Supporting CMMI Level 2
SAM PA with
Non-technical Features
Catalogues

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In the last decades, the use of methods and models for the evaluation and continuous improvement of software processes has become a common practice in software development organisations. This is not only due to the fact that software quality is becoming an increasing concern to both practitioners and researchers but also that the software market is becoming gradually more demanding in terms of development constraints, systems evolution and emerging business models. To cope with this reality, the adoption of Software Process Improvement Models such as capability maturity model integration (CMMI) is perceived by many software development organisations as a basic survival principle. However CMMI is not prescriptive; it provides instead a compendium of best practices which should be adopted by organisations usually after the development of several supporting assets. In this article, we propose the use of a unified catalogue of non-technical features to support some of the activities of CMMI level 2, namely the ones in relation to Supplier Agreement Management (SAM). Non-technical features included in the catalogue have been collected from the literature and also from our research and industrial experiences. We illustrate the approach with a software selection process carried out in a telecommunications company. Copyright © 2007 John Wiley & Sons, Ltd.

KEY WORDS: CMMI; COTS; quality models; ISO/IEC 9126

1. INTRODUCTION

Many software process improvement models and standards have been proposed in the last decades e.g. SWEBOK (SWEBOK), ITIL (Office of Government Commerce 2005), ISO/IEC 15504 (International Standards Organization 2003), ISPL (ISPL Consortium 1999), etc. Among them, SEI’s Software Capability Maturity Model (Software Engineering Institute-CMU 1995) rapidly gained wide acceptance in the community.1 SW-CMM is organised

* We assume that the reader is already familiar with some of the software process improvement models cited in this article, particularly CMMI (V1.1).
as a layered structure of capability maturity levels, each of them grouping together a set of software engineering best practices, intended to provide organisations with guidance on how to achieve continuous improvement in software engineering process. Capability maturity model (CMM) also provides a framework for the evaluation of the capacity of a given software organisation to successfully address and achieve the desired quality goals in a particular software engineering project.

However, as new software development paradigms emerged, some of the maturity levels, and their included practices, had to be adapted to support the emerging challenges. As a result, CMM evolved to the more comprehensive capability maturity model integration (CMMI) (Chrissis et al. 2003). An outline of the evolution may be found for instance in (Royce 2002). As an example, let us consider the CMM Level 2 Software Subcontract Management key process area (KPA) which was replaced by the Supplier Agreement Management (SAM) process area (PA) in CMMI. The original KPA of CMM Level 2 was intended to support the selection and management of subcontractors in charge of the development of a portion of the prime contractor’s work. Although the portion of the work was described as ‘system component’, the rationale of the KPA was to deal with the outsourced development of such component as part of the specification of a large system, rather than its acquisition in a packaged commercial form and its later integration into the system. On the other hand, the CMMI SAM PA explicitly addresses the selection of suppliers and Commercial-Off-The-Shelf (COTS) components, and their integration into a COTS-based system (Meyers and Oberndorf 2001), or other forms of hybrid systems (including legacy, COTS or Web-based components).

The SAM PA, as well as other PAs in CMMI, demands a comprehensive analysis of many factors that influence software process quality. Among these factors, non-technical features play a prominent role. For non-technical features, we mean those factors that may be of interest during the software process but are not directly related to the intrinsic quality of the product itself. As examples, we mention cost aspects, licensing, type of support, and others that have an impact on the process activities, such as selection of COTS components and their suppliers, establishment of agreements, etc. These non-technical factors are crucial when considering process improvement.

In spite of their recognised impact, literature review shows that most of the work in the field has focused on the technical aspects of quality, and has payed little attention to the analysis and categorisation of non-technical issues (Kunda 2003). In particular, whilst many catalogues of quality factors exist, starting from the seminal McCall’s McCall et al. (1977), through others like FURPS (Labs 1984) and even with standards like ISO/IEC 9126 (International Organization for Standardization 2001a), • non-technical catalogues are not commonplace. In our experience, since CMMI is not prescriptive, it requires the development of several assets to support software engineering activities, • catalogues being a helpful conceptual tool. Therefore, we claim that the absence of consolidated catalogues of non-technical factors hampers the adoption of several CMMI Level 2 PAs, and remarkably the SAM PA. The aim of this article is to outline such a catalogue and to make its benefits evident in the context of CMMI Level 2, focusing on the SAM PA as representative of all CMMI Level 2 PAs.

