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A CRITICAL REVIEW OF KNOWLEDGE MANAGEMENT IN SOFTWARE PROCESS REFERENCE MODELS

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ABSTRACT

Knowledge Management (KM) is a critical subject for software development organizations. For this reason, the purpose of this article is to provide a critical review on the way that KM is included in several models of reference of software process (SPRM). For this, five SPRM used in the Latin American countries were selected. Then, an analysis of each process of the SPRM was performed in order to identify features related to the KM. Finally, the KM aspects were mapped in relation to the KM schools (Earl) and the KM capacities (Gold et al). The main contribution of the paper is to show some breaches in SPRM content in relation to KM schools and capabilities.

Keywords: Knowledge Management Process, Knowledge Management in Software Engineering, Software Process Reference Models, Software Process Improvement

1. INTRODUCTION

The software development organizations (SDO) have been interested in achieving levels of capability in their processes to obtain organizational maturity. For this reason, researchers and professional organizations in the Software Engineering discipline (SE) have developed an increasing number of Software Process Reference Models (SPRM) and Processes Assessment Models. These models have emerged to provide the necessary elements to implement or assess SDO processes. Most of the SPRM are based on the ISO/IEC 15504 Standard (ISO/IEC, 2004), through which their constitutive elements are established. This means that all models based on this standard have a common structure even though they have been proposed for processes of diverse natures. Moreover, the content of most of SPRM used in the industry covers engineering, management and support processes, whose bases are all the disciplines of SE (Abran, Bourque, Dupuis, & Moore, 2001).

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On the other hand, in the last decade, Knowledge Management (KM) has become one of the management processes within SE. An increasing number of publications have treated this subject from diverse perspectives. A synthesis of the scientific work on KM in SE can be found in the systematic review performed (Bjørnson & Dingsøyr, 2008). In this work, it is found a predominant interest in subjects like codification, storage and recovery of knowledge using information technologies (IT). Subjects like the creation, transfer and application of knowledge, however, have not been treated extensively by the academic community. Furthermore, the authors conclude that the majority of the empirical research works are focused on the KM application in the software process improvement (SPI).

In this line of argument, KM in SPI is, in terms of (Aurum, Daneshgar, & Ward, 2008), an important research subject since the SPI initiatives have KM as their main component. Also, these authors argue that KM is useful in the definition of the software process in the application of a processes approach for SE and in the adaptation of software processes for future uses. However, a detailed review of papers published in the last five years, whose main subject is KM in SPI, led to the conclusion that the predominant approach is the knowledge codification, as it is found in (Alagarsamy, Justus, & Iyakutti, 2007, 2008a, 2008b; Capote, Llantén, Pardo, Gonzalez, & Collazos, 2008; Cruz Mendoza et al., 2009; Ivarsson & Gorschek, 2011; Montoni, Cerdeiral, Zanetti, & Cavalcanti da Rocha, 2008). Besides, there are works that treat the organizational knowledge mapping from the building of knowledge directories, as can be found in (Alagarsamy et al., 2008b; Li, Huang, & Gong, 2008), and in the creation and empowerment of organizational structures to promote the exchange and transfer of knowledge, as it is found in (Basri & O'Connor, 2011; Capote, Llantén, Pardo, & Collazos, 2009; Li et al., 2008; Nielsen & Tjørnehøj, 2010).

In synthesis, research works on KM in SPI have been focused on the application of KM as a technological and management tool in SPI initiatives and projects. Nevertheless, there are no approaches related to KM like a process included in SPI initiatives. For this reason, the purpose of this paper is to present a critical review about how KM has been included as a defined process within several SPRM used in the software industry in Latin America. It is important to say that the SPRM provide the basis for SPI initiatives as they contain the definition of all SE processes that SDO would have to implement and improve in order to achieve better levels of capability in their processes to obtain organizational maturity.

To present the results of the review, this paper was structured in the following way: The second section shows the KM theoretical foundations needed to compare, in accordance with a frame of common ideas, the diverse approaches on KM within the analyzed SPRM. In the third section the methodology used for the review is described. In the fourth section the review results are shown in accordance with selected theoretical foundations. Finally, the conclusions and references used in the preparation of the paper are discussed.

