Information Technology Governance and Service Management:
Frameworks and Adaptations

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Chapter XXI
An Overview of Models and Standards of Processes in the SE, SwE, and IS Disciplines

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ABSTRACT

This chapter develops a descriptive-conceptual overview of the main models and standards of processes formulated in the systems engineering (SE), software engineering (SwE) and information systems (IS) disciplines. Given the myriad of models and standards reported, the convergence suggested for the SE and SwE models and standards and the increasing complexity of the modern information systems, we argue that these ones become relevant in the information systems discipline. Firstly, we report the rationale for having models and standards of processes in SE, SwE and IS. Secondly, we review their main *characteristics. Thirdly, based on the identified aims and principles, we report and posit the concepts of process, system and service as conceptual building blocks for describing such models and standards. Finally, initial theoretical and practical implications for the information systems discipline of such models and standards are discussed, as well as recommendations for further research are suggested.*

… in the current marketplace, there are maturity models, standards, methodologies, and guidelines that can help an organization improve the way it does business. However, most available improvement approaches focus on a specific part of the business and do not take a systemic approach to the problems that most organizations are facing (SEI, 2006, p. 3).

INTRODUCTION

The manufacturing of products and the provision of services in the modern world has increased process engineering (including manufacturing or provision) and process managerial complexity (Boehm & Lane, 2006). The engineering complexity has been raised because of the variety of design, manufacturing or provision process, machines and tools, materials and system-component designs, as well as for the high-quality, cost-efficiency relationships, and value expectations demanded from the competitive worldwide markets. The process managerial complexity has increased because of disparate business internal and external process must be coordinated. To meet the time to market, competitive prices, market sharing, distribution scope and environmental and ethical organizational objectives, among others financial and strategic organizational objectives contribute to increased organizational pressures and organizational complexity (Farr & Buede, 2003).

Such process engineering and/or managerial complexity is manifested in: (1) the critical failures of enterprises information systems implementations (CIO UK, 2007; Ewusi, 1997; Standish Group, 2003), (2) the unexpected appearance of large batches of defective products that have had a proved high-quality image for decades, and (3) the increasing of system downtimes and/or low efficiency and effectiveness in critical services such: electricity, nuclear plants, health services and governmental services (Bar-Yam, 2003).

Organizations with global and large-scale operations have fostered the exchange of the best organizational practices (Arnold & Lawson, 2004). The purpose is to improve business processes and avoid critical failures in the manufacturing of products and provision of services. Best practices have been documented (via a deep redesign, analysis, discussion, evaluation, authorization, and updating of organizational activities) through models and/or standards of process by international organizations for the disciplines of systems engineering (SE), software engineering (SwE) and information systems (IS). Some models and standards come from organizations with a global scope, like the International Organization for Standardization (ISO) but others limit their influences in some countries or regions, like the US-based Software Engineering Institute (SEI). Whilst both types of organizations can differ in their geographic scopes, both keep a similar efficacy purpose: to make available a set of generic process (technical, managerial, support and enterprise) that come from the best international practices to correct and improve their organizational process, with the expected outcome being improved quality, value and cost-efficiency issues with respect to the software products and services generated.

However, because of the myriad of models and standards reported in the three disciplines, the convergence suggested for SE and SwE engineering process, models and/or standards (Boehm 2000; Hecht, 1999; ISO, 2006c; ISO, in press; Sommerville, 1998; Thayer, 1997) and the increasing complexity of the modern information systems (Mora et al, 2008), we argue that these models and standards of processes become relevant in the Information Systems discipline. Then, in this chapter we develop a conceptual description (Glass, Armes & Vessey, 2004; Mora, 2004) of the main models and standards of processes formulated in the SE, SwE and IS disciplines with the general purpose to identify aims, purposes, characteristics, and core building-block concepts. Firstly, we report the rationale for having models and standards of processes in such disciplines. Secondly, we review their main characteristics. Thirdly, based in the identified aims and principles, we report and posit the concepts of ***process***, ***system*** and ***service*** as the conceptual building-blocks for describing such models and standards. Finally, initial theoretical and practical implications for the Information Systems discipline of such models and standards are discussed, as well as recommendations for further research are suggested.