The rest of the article is structured as follows. Section 2 provides the necessary (and minimal) background to our work. Section 3 presents the research method. Section 4 analyses the effect that the existence of such a catalogue has in CMMI Level 2. Section 5 discusses a case study and Section 6 gives the conclusions.

2. BACKGROUND

In this section, we provide details about the two main models that we use in this article, namely the CMMI with emphasis on SAM PA, and the ISO/IEC 9126 quality standard, part 1, whose application will become evident hereafter.

2.1. The Supplier Agreement Management Process Area in CMMI Level 2

The CMMI (V1.1) model, in its staged version, is structured into five maturity levels (Chrissis et al. 2003): (i) Initial; (ii) Managed; (iii) Defined; (iv) Quantitatively Managed; and (v) Optimizing. Maturity levels include a set of predefined PAs, each with an assigned set of specific and generic 101 goals. Maturity levels are measured in relation 102
to the level of achievement of the goals of their encompassed PAs. Generic goals are decomposed into common features (commitment to perform, ability to perform, directing implementation and verifying implementation) and generic practices. Figure 1, presents an overview of the CMMI structure.

Software engineering processes in a CMMI Level 1 organisation are usually ad-hoc and chaotic. Because of this, even successful projects are usually over-exceeded in budget and time. Upgrading to CMMI Level 2 means that, the organisation follows a discipline that ensures that existing practices are retained during times of stress. Once these practices are adopted, projects are performed and managed according to documented plans.

In order to achieve CMMI maturity Level 2, an organisation must achieve the specific and generic goals of seven PAs: Requirements Management; Project Planning; Project Monitoring and Control; SAM; Measurement and Analysis; Process and Product Quality Assurance; and Configuration Management. The SAM PA specifically addresses the management of the process of acquisition of products from suppliers, including the purchase of COTS products. Two of them are the specific goals of SAM PA: to Establish Supplier Agreements and to Satisfy Supplier Agreements. Table 1 summarises the practices related to these goals.

Table 1. CMMI Level 2 SAM Practice-to-Goal relationship table

<table>
<thead>
<tr>
<th>Specific goal</th>
<th>Generic practice</th>
</tr>
</thead>
<tbody>
<tr>
<td>SG 1 Establish Supplier Agreements</td>
<td>SP 1.1 Determine Acquisition Type</td>
</tr>
<tr>
<td></td>
<td>SP 1.2 Select Suppliers</td>
</tr>
<tr>
<td></td>
<td>SP 1.3 Establish Supplier Agreements</td>
</tr>
<tr>
<td>SG 2 Satisfy Supplier Agreements</td>
<td>SP 2.1 Review COTS Products</td>
</tr>
<tr>
<td></td>
<td>SP 2.2 Execute the Supplier Agreement</td>
</tr>
<tr>
<td></td>
<td>SP 2.3 Accept the Acquired Product</td>
</tr>
<tr>
<td></td>
<td>SP 2.4 Transition Products</td>
</tr>
</tbody>
</table>

2.2. The ISO/IEC 9126 Standard, Part 1

The ISO/IEC 9126 quality standard (International Organization for Standardization 2001a) promotes the use of quality models as a framework for assessing software quality. An ISO/IEC 9126-compliant quality model is a hierarchy of quality features (Figure 2) which can be of three types: characteristics, subcharacteristics and attributes. Part 1 of the standard fixes the two upper levels of this hierarchy composed of a first level with six characteristics (functionality, reliability, usability, efficiency, maintainability and portability) decomposed into a first level of subcharacteristics (such as security, portability, etc). These subcharacteristics are further decomposed by adding detail to build the quality model. All ISO/IEC 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.

