

Adaptation of ISO/IEC 15504 Standard to SMBs Needs. Analysis of Required Roles to Meet Work Product Requirements.

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Summary. An analysis is presented on the possibility of deploying the ISO/IEC 15504 standard in the various SMBs categories defined by the European Union, in particular, on the roles that would be necessary for a company and the roles that each of the SMBs categories can support. Scenarios are provided, defining a set of roles for each category, and the possibility is analyzed of meeting Work Product requirements that are part of the Engineering and Project processes, as well as the attributes of capacity levels 2 and 3.

Keywords: Process Models, SMBs, ISO/IEC 15504, Roles, Work Product.

1 Introduction

Software Engineering has progressed in time with a clear tendency towards the maturity of development processes, with the purpose of considering all tasks related to software development as a process that can be controlled, measured and improved. Process-orientation in software development has achieved great popularity throughout the world through the publication of the already recognized quality standards, currently led by SEI (Software Engineering Institute) and ISO (International Standard Organization).

Software developers know in detail the factors and issues that affect their work, but without a strategy to improve, achieving the visibility of the efforts aimed at improving is difficult. Thus, an improvement plan that can lead the organization towards a continuous improvement is essential [1].

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There are various models that propose different methods for assessing process capacity, different ways of representing the activities needed to improve, and different ways of leading the organization into maturity. However, the application of these models is oriented to large organizations. They do not consider the needs of SMBs, where their application is costly in terms of economy and effort, since a significant, long-term investment of capital, time and resources is required [2].

The objective of this work is to analyze the needs of SMBs that attempt to deploy the ISO/IEC 15504 model as improvement process; in particular, the required roles for meeting the requirements defined by work products. Even though the model does not require a specific assignment of roles to carry out the activities, any organization that is on its way to deploying an improvement process is likely to have a structure that can comply with practices. This structure is directly linked to the size of the organization – in the case of a large development company, there will probably be a range of roles to fulfill the activities requested; but in the case of micro, small and medium businesses, this range of roles is very reduced.

The analysis of role assignment to carry out these activities in different types of organizations and the feasibility of meeting the requirements established for each activity is of interest.

The scope of this work is limited in the case of Capacity Levels, to levels 2 and 3, and in the case of processes, to the areas of Engineering (ENG) and Project (PRO). This limitation is based on the fact that a software development SMBs will certainly have a structure dedicated to project development and management. In Section 2, a brief description of standard ISO/IEC 15504 is included, as well as the economic context in which SMBs work, the impact of software development SMBs, the need to deploy improvement plans, and the complexities they must face. In the next section, the practices proposed by the model are described, together with their corresponding work products as proof of their execution, the assignment of roles within the organization, and the possible adaptations that can be done depending on business structure. Finally, the conclusions of the analysis carried out are presented.

2 ISO/IEC 15504 and SMBs

2.1 ISO/IEC 15504

The ISO/IEC 15504 standard defines a framework for process assessment and improvement that can be used by organizations to plan, manage, monitor, control, and improve software acquisition, development and operation, assessment, and support [3].

This process assessment framework is based on the evaluation of one instance of a specific process on which information can be collected. Each process instance is characterized by a set of maturity level valuations. Practice valuation is an assessment of the level of compliance of the practice with the roles defined by the standard [4].

The standard defines, in an abstract way, the fundamental activities that are essential for the “good practice” of software engineering. These activities are grouped

into processes, and processes are distributed in five categories: **Customer-Supplier** (CUS), **Engineering** (ENG), **Project** (PRO), **Support** (SUP), **Organization** (ORG). Each process in the model is described in terms of the base practices; these tasks or activities characterize the execution of a process. Activities carried out will be reflected through work products.

The evolution of process capacity is expressed in terms of maturity levels. Each level provides a significant improvement to the performance capacity of the process, compared to the previous level. The model has six levels: **0 - Incomplete**, **1 - Performed**, **2 - Managed**, **3 - Established**, **4 - Predictable**, **5 - Optimizing**.

2.2 SMBs

SMBs (Small and Medium Businesses) is a set of businesses whose dimensions are limited regarding number of employees and business volume. These restrictions are imposed by the State or the Region where these businesses operate. SMBs have an important role in the economy of every country, since they generate a high percentage of jobs.

The greatest advantage of a SMB is its ability to quickly change its production structure if market needs vary. On the flip side, due to their higher risk, it is harder for them to find financing at a suitable cost and term, and it is complicated for them to access international markets [5].