REVIEW ON MODELS AND STANDARDS OF PROCESSES

The Rationale of Models and Standards of Processes

Currently the global and large-scale organizations are faced with the challenge to meet the highest customer's expectations for their products and services, as well as to satisfy their own organizational financial and strategic objectives. To cope with such external and internal complexities, organizations have fostered the utilization (deployment and exchange) of best organizational practices. These global best practices have been documented via models and standards of processes. According to Succi, Valerio, Vernazza, and Succi (1998, p. 140) "*standardization means that there is an explicit or implicit agreement to do certain things in a defined and uniform way*".

Whilst the models are considered as *de facto* standards (not a legal mandatory use) and the standards as *de jure* (legal mandatory use when a country or business sector agrees use it), both help the organizations to improve the quality of their internal processes and to align them with international practices. In this way, the organizations foster an efficient and effective international exchange of goods and services. We consider that an insightful understanding of the models and standards concepts is required for their further analysis. The Table 1 (from several sources: Mora, Gelman, O'Connor, Alvarez & Macías, 2007a; Sheard & Lake, 1998; Tantara, 2001; Wright, 1998) shows the main conceptual attributes of the models and standards of process.

The main similarities between models and standards are the following: (1) both provide a map of generic processes from the best international practices; (2) both establish what-alike and must-be instructions rather than how-alike specific procedures, and (3) both do not impose a mandatory life-cycle but suggest a demonstrative one that is usually taken as a starting point. The implementers must complement such recommendations with detailed procedures and profiles of the deliverables. Regarding to the differences: (1) the models (at least the early reported[2]) have been focused on process improvement efforts (and consequently include a capability maturity level assessment such CMMI) while that the standards, on an overall complaint and not complaint general assessment (e.g., ISO, 1995), (2) models are used under an agreement between companies to legitimate their industrial acceptance (e.g., CMMI in the Americas) while that standards are used under a usually obligatory country-based agreement (e.g., ISO, 2003 in Europe and Australia), and (3) the models can be originated from any

Table 1. Models and standards of processes in SE and SwE

FEATURE	MODELS OF PROCESSES	STANDARDS[1] OF PROCESSES
General aim	To provide a set of best and generic management, engineering and organizational practices for performing high-quality processes (e.g., efficiency and effectiveness) related with SE, SwE and IT practices.	
Main purpose	- To improve processes -To measure the capability maturity level of organizational processes	- To define the processes - To measure compliance or not compliance of processes with the normative processes
	- To provide a generic map of processes	
Definition	"*A process model is a structured collection of practices that describe the characteristics of effective processes.*" (SEI, 2006)	A set of the state-of-the-art practices and their related vocabulary that provides a model to be strictly followed and fulfilled by organizations in order to be certified in its utilization.
Origin	Any organization with resources (knowledge, time, money)	An industry-approval and/or nation-endorsed is required.
Mandatory utilization	No, but some of them are become in *de facto* standards	No, but these are merged with national or industry-based regulations or are directly adopted for being mandatory (*de jure*)
Life-cycle uniqueness	No, these are open to any life cycle (but usually suggest a generic one)	No, but lifecycle reported as example are taken as the best recommended
What vs How recommendations	Both have been designed to provide only what-alike recommendations on what must be done and produced (activities, tasks and deliverables) rather than on the detailed specifications on how doing these (specific procedures, techniques and profiles of deliverables). However, some could provide how-alike guidelines.	

organization while that the standards are strongly endorsed by nations.

It is worth noting that the first standards were product-oriented (Tripp, 1996) (design and final product attributes, tolerances, specifications) and could be objectively assessed through testing and evaluation of the devices using physical instruments. However, the standards for process convey additional difficulties for automatic assessment. Observations, records, interviews, analysis and questionnaires applied to core people in site are required. Furthermore, for the case of the software as a product/artifact, additional complications emerge. While that the standard ISO 9126:1991 offers an initial solution, their set of attributes still requires a final interpretation on how to measure them. Other sources of complexity are the time and the human resource performance variability in the certification of standards of processes.

It has been reported also the critical roles that are played by the information and communications technologies (ICT) and the systems of information systems (SoIS) for supporting practically all business process in worldwide organizations (Mora, Gelman, Frank, Paradice, Cervantes & Forgionne, 2008). This assertion implies that for such organizations, the ICT infrastructure and the SoIS (and IS function), have become an essential resource and macroprocess (e.g., a system of systems of processes) for that the organization operates efficient and effectively. Relevant economic losses from ICT infrastructure downtimes or SoIS failures are present evidences of the high-dependability that worldwide organizations have on the correct availability, capacity, and reliability of such ICT resources and process.