2. THEORETICAL FOUNDATIONS

By considering the recent appearance and the conceptual diversity of the KM field, one way to identify a first perception of what KM means is to address the analysis through approaches and schools of thought. For this reason, seven proposals of classification for the KM approaches were identified, as shown in Table 1. Each one of these proposals was studied in order to select the most suitable to serve the objective of this review.

Authors	Proposed categories
(Sieber & Andreu, 1999)	1) Information perspective 2) Technological perspective 3) Cultural perspective
(McAdam & McCreedy, 1999)	1) Models of categorization of knowledge 2) Intellectual capital models 3) Models of Social Construction of knowledge
(Apostolou & Mentzas, 1999)	1) Approach in knowledge creation 2) Approach in knowledge processes 3) Technological approach 4) Holistic approach
(Alvesson & Kärreman, 2001)	1) KM like spread out libraries 2) KM like community 3) KM like regulatory control 4) KM like action templates
(Takeuchi, 2001)	1) Approach of knowledge measuring 2) Knowledge management approach 3) Knowledge Creation Approach
(Earl, 2001)	1) Technocratic schools 2) Economic schools 3) Behavioral Schools
(Choi & Lee, 2003)	1) Passive style 2) System-oriented style 3) People-oriented style 4) Dynamic style
(Kakabadse & Kakabadse, 2003)	1) Models based on philosophy 2) Cognitive models 3) Network models Models of communities of practice 4) Quantum Models
(Rodríguez Gómez, 2007)	1) Storage, access and transfer approaches 2) Sociocultural approaches 3) Technological approaches
(Barragán Ocaña,, 2009)	1) Philosophical, theoretical and conceptual models 2) Intellectual capital and cognitive models 3) Models of social and work networks 4) Technological and scientific models 5) Holistic models

Table 1 Proposals of classification of the KM approaches

In this sense, the first theoretical referent considered was the taxonomy of KM strategies proposed by (Earl, 2001). The selection of this taxonomy is based on the fact that it was built on a research that included: (1) six case studies in organizations, (2) direct research with twenty chief knowledge officers, (3) a workshop about KM programs in organizations with the network of knowledge managers from the United Kingdom, and (4) the analysis of KM programs published in academic and professional journals.

Furthermore, in relation to the content, it is believed that this taxonomy is the most detailed and, unlike others, the conceptual component is complemented by empirical studies. In addition, it is important to point out that although each school represents a particular purpose or approach, they are not competitive between themselves. On the contrary, in practice, KM programs are composed of strategies and tools from several schools. The identified KM schools are categorized as "technocratic", "economic", and "behavioral."

The technocratic schools are the systems, cartographic and engineering schools. The systems school is focused on the IT tools for codifying and exchanging of knowledge using a knowledge base. The cartographic school is focused on the creation and maintenance of maps or knowledge directories that belong to the organization. The engineering school is focused on the implementation of knowledge processes and flows within the organization.

The economic schools are focused on the exploitation of organizational knowledge like intellectual capital that allows the creation of flows of income for the organization. In this category, Earl identified only the commercial school.

The behavioral schools are focused on the promotion of knowledge creation and exchange, as well as all organizational and personal aspects involved in the use of knowledge as an organizational resource. In this third category, there are three schools: organizational, spatial and strategic schools. The organizational school is focused on the creation of formal and informal networks to exchange knowledge. The spatial school is focused on the design of physical workspaces to promote and improve the exchange of knowledge. The strategic school is focused on the design and implementation of all the organizational strategy taking knowledge as its essence. A summary of Earl's taxonomy is shown in Table 2.

Category	School	Core principle	Basic Ideas
Technocratic	**Systems**	Knowledge Codification of a specific domain	Codification of specialized knowledge in knowledge bases to be used by other specialists or qualified personnel
	Cartographic	People connectivity	Identification and mapping of the organizational knowledge for its promotion and utilization, ensuring that people with knowledge in the organization are accessible by others for consultancy and queries
	Engineering	Flows of knowledge to improve central capabilities of the organization	Supply staff with enough knowledge about their work Processes formalization of provision of contextual knowledge and better practices to the administrative and management staff
Economic	**Commercial**	Marketing of Intellectual or knowledge property	The protection and exploitation of the intellectual or knowledge assets in an organization to produce incomes
Behavioral	**Organizational**	Increase of the connectivity between the workers of knowledge	Use of organizational structures or networks to share knowledge Communities where knowledge is exchanged and shared in a, not common, personal and less structured way
	Spatial	Design of physical spaces to boost the contact and the activity of knowledge	Design and use of spaces to facilitate knowledge exchange Promotion of socialization as a way of knowledge exchange
	Strategic	Become aware about possibilities of value creation by recognizing knowledge as a resource.	Knowledge like an essential dimension of the competitive strategy The company is conceptualized like a business of knowledge The actions of knowledge management are varied and can frame in the other schools