3. RESEARCH METHOD

The research carried out to formulate the proposal has combined literature survey with a lightweight approach of action-research called participatory observation through different industrial experiences. We may divide the research performed into three phases:

Phase I. Detection of the problem. In the period from 2002 to 2007, we participated in seven projects (Carvallo et al. 2006), in which we applied the ISO/IEC-9126-based IQMC method (Franch and Carvallo 2003) to construct quality models for supporting different activities of the development of COTS-based systems that are closely related to SAMPA (evaluation of COTS components and COTS suppliers, requirements elicitation, etc.). In some of these projects, we also helped to define a roadmap and to construct some assets (based on the quality models) to support the activities of organisations aiming to achieve CMMI Level 2 certification. But at the same time, we discovered that non-technical requirements were playing a crucial role in the selection of coarse-grained COTS components and especially in Enterprise Applications such as Enterprise Resource Planning (ERP) systems, Customer Relationships Management (CRM) tools, etc. Since the ISO/IEC 9126 standard does not address these non-technical issues, and neither the practice areas of CMMI Level 2 provide an asset to manage them, we were forced to use different artifacts yielding to some management problems which we thought could be avoided.

Phase II. Formulation of a solution. We carried out a thorough study of the state of the art (see Carvallo et al. 2007b for details) which discovered some other proposals of catalogues that included some non-technical features (Powell et al. 1997, Kunda and Brooks 2000, International Organization for Standardization 2001b, Morisio and Torchiano 2002, Torchiano et al. 2002, Bertoa et al. 2003, Sahay and Gupta 2003, Krystkowiak et al. 2004). We analysed them from the perspectives of separation of concerns, use, domain, structure and clarity, and concluded that none of them fit satisfactorily enough to our needs. We decided to tackle the problem by adopting the hierarchical structure of the ISO/IEC 9126-1 standard for organizing non-technical features. We followed the process shown in Figure 3 and which is described in more detail in Carvallo et al. (2006):

1. We fix first just the characteristics and subcharacteristics to obtain the non-technical extension of...
2. Then, we enrich the NT-ISO/IEC catalogue with some more subcharacteristics and attributes that appear frequently in SAM PA-related issues obtaining thus an intermediate, highly reusable catalogue. We call it the extended NT-ISO/IEC catalogue. It adds up 126 new subcharacteristics, derived attributes and also basic attributes to the NT-ISO/IEC catalogue.

3. Lastly, each particular software development process extends these catalogues by decomposing their features into others, adding new ones, hiding others that are not relevant for the problem at hand, etc. The result is called customised NT-ISO/IEC catalogues. Table 2 shows the NT-ISO/IEC catalogue composed of 3 characteristics and 15 subcharacteristics (note then that the ratio of characteristics–subcharacteristics of first level, remains similar than the one for the technical part).
4. NON-TECHNICAL FEATURES AND THE CMMI LEVEL 2 SAM PA

In Section 2.1, we presented a short introduction to CMMI and CMMI Level 2 PAs. In this section, we focus on the SAM PA because it specifically addresses the acquisition of software products or components, including COTS. This is particularly relevant when considering organisational contexts and processes similar to the one presented in Section 6, which exhibit these characteristics:

- The organisation is intending to build a system with a hybrid architecture, in which several components developed in-house (usually strategic and highly business-specific) have to interoperate with some COTS components (usually core but generic) acquired from external suppliers.
- The organisation is already familiar with CMMI Level 2. At least it has analysed in detail the recommended practices and developed customised CMMI Level 2-compliant procedures and artifacts, in the form of a software quality manual.
- This software quality manual has been integrated into the standards that guide and manage the software engineering process.

Under these conditions, it is quite natural just to extend the Software Quality Manual to include additional assets to support SAM PA.

The generic practices of the SAM PA were listed in Table 1. Except for SP 2.1 which requires COTS components to be evaluated in relation to technical quality features, the remaining practices can be directly supported by the non-technical features included within our extended NT-ISO/IEC catalogue as shown below.

SP 1.1 Determine Acquisition Type: In order to build and deploy a system, its architecture must be engineered. In case of in-house, custom-made software, the architecture is proprietary and in most cases can be somehow defined in a straightforward way. On the other hand, the architecture of hybrid systems requires the analysis of an important amount of information in relation to several external aspects, such as the availability of required components, their acquisition costs and several characteristics of the potential suppliers. Depending on the results of this analysis, engineers have to decide about the viability of the architecture of the solution, the components to be acquired and the type of acquisition required (purchasing of COTS components, renting of on-line software, exploitation of web services, characteristics of the glue code, etc.).