Models and/or standards of processes for engineering and management of ICT and SoIS resources have been also developed. However, such development and deployment have increased the engineering and management complexity per se. To cope holistically with the technical and socio-organizational problems for their efficient and effective engineering and management, this chapter supports the premise[3] that an integrative and holistic approach based in an extended Systems Engineering philosophy and methods (Forsberg & Mooz, 1997; INCOSE, 2004; Sage, 1992, 2000; Sage & Amstrong, 2000) can provide the suitable conceptual lenses and methodological tools to study and cope with the increasing managerial, technical and organizational complexity of the engineering and management (E&M) of ICT and SoIS resources and processes. Overall expected contribution is to increase our understanding and control of such E&M processes.

This chapter then, is motivated by the reasons identified previously by authors (Mora et al., 2007a):

(i) the SE models and standards of processes have been ignored in IT&S or scarcely analyzed in SwE; (ii) the SwE literature has wrongly equaled the concept of software system with the concept of information systems when both constructs are ontologically different (Mora et al., 2003) *and consequently relevant organizational issues have been ignored in SwE models and standards of processes; and (iii) the Systems Engineering field and the Systems Approach philosophy has proved to be very successful in large scale projects when it is correctly applied* (Barker & Verma, 2003; Honour, 2002).

Furthermore, we have identified also (idem) core facts that become relevant the interaction of SE, SwE, and IT standards and models of processes for the IS discipline:

(i) the recognition that the scope and effects of software systems do not end with its completion but with its successful deployment of the whole (information) system (Boehm, 2000; Sommerville, 1998)*; (ii) the acceptance of the software engineering process involves also managerial, organizational, economic, sociopolitical, legal and behavioral issues* (Fuggetta[4], 2000; Kellner, Curtis, deMarco, Kishida, Schulemberg & Tully, 1991)*; (iii) the proposal of the integration of Systems Engineering (SE)[5] with Software Engineering[6] to enhance mutually their engineering and managerial process* (Andriole & Freeman, 1993; Bate, 1998; Boehm, 2000, 2006; Deno & Feeney, 2002; Hecht, 1997; Hole, Verma, Jain, Vitale & Popick, 2005; Johnson, 1996; Johnson & Dindo, 1998; Nichols & Connaughton, 2005; Sommerville, 1998; Thayer, 1997, 2002)*; (iv) the identification that the Information Technology and Systems (IT&S) field, which traditionally has its focus in the management and evaluation of IT-intensive systems, is highly dependent of the engineering activities* (Hevner, March, Park & Ram, 2004; Nunamaker, Chen & Purdin, 1991) *conducted in SwE and SE, and despite this has generated its own set of models and standards of processes, their conceptual relation with SwE and SE models and standards has been few explored, and (v) the proposal to widen the scope of SE standards of processes to define business process architectures in organizations* (Arnold & Lawson, 2004; Farr & Buede, 2003).

History and Aims of the Main SE, SwE and IS Models of Standards of Processes

A generic aim of the SE, IS and SwE is the definition, development and deployment of large-scale cost-effective and trustworthy integrated systems, system of information systems or software-intensive systems respectively (Sage, 1992, 2000; Sage & Amstrong, 2000; Thayer, 1997). In pursuit of this aim, these disciplines have generated models and standards of processes to guide and control the engineering and managerial activities involved in the creation of such systems. The models and standards provide a set of processes for good (or best) SE, SwE and IS practices, but differs in some items exhibited in Table 1. The Table 2 (derived from Collin, 2004; Garcia, 1998; ISO, 2005; ITGI, 2000; Sheard & Lake, 1998; SEI, 2006; Tantara, 2001; Wright, 1998) shows the history of the main models and standards in SE, SwE, and IS.