Table 2 Classification of GC schools. (Earl, 2001)

As a complementary perspective to the Earl's approach, the work done by (Gold, Malhotra, & Segars, 2001) was taken. In this proposal, the authors argue that organizations should take advantage of the knowledge they possess and create new knowledge to compete in their markets. To achieve this, organizations must develop two types of KM capabilities: knowledge infrastructure capabilities and knowledge processes capabilities.

Infrastructure capabilities enable maximization of the social capital, defined as "the sum of current and potential embedded resources, available through, and derived from the network of relations that a social unit has (Gold et al., 2001). In a complementary form, process capabilities are dynamic elements that take advantage of infrastructure capabilities to convert knowledge into an active organizational resource. As illustrated in Figure 1, in terms of (Gold et al., 2001), the dimensions of infrastructure and processes reflect an additive capability to release and maintain over time an organizational change program through KM, in order to achieve organizational effectiveness.

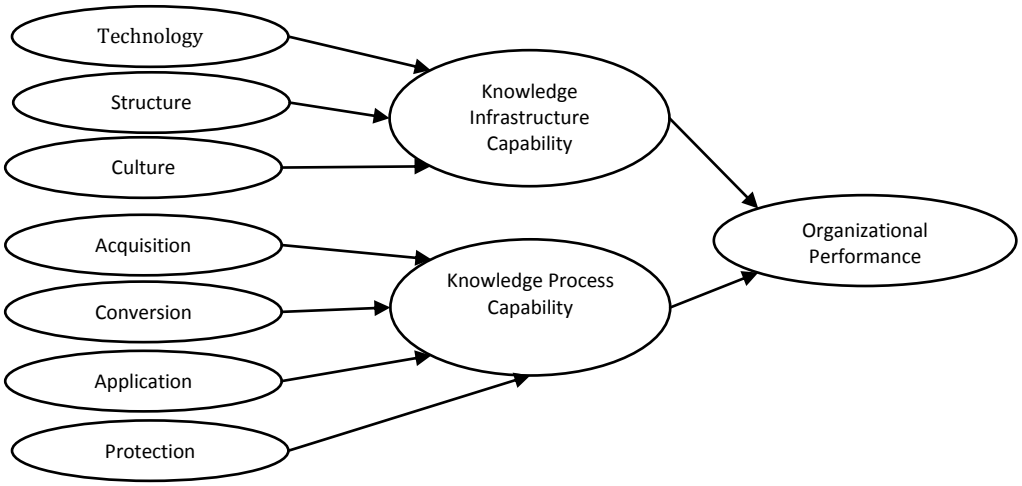

Figure 1 Knowledge Management Capabilities and Organizational Effectiveness. (Gold et al., 2001)

The three infrastructure capabilities are the technology capability, the structure capability and the culture capability. The technology capability addresses tools and means that enable flows of knowledge efficiently. The structure capability focuses on the existence of rules, trust mechanisms and formal organizational structures that encourage the creation and exchange of knowledge between people in the organization. The cultural dimension refers to the presence of shared contexts within the organization.

The four knowledge processes capabilities are knowledge acquisition, knowledge conversion, knowledge application and knowledge protection. The knowledge acquisition process is aimed at the gain of knowledge from various sources both within and outside the organization. The knowledge conversion process focuses on making existing knowledge useful from its encoding, combination, coordination and distribution. The knowledge application process is addressed to the real use of the knowledge in the daily practices of the organization. And the knowledge protection process is designed to define and implement the strategies to protect the organizational knowledge of theft or improper or illegal uses. Table 3 summarizes the KM capabilities proposed by (Gold et al., 2001).