To conduct the required analysis, a significant amount of information has to be obtained. This can be done through a particular kind of call for tenders’ document that we call Request For Information forms (RFI). We propose to use the extended NT-ISO/IEC catalogue as template for this document, in which answers from suppliers are stated as constraints over the attributes included in the catalogue, using the metrics defined for them. In this way information is provided in a very structured way which simplifies its management and thus the decision-making process.

SP 1.2 Select Suppliers: According to CMMI (Chrissis et al. 2003), suppliers have to be selected on the basis of the evaluation of their ability to meet the specified requirements and established criteria. The extended NT-ISO/IEC catalogue provides an extensive set of well-established criteria specifically intended for the evaluation of suppliers (see Table 3 for an excerpt, corresponding to the Supplier’s Organisational Structure subcharacteristic). The criteria includes all the example quality factors listed in the cited CMMI document, and largely extends it with a well-defined structure which includes additional levels of detail and metrics. Here again, it is important to remark that requirements are stated as constraints over the quality features included using the defined metrics. In this way, the catalogue becomes a framework in which supplier’s capabilities can be directly compared among them and with respect to requirements. This makes it easier for the identification of mismatches, and consequently, the selection of suppliers.

SP 1.3 Establish Supplier Agreements: Non-technical features included in the extended NT-ISO/IEC catalogue are also valuable for supporting the negotiation process and to establish contractual constraints and conditions. On the basis of the answers of the selected suppliers, the catalogue can be useful for the following:

- To perform a risk analysis considering several aspects, e.g. the reliability of COTS suppliers and their capacity to address the required project, their past experience, work methods and services, product ownership, etc.
Table 3. Excerpt of the extended NT-ISO/IEC catalogue (as included in the RFI document): Organisational structure subcharacteristic belonging to the supplier characteristic

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Subcharacteristics / Attributes</th>
<th>Supplier 1 answers</th>
<th>Supplier 2 answers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Division</td>
<td>Units in which the organization of the supplier company is divided</td>
<td>Administration, Customer services, Consultancy, Sales</td>
<td>Administration, Development, Implementation, Sales, Customers, Support, Consultancy</td>
</tr>
<tr>
<td>Employees</td>
<td>Number of employees that are currently working for the supplier company</td>
<td>32</td>
<td>30</td>
</tr>
<tr>
<td>Development Team</td>
<td>Number of employees that belong to the development team categorized by outlines</td>
<td>3 Sr. Programmers; 3 Sr. Analysts</td>
<td>4 Jr. Programmers; 2 Sr. Programmers; 3 Functional Implementers; 3 Technical Implementers</td>
</tr>
<tr>
<td>Research Team</td>
<td>Number of employees that belong to the research team categorized by outlines</td>
<td>2 MBA; 1 Commercial Engineer; 3 Software Engineers</td>
<td>2 Software Engineers</td>
</tr>
<tr>
<td>Support Team</td>
<td>Number of employees that belong to the support team categorized by outlines</td>
<td>3 Sr. Programmers; 3 Sr. Analysts</td>
<td>4 Support Engineers</td>
</tr>
</tbody>
</table>

Aspects that describe the relationships of the supplier company with its clients and providers

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Subcharacteristics / Attributes</th>
<th>Supplier 1 answers</th>
<th>Supplier 2 answers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Third Party Services</td>
<td>Development Services</td>
<td>Companies that are used as providers of development services, type of quality controls used and quality guarantees provided by the company</td>
<td>No</td>
</tr>
<tr>
<td>Support Services</td>
<td>Companies that are used as providers of support services, type of quality controls used and quality guarantees provided by the company</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Implementation Services</td>
<td>Companies that are used as providers of implementation services, type of quality controls used and quality guarantees provided by the company</td>
<td>No</td>
<td>Yes</td>
</tr>
</tbody>
</table>