Since the analysis was carried out in collaboration between a University in Argentina and a University in Spain, a decision had to be made in relation to the definition of SMBs that would be used. It was agreed to use that of the European Community [6] because it distinguishes categories based on the number of employees and the amounts invoiced by the businesses (see Table 4), as compared with the Argentinean classification [5] that uses only the amounts invoiced.

		Micro	Small	Medium
Employees		Less than 10	Between 11 and 50	Between 51 and 250
Maximum	Billing	2 Million	10 Million	50 Million
EU (EUR)				
Maximum	Billing	590,000	4,300,000	28,300,000
Argentina (ARS)				

Table 1 SMBs in the EU and Argentina

SMBs have a very significant specific gravity in software development. However, this type of businesses in general does not use any explicit development methodology, and therefore they often suffer delays in their deliveries, exceed their costs, fail to comply with their commitments, etc. Consequently, the application of process improvement models becomes a complex task for this type of businesses.

The application of an improvement model in a SMB carries some problems, such as: high auditing and certification costs, costs in human resources dedicated to the improvement process, changes in work philosophy, etc. In the specific case of the organization of small or micro businesses, the following problems also appear:

excessive documentation of software development and organization processes, planning, organization, and management of key processes areas oriented to large organizations, limited resources, high personnel training costs, lack of guidance on project needs and the development team [7,8].

As a consequence, the economic costs associated with these models can be a serious obstacle for their adoption

3 Analysis Carried Out

As mentioned in the previous section, one of the main obstacles for the deployment of the model in SMBs are the human resources needed to meet all the requirements established by the practices. In order to gain a deeper understanding of these requirements, the work products suggested by the standard as indicators of processes and evidence of their performance were studied in detail [9].

3.1 Work Product

Work Products (WP) are documents that include a set of characteristics that should be reflected on process input and output documentation. These documents help the assessor determine if the information recorded about the process is appropriate. One of the characteristics of these documents is that they help keep a comprehensive control of the person carrying out the practice and recording the corresponding information, but the model makes no reference to the roles that are responsible for performing the task.

The structure presented in the WP standard is informative, since organizations could have the information requested in one or several documents, with different structures, but which, as a whole, meet the characteristics requested for the WP at hand.

WPs are one of the main sources of evidence for the assessment. The full definition of WP, their set of characteristics, and their relation among processes can be found in the annexes to Part 5 of the standard [9].

For this work, of the 109 WPs of the model, those necessary for capacity levels 2 and 3 and the ENG and PRO processes were analyzed.

3.2 Roles in SMBs

Large software organizations organize their employees based on their set of responsibilities, which is called Role. There is no standard definition for role; roles are generally defined by the needs of the businesses. However, there is agreement in software-related business management literature that in large organizations, there are certain responsibilities that must be covered by a specific role. Table 2 shows a role structure for a software development business.

SMBs must cover the same responsibilities, but their composition widely differs from that of software development businesses. The proposed role structure cannot be covered by the employees an SMB has, even considering that one employee may have different, simultaneous roles within the organization if there are no conflicts between his/her responsibilities.

AB	Role
CIO	Chief Information Officer (CIO)
PL	Project Leader
ARCH	Architect
FA	Functional Analyst
TA	Technical Analyst
P	Programmer Analyst
T	Tester Analyst
QA	Quality Assurance Analyst
CA	Configuration Administrator
TEA	Testing Environment Analyst
DBA	Data Base Analyst
OP	Operator
HRM	Human Resources Manager
HDA	Help Desk Analyst

Table 2 Roles of a software development organization

Role	Level 2	Level 3
CIO	9	2
PL	24	23
ARCH	12	3
FA	13	4
TA	4	1
P	1	0
T	4	0
QA	14	5
CA	16	4
TEA	2	0
DBA	1	0
OP	1	0
HRM	4	2
HDA	4	1
Total WP	109	45

Table 3 WPs assigned to each role

In order to see the relationship between roles and WPs, the roles from Table 2 are assigned to the 109 WPs of the standard. The assignment was done based on the definition of the role and the characteristics of the WP. Table 3 shows the results of the distribution and allows identifying the set of WPs for which a role is responsible. For instance, the PL is responsible for 24 WPs in the entire model, 23 WPs corresponding to level 2, and 18 from level 3.

If we try to analyze the deployment of this model in SMBs, being able to meet WP requirements with a very reduced staff is very complicated. Taking the different SMB categories defined in Section 2.2 as a starting point, *micro*, *small* and *medium*, a set of possible scenarios based on these categories are presented.