Table 2. History of models and standards of processes in SE, SwE, and IT

YEAR	STD/ MOD	ORIGIN	SE	SwE	IS
1987, 2000	Std	TC 176/SC 2/WG 18	**ISO 9001:2000 (Standard Base)**		
1995, 2002, 2004	Std	JTC 1/ SC7		**ISO/IEC 12207**	
1999, 2002	Std	EIA	**SECM (EIA-731)**		
1996, 2002	Std	JTC 1/ SC7	**ISO/IEC 15288**		
2003, 2004, 2006	Std	JTC 1/ SC7	**ISO/IEC 15504**		
2004	Std			**ISO/IEC 90003:2004**	
1995, 2001, 2006	Mod	SEI	**CMMI-DEV+IPPD 1.2 (SE,SW,HW)**		**CMMI-SVC[7] 1.2**
1996, 2000, 2006	Std	ISACA			**CobIT[8]**
2005	Std	JTC 1/ SC7			**ISO/IEC 20000[9]**
2006	Std	JTC 1/ SC7	**ISO/IEC 15289**		

The main finding from Table 2 is the lack of models and standards of processes for IS area. Except for the ISO 20000 standard (published in 2006 but based in ITIL v.2.0 model from 1995) and the model CobIT, no significant model or standard of process has been posed[10]. SE and SwE disciplines have developed more standards in the last two decades but both face the challenge of integration toward single standards (e.g., ISO 15289, CMMI for SE and SwE). From the descriptions of the aims of the standards and models of processes in Table 3, we identify two core purposes: (1) the improvement/assessment of processes and (2) the definition/provision of processes.

Mora et al (2007a) report that such standards and models also exhibit a(n):

1. *… rationality to organize the managerial and engineering functions to define, develop and deploy products and services in a generic organization through a process approach;*
2. *… acknowledgement of the increasing interrelationship between software, hardware and general IT-based products, services and/or systems, [that] has fostered the integration of SwE and SE standards and models to address the needs a whole product, service or system to be engineered;*
3. *… emergence of the service-oriented approach in the future (as the forthcoming CMMI-SVC, and the current ISO20000 standard)*
4. *… implicit need for an interdisciplinary body of knowledge and research related to the management and engineering of process from SE, SwE and IT&S disciplines including BPM;*
5. *… implicit utilization of the Systems Approach to establish the initial foundations such as concepts, principles and philosophy, for the design of standards.*

Table 3. Official description and status of models and standards of processes in SE, SwE and IT

STD/MOD	OFFICIAL DESCRIPTION OF THE STANDARD OR MODEL'S AIM	STATUS
ISO 9001:2000	*"Quality management systems – Requirements: ISO 9001:2000 specifies requirements for a quality management system where an organization needs to demonstrate its ability to consistently provide product that meets customer and applicable regulatory requirements, and aims to enhance customer satisfaction through the effective application of the system, including processes for continual improvement of the system and the assurance of conformity to customer and applicable regulatory requirements. All requirements of this International Standard are generic and are intended to be applicable to all organizations, regardless of type, size and product provided" (ISO, 2006a).*	Code ISO 90.92 (International Standard to be revised)
ISO/IEC 12207	*"Information technology – Software life cycle processes: Establishes a system for software life cycle processes with well-defined terminology. Contains processes, activities and tasks that are to be applied during the acquisition of a system that contains software, a stand-alone software product and software services" (ISO, 1995).*	Code ISO 90.92 (International Standard to be revised)
ISO/IEC 15504-1 to 5	*"Information technology – Process assessment: ... ISO/IEC 15504 (all parts) provides a framework for the assessment of processes. This framework can be used by organizations involved in planning, managing, monitoring, controlling and improving the acquisition, supply, development, operation, evolution and support of products and services" (ISO, 2003).*	Code ISO 60.60 (International Standard published)
ISO/IEC 90003	*"Software engineering -- Guidelines for the application of ISO 9001:2000 to computer software: ... ISO/IEC 90003:2004 provides guidance for organizations in the application of ISO 9001:2000 to the acquisition, supply, development, operation and maintenance of computer software and related support services ... identifies the issues which should be addressed and is independent of the technology, life cycle models, development processes, sequence of activities and organizational structure used by an organization" (ISO, 2004a).*	Code ISO 60.60 (International Standard published)
SECM (EIA/IS 731)	*System Engineering Capability Model: "... describes the essential systems engineering and management tasks that an organization must perform to ensure a successful systems engineering effort" (Minnich, 2002); "...(is) a method for assessing and improving the efficiency and effectiveness of systems engineering" (same core idea shared with SECAM former standard, INCOSE, 1996).*	(International Standard published)
ISO/IEC 15288	*"Systems engineering System life cycle processes: ... this standard encompasses the life cycle of man-made systems, spanning the conception of the ideas through to the retirement of the system. It provides the processes for acquiring and supplying system products and services that are configured from one or more of the following types of system components: hardware, software, and human interfaces. This framework also provides for the assessment and improvement of the project life cycle" (ISO, 2002; Magee, 2006).*	Code ISO 90.92 (International Standard to be revised)
ISO/IEC 15289	*"Systems and software engineering -- Content of systems and software life cycle process information products (Documentation): ... ISO/IEC 15289:2006 was developed to assist users of systems and software life cycle processes to manage information items (documents) ... may be applied to any of the activities and tasks of a project, system or software product, or service life cycle. It is not limited by the size, complexity or criticality of the project" (ISO, 2006c).*	Code ISO 60.60 (International Standard published)
CobIT	*"COBIT provides good practices for the management of IT processes in a manageable and logical structure, meeting the multiple needs of enterprise management by bridging the gaps between business risks, technical issues, control needs and performance measurement requirements" (ITGI, 2000).*	(International Model published)