External Consultants

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Subcharacteristics / Attributes</th>
<th>Supplier 1 answers</th>
<th>Supplier 2 answers</th>
</tr>
</thead>
<tbody>
<tr>
<td>External Consultants Organization</td>
<td>Does the company has a dedicated team of external consultants</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>External Consultants Team Composition</td>
<td>Number of employees that belong to the external consultants team categorized by outlines</td>
<td>Not applicable</td>
<td>Variable according to the project</td>
</tr>
</tbody>
</table>

- To establish project budget based on product costs, licensing schemas and services to be provided.
- To estimate the effort required for COTS components, adoption and integration.
- To set the project scope, milestones and deliverables.
- To establish responsibility of the parties, including work loads, resources and facilities to be provided and the structure of the implementation team.
- To establish the methodology and standards to be used in the project.
- To state contractual conditions such as the services and the warranties to be provided, the ownership of final work products, and the detailed costs.

SP 2.2 Execute the Supplier Agreement: If the supplier’s contract has been issued on the basis of the answers provided by the suppliers or even better, if the template provided by the extended NT-ISO/IEC catalogue is a constitutive part of the agreed contract, it can be useful during project development to clarify eventual disputes. In this stage, non-technical features can be useful for several monitorisation tasks, e.g. general progress and fulfillment of project milestones, the application of the proposed methodology, the accomplishment of the appointed services and the actual state of the potential risks.

SP 2.3 Accept the Acquired Product: Finally at project wrap-up, the non-technical quality features included in the extended NT-ISO/IEC catalogue can be useful not only to measure the degree of accomplishment of non-technical commitments associated with the acquired work product but also as the basis for negotiating the future relationship with suppliers, including the services to be offered, licensing and recurring fees, and management and deployment of new versions.

SP 2.4 Transition Products: Transitioning the final work products from suppliers to the project is
probably one of the most critical practices to be performed in the SAM PA. Among other issues it requires the project team to be properly trained, the facilities for deployment, management, and evolution to be provided and all the conditions in the supplier agreement to be fulfilled. Here again, a set of non-technical attributes in the extended NT-ISO/IEC catalogue comes on handy to support the transition. For instance, warranties in relation to technological transfer, future support and compatibility with new versions are critical in granting the autonomous maintenance and evolution of the work products, without critical dependence of suppliers.

5. A CASE STUDY

ETAPATELECOM is a private but public-founded telecommunications company, based in Cuenca, Ecuador, established in 2002. Currently, ETAPATELECOM provides internet access, data carrying and, public and domiciliary fixed telephone services in several locations of the country.

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 and is still ongoing as its nationwide platform is being deployed.

5.1. A COTS-based System Architecture for ETAPATELECOM

In a preliminary effort to identify the software work products required in ETAPATELECOM, we used the first two activities of the COTS-based System Quality Model dEvelopment (COSTUME) method presented in Carvallo et al. (2004). Using this approach, six different software domains were identified in the preliminary hybrid architecture: Mediation components (required to interact with telephone switching devices, softswitchs, AAA servers or other telecommunications management equipment); a Telecommunications Billing component; an ERP component; a CRM component; a Balanced Score Card (BSC) component; and a Call Center management component.

5.2. Determine Acquisition Type

Given a preliminary architecture, detailed analysis has to be performed in order to determine the acquisition type of the required work products, and implicitly the viability of the proposed solution. In the ETAPATELECOM case, there were at least two options for the acquisition type: to acquire them from an in-house vendor (the informatics department software development team), or to acquire them from external vendors in the form of COTS components. Particularly in the last case, 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 may be due to work only in proprietary platforms; some of them may not be designed to interoperate with other components, etc. In addition, this type of acquisition may not align with the organisational goals, schedule or budget, making the project unfeasible in practice.