A *micro* software development business has an internal structure with a maximum of 10 employees. Their composition will be at least a team of *developers*, responsible for all programming-related tasks, decisions on the codification used, support and getting the project to the production stage. It requires some *functional analyst*, responsible for the analysis of requirements, the functional analysis and the analysis of project changes feasibility. A *project leader*, who is in charge of one or more simultaneous projects and who knows how to manage each of them in particular, analyze the possible reutilization of components, manage configuration, and determine the assignment of resources based on the priorities of each project.

Finally, it requires a *business manager*, who must have extensive knowledge both in the business area to ensure the subsistence of the business and also in the technical area to be aware of what the business can and cannot produce from a technical perspective. This business manager will be responsible for ensuring the quality of the product or service provided.

With a structure of up to 50 employees, a *small* business differs from a *micro* business in the incorporation of the role of *configuration management* and the detachment of developers from the responsibilities of production start-up and project leaders from the activities related to configuration management. Also, the vision of an *architect* can be added, detaching the project leader from the reusability analysis and allowing him/her to focus on the goal of leading the management of the project itself.

In a *medium* business, the size of the staff grows considerably, and therefore, it is possible to include roles specifically determined to ensure the quality of the product or service, freeing *project leaders* from the responsibility of managing and controlling metrics and *business management* from the responsibility of managing quality standards and policies. In this type of businesses, the role of the *business manager* is more oriented to the business sector rather than the technical aspects because there is a strong internal structure that supports technical feasibilities.

Table 4 shows a role structure that would be achievable for SMBs

Ab	Role	Micro	Small	Medium
M	Business Management	X	X	X
PL	Project Leader	X	X	X
FA	Functional Analyst	X	X	X
D	Developers	X	X	X
ARCH	Architect		X	X
CA	Configuration Management		X	X
PM	Process and QA Manager			X

Table 4 Role structure based on the type of SMBs

The analysis was carried out with a double-entry matrix or table, with WPs on the vertical axis and, on the upper horizontal axis, first the attributes corresponding to levels 2 and 3, and then the processes from the ENG and PRO categories. At the center of the matrix, required WPs were identified, and then each of them was assigned a role according to the type of business and the relationship between the characteristics of the WP and those of the role.

3.2.1 Analysis by Capacity Levels

Initially, the roles were assigned to the WPs required for levels 2 and 3. The assignment was carried out based on the role structure of the SMB, starting from the

same principle of relationships between the responsibilities of the role and the characteristics of the WP.

Table 5 shows a quantitative analysis of the result of the assignment of roles to the WP carried out for level 2, Managed. As it can be seen, in *micro* and *small* businesses, most of the responsibilities correspond to the *project leader* and *business management*. This agrees with the model, since at this level, it is only corroborated that the practices are planned, controlled and verified as established. In the case of *medium* businesses, responsibilities are more equally distributed.

Role	Level 2			Level 3		
	Micro	Small	Med.	Micro	Small	Med.
Business Management	12	12	6	10	9	1
Project Leader	25	21	15	17	15	11
Functional Analyst	4	4	4	2	0	0
Architect	0	2	2	0	3	3
Developers	4	1	0	0	0	0
Configuration Management	0	5	5	0	2	2
Process and QA Manager	0	0	13	0	0	12
Total	45	45	45	29	29	29

Table 5 Level 2 and 3 WPs assigned to the roles of a SMB

In the case of level 3, Performed, again, in *micro* and *small* businesses the greatest responsibility lies on *business management* and the *project leader*, but in the case of *medium* businesses, it is the *Process and QA Manager* who carries most of the responsibility, which agrees with the purpose of the level of having practices based on well-defined processes.

The assignment of roles in both levels tends to find a balance as the size of the business grows and the business changes categories, mainly removing a work overload from the *project leader* (in a *micro* business, the PL is responsible for 17 WPs and in a *medium* business, for 11 WPs) and *business management*, which are, in the case of *micro* businesses, those leading the organization. Once the business reaches a *medium* size, it deals only with its own management.

3.2.2 Analysis by Process Maturity

The role assignment process was repeated for the ENG and PRO categories, with the same criteria described in the previous section, and the corresponding quantitative analysis was carried out. Table 6 shows the results for the ENG category. It was observed that the load assigned to the role of *developer* remains stable in *micro*, *small* and *medium* businesses. This category is responsible for development activities, the core of a software development business, and must be present from the minimum

structure of any software development business. An overload of the *functional analyst* role can also be observed in the case of *micro* businesses, which becomes more stable in *small* and *medium* business due to the addition of the role of *architect*.