Categories	Capabilities	Main principle
Infrastructure	Technology	The IT systems determine the way in which knowledge is transferred and accessed.
	Structure	The organizational structures, formal and informal, can inhibit or facilitate interaction between people, essential in the KM.
	Culture	The organizational culture must support and enhance the activities of knowledge.
Processes	Acquisition	The location and Acquisition of knowledge or creation of knowledge through the collaboration between individuals and business partners.
	Conversion	Knowledge must be organized and structured in a way that facilitates their distribution and use within the organization.
	Application	Knowledge must be used to adjust the direction, strategy, solve new problems and improve efficiency.
	Protection	Knowledge must be protected from inappropriate use, or unauthorized exploitation.

Table 3 Knowledge Management Capabilities: Infrastructure and Processes

3. METHODOLOGY

The review methodology designed to perform this work consists of three stages. In the first, SPRM (Software Process Reference Models) were selected for analysis in the practice of revision. For this, a set of publications by authors from Latin America over the past decade have been analyzed, whose main subject was the improvement of software processes. The analysis consisted in the identification and quantification of the worked or used SPRM as a foundation in the publications, with the purpose to select the five more worked SPRM.

In the second stage, the processes related to KM were identified in each of the SPRM included in the review. Here, the specification of each process was studied, in other words, the statement of the purpose and expected outcomes of the process. With this analysis, a subset of processes were selected which have related aspects with KM.

In the third stage, the processes identified in the second stage were analyzed in relation to the KM schools (Earl, 2001) and the KM capabilities (Gold et al., 2001). In this sense, each of the identified aspects was located in schools and corresponding capabilities. Table 4 describes each one of the steps of the methodology used in this study.

Stage	Name	Objective	Activities
1	**Selection of SPRM**	Select a set of SPRM used in Colombian and Latin American contexts.	• The search of papers on the improvement of software processes, published in the last decade, with origins in any of the countries of Latin America using SCOPUS and ISI Web of Knowledge. • Identification of the SPRM in the article, based on the reading of the metadata of the publication. • Data analysis to identify and select the most mentioned SPRM in academic publications. • The search of primary documents, with the description of the processes involved in each selected SPRM.
2	**Identification of processes**	Identify the processes, defined within the selected SPRM, that contained aspects related with the KM.	• Extraction of the description of the purpose and the results of each process in a database. • The search and record of key statements related to KM in the description of the purpose of the process. • The search and record of key statements related to KM in the description of the expected results of the process. • Selection of processes identified with relative aspects of KM.
3	**Mapping of processes**	Relate the relative aspects of the KM, from the processes identified in step two, with the schools of KM and the organizational capabilities of KM.	• Location of each key statement identified in step two in the corresponding KM school. • Development of mapping of the processes against KM schools. • Location of each key statement identified in step two in the corresponding KM capabilities. Development of mapping of the processes against the capabilities of KM. Summary and discussion of the obtained results.

Table 4 Stages of the methodology

4. RESULTS

By following the steps of the methodology, the main results were: 1) the selection of five SPRM, 2) the identification of 19 processes related to the KM in the SPRM, and 3) the mapping of the 19 processes in relation to KM schools and the KM capabilities. In the following three subsections the results of each stage are described in detail.

1. Selection of SPRM

The selection of SPRM began with the definition of the search equations used in the ISI Web of Knowledge and SCOPUS databases. These equations are composed of phrases in English about improvement, capability and maturity of processes of software engineering. Table 5 shows the search equations and the results obtained from 2001 to 2012.

Source	Search Equations	Results
ISI Web of Knowledge	(TS=(((("software process" OR "software engineering") AND ("improvement" OR "capability" OR "maturity" OR "reference model")) OR "ISO/IEC 15504")) AND (CU=("Argentina" OR "Bolivia" OR "Brazil" OR "Chile" OR "Colombia" OR "Costa Rica" OR "Ecuador" OR "El Salvador" OR "Guatemala" OR "Honduras" OR "Mexico" OR "Nicaragua" OR "Panama" OR "Paraguay" OR "Peru" OR "Portugal" OR "Spain" OR "Trinidad and Tobago" OR "Uruguay" OR "Venezuela"))	65
SCOPUS	TITLE-ABS-KEY((("software process" OR "software engineering") AND ("improvement" OR "capability" OR "maturity" OR "reference model")) OR "ISO/IEC 15504") AND (AFFILCOUNTRY("Argentina" OR "Bolivia" OR "Brazil" OR "Chile" OR "Colombia" OR "Costa Rica" OR "Ecuador" OR "El Salvador" OR "Guatemala" OR "Honduras" OR "Mexico" OR "Nicaragua" OR "Panama" OR "Paraguay" OR "Peru" OR "Portugal" OR "Spain" OR "Trinidad and Tobago" OR "Uruguay" OR "Venezuela"))	450

Table 5 Search Equations

By eliminating duplicates, 424 items were obtained. Subsequently, on a first reading to exclude unrelated thematic articles a set of 124 articles to execute the data extraction were obtained as a result. The data extraction focused on classifying the articles according to the referenced SPRM in the content as part of the theoretical foundation or as methodological sustenance. The result of the classification is shown in Figure 2.