continued on following page

Table 3. continued

ISO/IEC 20000	*"Information technology -- Service management: defines the requirements for a service provider to deliver managed services ... promotes the adoption of an integrated process approach to effectively deliver managed services to meet business and customer requirements. For an organization to function effectively it has to identify and manage numerous linked activities. Coordinated integration and implementation of the service management processes provides the ongoing control, greater efficiency and opportunities for continual improvement" (ISO, 2005).*	Code ISO 60.60 (International Standard published)
CMMI-DEV	*"CMMI® (Capability Maturity Model® Integration) is a process improvement maturity model for the development of products and services. It consists of best practices that address development and maintenance activities that cover the product lifecycle from conception through delivery and maintenance. This latest iteration of the model as represented herein integrates bodies of knowledge that are essential for development and maintenance, but that have been addressed separately in the past, such as software engineering, systems engineering, hardware and design engineering, the engineering "-ilities," and acquisition. The prior designations of CMMI for systems engineering and software engineering (CMMI-SE/SW) are superseded by the title "CMMI for Development" to truly reflect the comprehensive integration of these bodies of knowledge and the application of the model within the organization. CMMI for Development (CMMI-DEV) provides a comprehensive integrated solution for development and maintenance activities applied to products and services" (SEI, 2006).*	(International Model published)

The aforementioned characteristics are based on the fact of the ISO 9000 family of standards (which deal with a generic industry-independent quality management system and an organizational encouragement toward a continuous process improvement) is identified as the main source for the SE, SwE, and IT standards and models of process. Table 3 shows the official self-description and status of these models and standards.

The Core Building-Block Concepts for Understanding Models and Standards of Processes: Process, Service and System

The ISO 9000 standard in its 2000-year version has established eight management principles where two of them (Principle 4 and 5) endorse the ***process approach*** and the ***systems approach*** as critical management paradigms respectively. Principle 4 establishes that an organization will be more likely to achieve the results expected efficiently, if the resources and activities are managed as ***processes***. In turn, the Principle 5 sets forth that an organization can identify, understand and manage more efficiently and effectively the ***processes*** if they conceptualized them as a ***system***. Furthermore, the ISO 9001:2000 standard remarks that "*… concerns the way an organization goes about its work ... concern processes not products—at least not directly*" (ISO, 2006b). However, this standard admits also that, " *… the way in which the organization manage its processes is obviously to affect its final (quality of) product*" (*ibid*).

This ***process management premise*** (e.g., "*the quality of a system is largely governed by the quality of the process used to develop and maintain it*") has been largely used in quality management systems (Paulk, Chrissis, Weber & Perdue, 1987). With these insights, we posit that the concepts of ***process***, ***system*** and ***service*** and their conceptual systemic interrelationships become critical to understanding the different standards and models under study. The relevance of the notion of ***process*** is self-evident. The notion of ***service***, for SwE is becoming of critical relevance for the shifting from the object and component-based paradigm toward the Web service-computing paradigm. In SE and IS, the broad initiative on Service Science, Management and Engineering (SSME) (Chesbrough & Spohrer, 2006; Demirkan & Goul, 2006) justifies its relevance. The notion of ***system*** is justified by the ISO 9000:2000 principles.

In order to describe the relationships between ***process**, **service*** and ***system*** in the context of standards and models of process, we develop the Tables 4, 5 and 6 (updated from Mora et al., 2007a) to report the main definitions from such concepts.