In the case of the PRO category, it can be seen that the most significant changes occur going from the *small* to the *medium* business, due to the addition of the *process and QA manager*.

Role	ENG Category			PRO Category		
	Micro	Small	Med.	Micro	Small	Med.
Business Management	1	1	1	22	22	6
Project Leader	6	2	2	22	21	16
Functional Analyst	12	8	7	9	5	4
Architect	0	3	3	0	4	4
Developers	4	4	4	2	1	0
Configuration Management	0	5	5	0	2	2
Process and QA Manager	0	0	1	0	0	23
Total	23	23	23	55	55	55

Table 6 WPs corresponding to categories ENG and PRO assigned to the roles of a SMB

A difference was observed between the WPs corresponding to the ENG category and those analyzed at capacity levels 2 and 3. This is because the ENG category tries to corroborate that the process was carried out, and Level 2 assumes that the process has already been done and tries to corroborate its management. In the case of the WPs from the PRO category, they matched those of levels 2 and 3 for the most part.

4 Conclusions

In this paper, a description of the ISO/IEC 15504 standard was provided, and the possibility for deployment by capacity levels or process maturity. Both methodologies use work products as one evidence of process completion. An organization that is interested in implementing an improvement process should start by getting records of the information required by these work products, and should focus on those who are responsible for them. Even though the standard does not indicate roles that are responsible for each of the documents, the organization that is interested in the improvement should have a role structure that allows meeting the characteristics of the documents. The structure of roles that are available for the practices depends on the size of the organization.

The deployment of standards such as ISO/IEC 15504 is a significant challenge, particularly as regards its associated costs, mainly in human resources required to meet the practices required by the model. In this sense, the need arises to study how the structure of SMBs responds to the requirements of the model.

Work products were considered, as well as the definition of roles of a standard business that can deploy the ISO/IEC 15504 model. It was found that none of the

variations of SMBs, *micro*, *small* or *medium* business, would be able to support a role structure as that of the standard organization mentioned.

The problem was then thought in the reverse direction – what are the roles and responsibilities that each SMBs category can support?

In answer to that, we have a *micro* businesses which, given its characteristics of software developer, has a team of *developers*, some *functional analysts*, some *project leader* and a *business manager*. In the case of *small* businesses, in addition to the already mentioned roles, there can be some *architect* and someone responsible for *configuration management*; and in the case of *medium* businesses, a group of *process and QA management* is added. Then, roles were assigned to each of the work products, depending on the type of business.

After assigning the roles, first the necessary documents to achieve level 2, Managed, were analyzed. It can be seen that most of the responsibilities of *micro* and *small* businesses correspond to the *project leader* and *business management*. This agrees with the model, since at this level, it is only corroborated that the practices are planned, controlled and verified as established. In the case of medium businesses, responsibilities are more equally distributed.

For level 3, Produced, again in *micro* and *small* businesses the greatest responsibility is with *business management* and the *project leader*, but in the case of *medium* businesses, it is the *process and QA manager* who carries most of the responsibility. This agrees with the goal of the level – carrying out practices based on well-defined processes.

In the case of process analysis, for the ENG category, the transition from *micro* to *small* business is reflected on the roles of *functional analyst* and *project leader* and there are no significant changes when going from *small* to *medium* business. This is because the ENG category describes the specific development and includes the minimum requirements any organization should grant regardless of its size. In the case of the PRO category, as for ENG, the transition from *micro* to *small* business is observed in the role of *functional analyst*; but when going from *small* to *medium* business, there is a significant reduction of the responsibilities of the *project leader*.

Finally, it can be seen that the application of this type of standards to SMBs requires, as a first step, a structure that is capable of carrying out the necessary work to produce evidence of process completion. The load that is generated on the responsibilities of workers in a *micro* business is considerably high. If the business works in an organized way, following defined processes, standardized templates and a limited number of projects, process improvement is achievable with a significant sacrifice. In the case of *small* businesses, since there are more human resources available, other roles can be assigned. Responsibilities are a little better distributed, and the business will be able to manage more projects, although it will also require a significant sacrifice to initiate the improvement process. In the case of *medium* businesses, human resources should not be a problem, since work distribution among roles is balanced.

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