In order to support this analysis, ETAPATELECOM issued an RFI form structure as proposed in SPI1.1 (Section 5). Although the original idea was to purchase all of the components, a strategic risk analysis performed by the senior management over supplier answers resulted in the decision to develop in-house some of them, namely the Billing and Mediation components, as well as part of the CRM functionality. These components were considered too business-specific, and the ability to fully tailor them to the very dynamic requirements of this kind of organisation (commercial plans and offers, new services, combined services packages, etc.), could give to the company a competitive advantage. The values of several non-technical quality factors included in the extended NT-ISO/IEC catalogue influenced this decision. For instance:

- The lack of companies in the country that specialised in the provision of telecommunications billing components was considered a serious threat. Billing is a key component in today’s telecom companies. The provision of new services in this very dynamic and creative market depends greatly on the evolution of this system to include new features. This requires continuous analysis and coordination, e.g. among the marketing department and the COTS suppliers. Distance and lack of knowledge of the local real- ity are therefore considered as prominent risk factors.
The continuous evolution of telecommunication hardware devices and protocols requires the continuous development of new interfaces among them, and several software components. As an example, we can mention the automatic management of service provisioning; services are activated and deactivated from the billing system or from the invoicing or accounts recoverable modules of the ERP system, depending on the available credit of the account. The supplier’s response time and the cost of consulting services required for these punctual, but continuous developments are therefore critical aspects to be considered.

The vertical market experience and orientation of the suppliers is another critical aspect. For instance, the potential suppliers of CRM solutions in the country were mainly oriented to pharmaceutical or industrial segments. Service-oriented companies are clearly different with respect to its operation and interaction with customers. Just to mention a couple of specific aspects: the actual state of the provision of a service to a given customer (e.g. installation, repair, transfer to a new location, etc.) and the way in which invoices are presented to them, are very different from other market segments. Therefore, even if there were experienced CRM suppliers in the country, some in-house development was required to adapt its functionality and grant its interoperability with other components of the system.

The decision to purchase other more generic components, e.g. the ERP system, was also based on non-technical features. Costs, warranties, experience of suppliers in similar implementations and the availability of local support, were some of the aspects considered critical for this decision.

### 5.3. Select Suppliers

Eleven COTS suppliers were invited to present answers to the RFI in relation to the required components. Some of them completed the RFI and handled answers in relation to more than one component.

Here again, the use of the extended NT-ISO/IEC catalogue as template, proved to be useful in practice. The catalogue was particularly helpful in not only simplifying the statement of requirements in relation to the non-technical quality features included, but it also helped in the identification of intrinsic requirement, elimination of abstract and incorrectly stated requirements and their implicit extension (see Carvallo et al. 2007b for more details).

Once the answers from the suppliers were available, they were placed alongside the others in a single matrix, to simplify their management and comparison. Columns in the matrix were those non-technical features included in the RFI; see Table 3 for the layout of an excerpt. This is a very direct and simple task since supplier answers were described in a uniform way, using the same template and the included metrics. The resulting matrix was used as a basis for the discussion and support of supplier’s selection activities.

With answers in place, the identification of mismatches among supplier characteristics and with respect to the stated requirements was a straightforward task. Evaluators focused only on the reduced set of non-technical quality features (about 30), where mismatches were identified, 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.

The answers to some of the non-technical features proved to be useful for identifying potential risks, e.g. suppliers with a reduced consulting team addressing several projects at the same time, suppliers of two competing products at the same time, or the lack of participants in providing some required services. More specifically in the case of ETAPATELECOM, one of the participants was ranked with a high level of risk since most of the development effort was to be conducted by third party subcontracted engineers, without providing any means for quality assessment.

### 5.4. Establish and Execute Supplier Agreements

Suppliers’ answers were used to support the negotiation process and the establishment of contractual agreements with selected suppliers. Contractual clauses were defined in detail in relation to most of the aspects mentioned in SP1.3 of Section 5, using again the non-technical catalogue as driver of this process. For instance:

- Cost-related clauses included not only licensing fees but also costs in relation to platform...
(hardware and software), consulting services and development tools, as well as recurring fees. This allowed for the definition of a complete budget and the total cost of ownership at the short, medium and long time.

- Part of the non-technical features in the catalogue are in relation to the methodology to be applied, the estimated number of hours for performing each of the required services and the effort required to get the component running, based on past similar experiences. This allowed the statement of clauses in relation to the schedule including the main activities to be performed, the estimated time for their conclusion and the resources (people and money) required.