Definitions in the Table 4 show that the concept of ***process*** is not unique. However several attributes are shared in the definitions: (1) an overall purpose (transform inputs in outputs), (2) activities interrelated, and (3) utilization of human and material resources, procedures and methods. Then, a ***process*** –based in all definitions-, can be defined as "an ordered set of processes (called sub-process) and/or activities that are performed by agents (either people and/or mechanisms) exercising roles and using procedures, tools and machines for its realization, to transform a set of inputs in a set of expected outputs" (extended from Mora et al., 2007a).

In the Table 5, the concept of ***service*** is implicitly used for most standards except by those focused on such an issue. Because the most important standards and models of processes for IS (ITIL, CobIT, ISO 20000) and for SwE/SE (CMMI-SVC) are now oriented toward services, a plausible generic definition of what is a ***service*** is fundamental. Similar to the notion of ***process***, there is not unique definition but several attributes are also shared by the definitions: (1) intangible, (2) non-storable, (3) ongoing realization, and (4) people involved for the value appreciation attribute. Whilst the human beings can assess the value scale of nonliving artifacts, the automated processes (by using tools) can assess quality attributes (e.g., agreed physical specifications). Therefore, a ***service*** can be defined as "the intangible, non-storable and user value-appreciated ongoing outcome (but with a start and end time point) from a system of processes" and consequently a **product** can be defined as "the tangible, storable and quality-measured for instruments or users from a system of processes" (extensions from Mora et al., 2007a).

Table 4. Definitions of the concept of process

AREA	DEFINITION OF THE CONCEPT: PROCESS	SOURCE
Quality Management Systems	*"Set of interrelated or interacting activities, which transforms inputs into outputs. These activities require allocation of resources such as people and materials."*	ISO 9001:2000
SwE	*"The means by which people, procedures, methods, equipment, and tools are integrated to produce a desired end result." A process can be also considered the "glue that ties them" in order to get a work done. (Based in CMMI-DEV (SEI, 2006)*	CMM-SW, CMMI-DEV 1.2
SwE	*"... a (software development) process is a collaboration between abstract active entities called roles that perform operations called activities on concrete, tangible entities called artifacts."*	UPM (OMG, 2005)
BPM	*"A Process is an activity performed within a company or organization. In BPMN a Process is depicted as a graph of Flow Objects, which are a set of other activities and the controls that sequence them. The concept of process is intrinsically hierarchical. Processes may be defined at any level from enterprise-wide processes to processes performed by a single person. Low-level processes may be grouped together to achieve a common business goal."*	BPMN (OMG, 2006)
SE	*"A set of inter-related functions and their corresponding inputs and outputs, which are activated and deactivated by their control inputs."*	SysUML (2005)
IS	*"A connected series of actions, activities, changes, etc., performed by agents with the intent of satisfying a purpose or achieving a goal."*	ITIL (2004)

Table 5. Definitions of the concept of service

AREA	DEFINITION OF THE CONCEPT: SERVICE	SOURCE
Quality Management Systems	An explicit definition is not reported.	ISO 9001:2000
SwE	*"a service is a product that is intangible and non-storable."*	CMMI-DEV 1.2
SwE	*An explicit definition is not reported.*	UPM (OMG, 2005)
BPM	*An explicit definition is not reported.*	BPMN (OMG, 2006)
SE	*Missing concept. Instead of it, the concepts of: operation, function, activity and action are reported. In particular, the concept of operation is defined as "A feature which declares a service that can be performed by instances of the classifier of which they are instances."*	SysUML (2005)
IS	*"One or more IT systems which enable a business process."*	ITIL (2004)
SSME	*"Service can be defined as the application of competences for the benefit of another, meaning that service is a kind of action, performance, or promise that's exchanged for value between provider and client. Service is performed in close contact with a client; the more knowledge-intensive and customized the service, the more the service process depends critically on client participation and input, whether by providing labor, property, or information."*	Spohrer et al. (2007)

Hence, the main visible distinctions between ***product*** and ***service*** are: (1) its tangibility property that leads to the quality (e.g., the attributes expected in the product) vs. the value (e.g., the benefits to quality-prices rate perceived from a customers' perspective (e.g., human beings), and (2) the ongoing service experience (Teboul, 2007) vs. the time-discrete (includes also periods) utilization of products. An additional difficult to define the building blocks is the omission of the responsible entity that generates a ***service***. The definitions proposed (because these appear in the standards) are the notions of ***system*** and ***process***. Still, the difference between both concepts has not been still well reported.