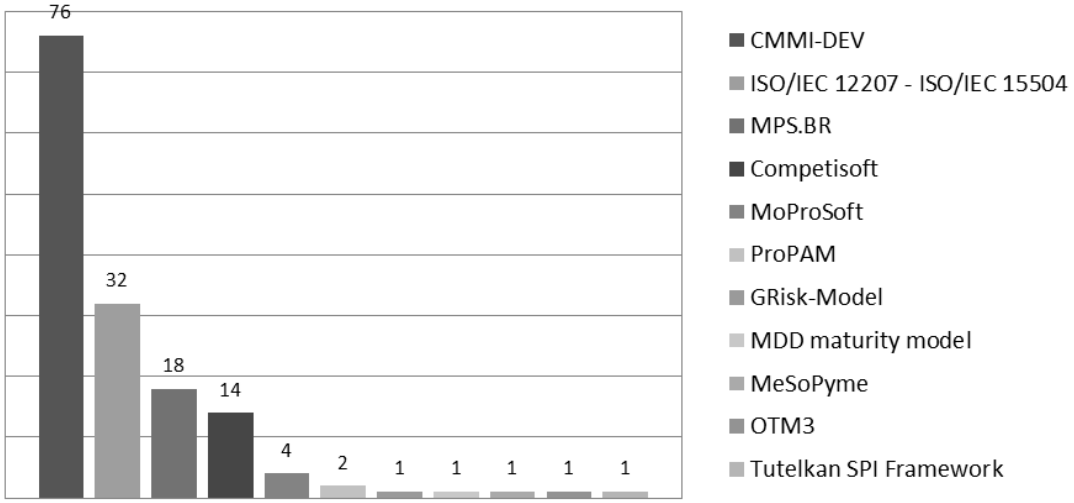

Figure 2 Identification of the SPRM in the Analyzed Articles

After the analysis, the first result was the selection of five SPRM: 1) the international standard, ISO / IEC 12207, 2) the Brazilian SPRM called MPS.BR by the acronym from the Portuguese expression " Melhoria de Processo do Software Brasileiro " or Improvement of Processes of the Brazilian Software, 4) The Process Model of the Mexican Software Industry (MoProSoft) and 5) the process model defined as part of the Process Improvement Program to Enhance the Competitiveness of Small and Medium Software Industry in Latin America - COMPETISOFT. Table 6 describes the selected SPRM.

SPRM	Year	Institution	Country	Processes	Used References
CMMI-DEV	2011	Software Engineering Institute	United States	22	(CMMI Product Team, 2010) (Chrissis, Konrad, & Shrum, 2011) (SCAMPI Upgrade Team, 2011)
ISO/IEC 12207	2008	International Organization for Standardization	International	43	(Pino, García, Ruiz, & Piattini, 2005); (Pino, Garcia, Ruiz, & Piattini, 2006); (ISO/IEC, 2006); (ISO/IEC, 2008); (Baldassarre, Piattini, Pino, & Visaggio, 2009);
MPS.BR	2011	Asociación para la Promoción de la Excelencia del Software Brasilero	Brazil	19	(Weber et al., 2005) (Santos et al., 2010) (SOFTEX, 2011a) (SOFTEX, 2011b)
Competisoft	2008	COMPETISOFT Project	Latin America	9	(Oktaba et al., 2007) (Competisoft, 2008a) (Competisoft, 2008b) (Oktaba, 2009) (Aguirre, Pardo Calvache, Mejía, & Pino, 2010)
MoProSoft	2005	Asociación Mexicana para la Calidad en Ingeniería de Software - AMCIS	Mexico	8	(Oktaba et al., 2005a) (Oktaba et al., 2005b) (Oktaba et al., 2006) (Oktaba, 2006)

Table 6 Description of the selected SPRM

2. Identification of related processes with KM in the SPRM

The process analysis to identify those that contain aspects related to KM resulted in a set of 19 processes out of 101 processes from the five selected SPRM. Table 7 shows the identified processes in each SPRM.