- Some attributes were particularly important in identifying the additional components required. This was the case of the RFI issued for the Call Center component which revealed the need for special hardware components required as part of the operational platform. As a consequence, the project budget had to be modified and additional clauses had to be included in relation to: warranties, delivery time, costs and specifications.

Special clauses were included in the agreements to reduce risks associated with the project in relation to some of the non-technical quality attributes in the catalogue, more specifically the ones in relation to warranties of current and future support, compatibility with future versions, full technology transfer, commitment to implementation schedule, continuous operation and correction of potential system errors and bugs, including the affected data.

Now it is important to remark that not all the suppliers felt comfortable with working this way. Some of them decided to withdraw their offers during the negotiation process because they felt that the analysis was too exhaustive and placed too much risk on their side. Detailed definition of schedules, budgets and warranties from the start was against their traditional way of working.

Once agreements with suppliers were reached, their execution was monitored until their conclusion in relation to the defined clauses.

5.5. Acceptance and Transition of the Products

Acceptance of the finished work products required technical specification to be fulfilled, but also the explicit acceptance of non-technical aspects included in the agreement. For instance, warranties in relation to commitment to implementation schedule and technology transfer had to be released, usually after evaluating the training of personal and the satisfaction of final users; future relationship with suppliers had to be stated, including Service Level Agreements (SLA), support channels and the mechanisms for the transition to future versions. Although all of these aspects can be included in the original agreement, in a number of cases some of the clauses will need to be updated at project wrap-up, for instance to relax or endorse originally stated SLAs.

6. CONCLUSIONS

In this article, we have stressed the importance that non-technical issues have in the context of a process area of CMMI Level 2, the SAM area, and how a catalogue organizing these issues into a hierarchy may support the goals of this area. The catalogue is organised following the layout of the ISO/IEC 9126-1 quality standard. We have discussed the applications of the catalogue and shown the application in a real case.

The most important contributions of our approach are as follows:

- We have provided a structured and flexible way of dealing with non-technical issues. Structured, as a result of the use of the hierarchy and the decisions we have made about levels of abstraction, overlapping, etc. Flexible, because of the three-level conception of the catalogue. The first level, NT-ISO/IEC 9126-1, just provides the most abstract non-technical features which remain immutable throughout a particular process. The second level, extended NT-ISO/IEC 9126-1, embraces those features that are considered to appear in most processes facilitating identification of applicable features. The third level, customised NT-ISO/IEC 9126-1, is devoted to complete the particular features that a particular process may have.

- Because of the use of ISO/IEC 9126-1 structure for defining the catalogue, we may say that we have leveraged technical and non-technical issues allowing their uniform and homogêneous treatment. We have mentioned that this is 101 true not just because of the form and structural
CMMI Level 2 SAM PA with Non-Technical Features

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Focusing on the catalogue of non-technical features, the main differences with other approaches are the number on non-technical quality features that we have identified in the extended NT-ISO/IEC catalogue, the way in which they have been organised, and the provision of metrics for evaluating each feature. Our catalogue is much richer than others that we know about; it encompasses 180 non-technical quality features (including most of the ones identified in the reviewed approaches).

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AQ2 Please provide the expansion of “SW-CMM” in this context.

AQ3 Please confirm if the edit is appropriate.

AQ4 Please confirm if the edit retains the sense implied in this context.

AQ5 Please confirm whether the edited text retains the intended meaning.

AQ6 Please clarify if the term “mark of” in this context is correct.

AQ7 Can we change this term “punctual” to “timely” in this context.

AQ8 We have changed “one aside the others” to “alongside the others”.

AQ9 Please provide the place of conference for this reference.

AQ10 Please provide the place of conference for this reference.

AQ11 This reference (Carvallo et al. 2007a) has not been cited in text. Please provide the citation for this reference.

AQ12 Please provide the page range for this reference.

AQ13 Please provide the place of conference for this reference.

AQ14 Please provide the place of conference for this reference.

AQ15 Please provide the place of publication for this reference.

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AQ21 Please provide the place of publication for this reference.

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AQ23 Please provide the publisher’s name and place of publication for this reference.

AQ24 Please provide the page range for this reference.

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AQ27 Please provide the place of conference for this reference.
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