For the aforementioned arguments and definitions showed in the Table 6, the construct ***system*** becomes a critical concept to link logically the ***process*** and ***service/product*** constructs. Hence, the utilization of a Systems Approach (Ackoff, 1971, 1973; Bertalanffy, 1972; Checkland, 2000) as well as the relevance of the correct conceptualization of what is a ***system*** can be considered fundamental notions to be untapped. Despite, it could be considered that the concept system is a well defined and understood construct, Gelman and Garcia (1989), Gelman et al. (2005), Mora, Gelman, Cervantes, Mejia, and Weitzenfeld (2003) and Mora, Gelman, Cano, Cervantes, and Forgionne (2006) studies on the formalization of the construct ***system***, have proved the ambiguity, incompleteness and informality of main definitions reported in the context of SE and IS. Then, the concept of ***system*** used in these standards, despite can be considered practically illustrative and useful is theoretically incomplete from a systems science discipline. In Mora et al. (2007a) it is argued that "it has diminished the clarity on the critical role of the Systems Approach as the philosophical and practical source to establish the principles and methods of such standards and has increased consequently the complexity for a mutual understanding and integration. Whilst Process Approaches have been the corner stone for the development and utilization of standards and models of processes, we claim that the Systems Approach is in turn the corner stone that holds to the Process Approach."

Table 6. Definitions of the concept of system

AREA	DEFINITION OF THE CONCEPT: SYSTEM	SOURCE
Quality Management Systems	From the Principle 5 and other arguments reported in available documents, a system can be considered *as a network of interdependent processes connected for achieving expected products and services.*	ISO 9001:2000 (2000)
SwE	An explicit definition is not reported.	CMMI-DEV 1.2
SwE	An explicit definition is not reported.	UPM (2000)
BPM	An explicit definition is not reported.	BPMN (2006)
SE	*"An item, with structure, that exhibits observable properties and behaviors."*	SysUML (2005)
SE	*"An integrated set of elements that accomplish a defined objective. These elements include products (hardware, software, firmware), processes, people, information, techniques, facilities, services, and other support elements."*	INCOSE (2004)
IS	*"An integrated composite that consists of one or more of the processes, hardware, software, facilities and people, that provides a capability to satisfy a stated need or objective."*	ITIL (2004)
SSME	*"… a service system [is] a value-coproduction configuration of people, technology, other internal and external service systems, and shared information (such as language, processes, metrics, prices, policies, and laws). This recursive service system definition highlights the fact that service systems have internal structure (intraentity services) and external structure (interentity services) in which participants coproduce value directly or indirectly with other service systems."*	Spohrer et al. (2007)

However, from a practical worldview and with the purpose to propose a plausible relationship between the three concepts, a ***system*** as an abstract entity, can be defined as "*a whole into a wider system, with unique attributes co-generated by their parts, where the main attribute is its purpose, function or mission*". Given that such a definition is open, a specific definition of a ***system*** abstraction in the context of organizations is required. In particular, the notion of ***organizational system*** is relevant for the context of standards and models of processes. In concordance with system foundations (Gelman & Garcia, 1989; Mora et al., 2006), this concept can be defined as*:* "a whole (the real physical system) into a wider system (the wider real physical system), with unique attributes co-generated by their parts (subsystems and process (that include the parts of every process has)), which the main attribute is its purpose, function or mission (to manufacturing a product or provision a service)". Such a notion is also congruent with the SSME's notion of **service system** (Spohrer et al., 2007).

As illustration, from a high practical worldview perspective, the following eleven conceptual relationships between the core building-block concepts can be posed[11].

- R1: a <S: system> is whole into a wider <SS: system>, with unique <A: attributes: a1,a2,…> co-produced by their (at least two) parts called <sB: subsystems>, where the main attribute is its purpose, function or mission <attribute: a*>.
- R2: a <sB: subsystem> is just a <S: system> that is part of a wider <SS: system>.
- R3: a <C: component> is a constituent of a <sB: subsystem> that is not decomposable in parts (from a modeling viewpoint) but with attributes.
- R4: an <O: organization> is a <S: system> composed of <OsS: organizational sub-systems>.
- R5: an <OsB: organizational sub-system> is a <S: system> composed of <OsB: organizational sub-systems> and/or <BP: business processes>.