Model	Related processes to the KM
ISO 12207	Management of the Software Configuration. Process of Resolution of Software problems. Management of the Cycle of Life model. Management of Human Resources. Management of Reuse of Assets. Domain Engineering.
CMMI-DEV	Management of the Configuration. Definition of the Organizational Process. Organizational training.
MPS.BR	Management of the Configuration. Definition of the Organizational Process. Management of Human Resources. Development for the Reutilization.
MoProSoft	Management of the Process. Management of Human Resources and of the Work Environment. Organizational Knowledge.
Competisoft	Management of the Process. Management of Human Resources and of the Work Environment. Organizational Knowledge.

Table 7 Processes that contain KM aspects

3. Mapping of processes in relation to km schools and capabilities

In relation to the analysis of the SPRM regarding the KM schools it was discovered that most of the identified aspects are related to the school system. In other words, the dominant approach is the encoding of knowledge. In fact, although in several SPRM there is an explicit reference to the KM (MoProSoft, Competisof), the scope of this process is limited to manage a repository of organizational knowledge. The contents of this repository of knowledge are, primarily, best practices, records of learned lessons, knowledge artifacts resulting from activities of software construction, and knowledge regarding the definition of the processes of the organization. Added to this, the ISO / IEC 12207, CMMI-DEV and MPS.BR models include the concept of repository of the organizational knowledge within the management processes of configuration and definition of the organizational process.

Also, all SPRM include aspects related to the engineering school. In particular, this school is materialized in the form of training activities and the provision of qualified personnel to carry out the activities of knowledge. These proposals become part of the processes of human resource management. Table 8 shows the relationships between the processes of the selected SPRM and KM schools.

Model	Related Processes to KM	KM Schools						
		Systems	Cartographic	Engineering	Commercial	Organizational	Spatial	Strategic
ISO 12207	Management of the Configuration.	X	-	-	-	-	-	-
	Resolution of Software problems	X	-	-	-	-	-	-
	Management of the Cycle of Life model	-	-	X	-	-	-	-
	Management of Human Resources	X	-	X	-	-	-	-
	Management of Reuse of Assets	X	-	-	-	-	-	-
	Domain Engineering	X	-	-	-	-	-	-
CMMI-DEV	Management of the Configuration	X	-	-	-	-	-	-
	Definition of the Organizational Process.	X	-	-	-	-	-	-
	Organizational training.	-	-	X	-	-	-	-
MPS.BR	Management of the Configuration.	X	-	-	-	-	-	-
	Definition of the Organizational Process.	X	-	-	-	-	-	-
	Management of Human Resources.	-	-	X	-	-	-	-
	Development for the Reutilization.	X	-	-	-	-	-	-
MoProSoft	Management of the Process.	X	-	-	-	-	-	-
	Management of Human Resources and of the Work Environment.	-	-	X	-	-	-	-
	Organizational Knowledge.	X	-	-	-	-	-	-
Competisoft	Management of the Process.	X	-	-	-	-	-	-
	Management of Human Resources and of the Work Environment.	-	-	X	-	-	-	-
	Organizational Knowledge	X	-	-	-	-	-	-

Table 8 Relationship between the SPRM processes and KM schools

The analysis of the SPRM regarding the organizational KM capabilities resulted in the fact that most of the aspects of KM identified in the processes are related to the technological infrastructure capability and the knowledge conversion process capability. This is coherent with the emphasis on the systems school. In addition, another important element is that all SPRM have, at least, a process concerning the design and implementation of an organizational structure with a processes approach. Also, the knowledge acquisition and application processes are explicitly covered within the models. The relationship between the SPRM processes and KM capabilities is shown in Table 9.

