FC02, FC03] and enriched in [Carvallo05]. The resulting models will include not only technical quality features, but also the catalogue of non-technical ones introduced in this paper. We expect this catalogue to be useful in several activities at the future:

- During negotiation to provide the basis to set project goals, and to establish responsibility of the parties involved, 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. Also in this stage they can be useful to: check general progress and fulfillment of project targets, the application of the proposed methodology and the accomplishment of the appointed services.
- Finally 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 the services to be offered, licensing and recurring fees, and management and deployment of new versions.

5. RELATED WORK

Other works also address non-technical quality attributes. In [BTV03] authors explore some commercial COTS vendors web pages and identify some non-technical attributes. Also in [TJS+02] authors identify and categorize a set of non-technical attributes. However the aim of these works is different to ours; in the first case the objective is to evaluate the quality of the information provided by COTS suppliers in relation to technical quality features, whilst in the second case the work is intended to provide COTS components categorization criteria. Other facts that make our approach different are the number on non-technical quality features identified and the way in which they have been categorized. Our catalogue is much richer; it encompasses over 200 non-technical quality features 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.

In addition to this, in our approach we have identified 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.

We have also considered the ISO/IEC 12119 standard as possible candidate for our work. However, we found some drawbacks that drove us to prefer the ISO/IEC 9126-1 catalogue: 1) lack of balance in the standard (*user interface* is a clear example); 2) it seems incomplete at some points (e.g., *adaptation to user needs*); 3) there are not metrics in the proposed requirements; 4) not only non-technical but also technical attributes are considered, but all of them are put together without clear differentiation.

6. CONCLUSIONS

Technical and non-technical factors are diverse but they share some fundamental properties. Therefore, it seems natural to treat them uniformly and this has been the goal of this work. We have worked in the context of COTS selection, but the resulting extended ISO/IEC 9126-based quality model could be used for other purposes.

7. ACKNOWLEDGMENTS

This work has been supported by the research project UPIC, TIN2004-07461-C02-01, MCyT, España.

8. REFERENCES

[BB03] L. Beus-Dujic, J. Boegh. "COTS Sofware Quality Evaluation". In *Proceedings 2nd International Conference on COTS-Based Software Systems* (ICCBSS'03), 2003.

[BBC+04] P. Botella, X. Burgués, J.P. Carvallo, X. Franch, G. Grau, J. Marco, C. Quer. "ISO/IEC 9126 in practice: what do we need to know?". *Procs. First Software Measurement European Forum* (SMEF), Roma, January 2004.

[BTV03] M.F. Bertoa, J.M. Troya, A. Vallecillo. "A Survey on the Quality Information Provided by Software Component Vendors". In Proc. of QAOOSE 2003 at 7th ECOOP, July 2003.

[Car05] J.P. Carvallo. *Systematic Construction of Quality Models for COTS-Based Systems*. PhD Thesis, LSI-UPC, Sept. 2005.

[Car06] J.P. Carvallo. "Supporting Organizational Induction and Goals Alignment for COTS Components Selection by Means of *i***". In *Proceedings 5th International Conference on COTS-Based Software Systems* (ICCBSS'06), 2006.

[CFGQ04] J.P. Carvallo, X. Franch, G. Grau, C. Quer. "COSTUME: A Method for Building Quality Models for Composite COTS-based Software Systems". In *Proceedings 4th Intl. Conference on Quality Software* (QSIC'04) 2004.

[CFQ05] J.P. Carvallo, X. Franch, C. Quer. "A Quality Model for Requirements Management Tools". Chapter in *Requirements Engineering for Sociotechnical Systems*, J.L. Maté and A. Silva (ed.), Idea Group, 2005.

[CFQR04] J.P. Carvallo, X. Franch, C. Quer, N. Rodriguez. "A Framework for Selecting Workflow Tools in the Context of Composite Information Systems". In *Proceedings Int. Conf. Database and Expert systems Application* (DEXA'04), 2004.

[CNYM00] L. Chung, B. A. Nixon, E. Yu and J. Mylopoulos. *Non-Functional Requirements in Software Engineering*. Kluwer Aceademic Publishers, 2000.

[FC02] X. Franch, J.P. Carvallo, "A Quality-Model-Based Approach for Describing and Evaluating Software Packages". In *Proceedings 10th IEEE Joint Conference on Requirements Engineering* (RE), 2002.

[FC03] X. Franch, J.P. Carvallo, "Using quality models in software package selection". *IEEE Software*, 20(1), 2003.

[FP97] N.E. Fenton, S.L. Pfleeger. *Software Metrics: A Rigorous and Practical Approach*. 2nd edition, 1997

[ISO94] International Organization for Standarization. *ISO/IEC 12119 Information Technology - Software packages - quality requirements and testing*, 1994.

[ISO01] International Organization for Standarization. *ISO/IEC Standard 9126: Software Engineering – Product Quality, part 1*. 2001.

[Kon96] J. Kontio. "A case study in applying a systematic method for COTS selection". In *Proceedings 18th Interna-tional Conference on Software Engineering* (ICSE'96), 1996.

[MN98] N. Maiden, C. Ncube. "Acquiring Requirements for COTS Selection". *IEEE Software*, 15(2), 1998.

[Ols99] L. Olsina. "Web-site Quality Evaluation Method: a Case Study on Museums". *2nd Workshop on Software Engineering over the Internet* at ICSE'99, 1999.

[PTK04] T. Punter, A. Trendowicz, P. Kaiser. "Evaluating Evolutionary Software Systems", 2004.

[RG94] M.C. Reingruber, W.W. Gregory. *The Data Modeling Handbook. A Best-Practice Approach to Building Quality Data Models*. John Wiley&Sons Inc., 1994.

[TJS+02] M. Torchiano, L. Jaccheri, C.-F. Sørensen and A. I. Wang. "COTS products characterization". In *Proceedings of the 14th International Conference on Software Engineering and Knowledge Engineering* (SEKE'02), 2002.