Model	Related Processes to KM	KM Capabilities						
		Technology	Culture	Structure	Acquisition	Conversion	Application	Protection
ISO 12207	Management of the Configuration.	X	-	-	-	X	-	-
	Resolution of Software problems	X	-	-	-	X	-	-
	Management of the Cycle of Life model	-	-	X	X	-	-	-
	Management of Human Resources	-	-	-	X	-	-	-
	Management of Reuse of Assets	X	-	-	-	X	X	-
	Domain Engineering	X	-	-	X	X	-	-
CMMI-DEV	Management of the Configuration	X	-	-	-	X	-	-
	Definition of the Organizational Process.	X	-	X	-	X	-	-
	Organizational training.	-	-	-	X	-	-	-
MPS.BR	Management of the Configuration.	X	-	-	-	X	-	-
	Definition of the Organizational Process.	X	-	X	-	X	-	-
	Management of Human Resources.	-	-	-	X	-	-	-
	Development for the Reutilization.	X	-	-	-	X	X	-
MoProSoft	Management of the Process.	X	-	X	-	X	-	-
	Management of Human Resources and of the Work Environment.	-	-	-	X	-	-	-
	Organizational Knowledge.	X	-	-	-	X	-	-
Competisoft	Management of the Process.	X	-	X	-	X	-	-
	Management of Human Resources and of the Work Environment.	-	-	-	X	-	-	-
	Organizational Knowledge	X	-	-	-	X	-	-

Table 9 Relationship between the SPRM processes and capabilities of KM

5. CONCLUSIONS

From the perspective of the KM schools, the subjects included in the SPRM are limited to systems and engineering schools. Therefore, any SDO that works on a SPI initiative based on the analyzed SPRM could not include strategies from other KM schools within the certification of their processes. For example, the design of the physical spaces to promote the creation and exchange of knowledge, from the spatial school, is not included in the studied SPRM, although a growing number of companies have been applying it in practice.

In addition, several authors argue that the software industry is a knowledge-intensive industry. Therefore, it is surprising and regrettable that the commercial school's approaches are not explicitly included in the studied SPRM. It s also noteworthy that the approaches of the organizational and strategic schools are not included in the studied SPRM, since these schools have a very close relationship with the principles and practices of the agile methods for software development which have an important influence on the software industry.

Concerning the organizational KM capabilities, the studied SPRM explicitly exclude the culture capability. However, in recent years the scientific literature on design and process improvement, and especially the movement of agile methods, has emphasized the crucial role of the organizational culture for SDO. For this reason, this absence is a gap that must be addressed soon. Moreover, the studied SPRM do not include two process capabilities that are crucial for any organization: knowledge application and protection.

In this order of ideas, the present paper shows that the studied SPRM include within their scope some aspects of KM. This fact reaffirms the importance of KM for SDO, and in particular, the importance of KM in SPI. Mainly, the subjects of interest about KM in the SPRM are: 1) the encoding of knowledge, 2) the use of knowledge repositories, and 3) the organizational training. These topics of interest are located, in terms of (Buono & Poulfelt, 2005), in a first-generation KM. In this type of KM, knowledge is considered as a possession or something that can be captured and stored in repositories of knowledge-based technology. On the contrary, in the second-generation KM, knowledge is considered a complex phenomenon related to socio-cultural, political and technological aspects. For such a reason, a gap is evident in the content of the analyzed SPRM as these do not take into account elements of the second-generation KM.

The previous arguments encourage the formulation of three questions that serve as a source of motivation for future investigations: 1) what KM purposes and results should be incorporated into existing SPRM to have a more complete reference in the design, implementation, evaluation and improvement of processes within SDO? 2) Is it possible to incorporate these KM purposes and results as a new process within the existing SPRM? Or perhaps a reference model of KM processes for SDO is needed? 3) If the resulting reference model of KM processes could be used in an initiative for determining the levels of capability of SDO processes, what should the corresponding evaluation model of KM processes be like? The answers to these questions are highly valued in KM research and may be a significant contribution to the field since they are aligned with KM research trends identified by (Dwivedi, Venkitachalam, Sharif, Al-Karaghouli, & Weerakkody, 2011). They argue that the future research in the KM field requires studies related to the unification of the various KM models that exist today in the literature, and the understanding of the determinants of the evolution of KM in organizations. Also, studies are deemed relevant to the effectiveness of the KM and the necessary organizational and technological support to achieve it.

In summary, this study constitutes an important reference for research and practice as it represents a synthesis of the KM subjects included in the SPRM, and helps SDO to identify the fundamentals and the existing options for implementing KM initiatives. Moreover, this study helps researchers to identify trends and subjects to develop new research projects about the inclusion of the different "varieties" of KM in the SPRM, or to develop a reference model of KM processes for SDO.

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