- R6: a <BP: business process> is a <S: system> composed of <BsP: business sub-process> and/or <BA: business activities>.
- R7: a <BA: business activity> is a <C: component> with the <A: attributes: a-tasks, a-personnel, a-tools-infrastructure, a-methods-procedures and a-socio-political-mechanisms-structures>
- R8: a <Sv: service> is an intangible ongoing <BO: business outcome> of a <BP: business process> into an <OsB: organizational sub-system>
- R9: a <Pr: product> is a tangible and discrete <BO: business outcome> of a <BP: business process> into an <OsB: organizational sub-system>
- R10: a <BsP: business sub-process> is just a <BP: business process> that is into a <process>.
- R11: a <BO: business outcome> is a perceived output of a <BP: business process> with either <VoP: value-oriented people attributes: v1,v2, …> or <QoM: quality-oriented machines attributes: q1,q2, …>.

Hence, the manufacturing of ***products*** and the provision of ***services*** needs a ***business process approach*** where the ***business process*** can be conceptualized as a ***system*** (composed of ***business subprocesses*** and/or ***business activities***) contained in an ***organizational system*** that affects to and it is affected by a wider system called the ***suprasystem***. Initial but substantial theoretical and practical implications of such relationships are discussed in the final section.

INITIAL THEORETICAL AND PRACTICAL IMPLICATIONS FOR THE IS DISCIPLINE

This chapter is part of a research in progress and an extensive discussion of their contributions is out of the planned scope. However, initial results on the how to apply such a set of conceptual relationships have been reported in Mora et al. (2007a, 2007b). From a theoretical viewpoint, however, we can argue that these conceptual findings contribute: (1) to identify the building-block concepts of the highest abstraction level to define and understand the rationale of standards and models of processes; (2) to establish a conceptual hierarchical set of initial relationships between such conceptual building-blocks that permits the development of a further formalization via an ontology; (3) to keep a theoretical congruence with the formal notions of what is a ***system***, ***subsystem*** and ***suprasystem***; and (4) to provide a parsimonious theoretical model of what is a ***business organization***, ***business process***, ***business activity***, ***service*** and ***product***.

From a practical viewpoint, this study contributes: (1) to help to practitioners to understand the conceptual relationships between ***process***, ***system*** and the final outcomes of ***services*** and ***products*** using a domain vocabulary linked to formal systemic foundations; (2) to provide the foundation for the development of a computerized ontology for standards and models of processes that would permit automated knowledge-based inquires; and (3) to provide the foundations for the development of a framework/model to describe and compare the standards and models of processes from a top-bottom perspective according to the level of detail required by the modeler (Mora et al., 2007b).

CONCLUSION

In this chapter, we have developed a conceptual description of the main models and standards of processes formulated in the disciplines of SE, SwE and IS. Based in such descriptions, we have developed a conceptual analysis of the concepts of ***process***, ***system*** and ***service***. Such concepts have been identified as the core building blocks for describing models and standards of processes. Eleven semi-formal conceptual relationships between the building-blocks concepts have been also posed. The main theoretical contribution is the generation of a parsimonious model theoretically congruent with the Theory of Systems. The main practical contribution is the provision of a conceptual tool to describe and compare standards and models of processes. Two recommendations that emerge for further research are: (1) the refinement of the relationships to describe and compare standards and models of processes and (2) the development of a computerized ontology based in this theoretical model for permitting knowledge-based inquires on the digital description of standards and models of processes in SE, SwE and IT. These two research recommendations are part of the research goals of this study under progress.

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REFERENCES

Ackoff, R. (1971). Towards a system of systems concepts. *Management Science, 17*(11), 661-671.

Ackoff, R. (1973). Science in the systems age: Beyond IE, OR and MS. *Operations Research, 21*(3), 661-671.

Andriole, S., & Freeman, P. (1993). Software the case systems engineering: For a new discipline. *Software Engineering Journal*, May, 165-179.

Arnold, S., & Lawson, H. W. (2004). Viewing systems from a business management perspective: the ISO/IEC 15288 standard. *Systems Engineering, 7*(3), 229-242.

Barker, B., & Verma, D. (2003). System engineering effectiveness: A complexity point paradigm for software intensive systems in the information technology sector. *Engineering Management Journal, 15*(3), 29-35.

Bar-Yam, Y. (2003). When systems engineering fails—Toward complex systems engineering. In *Proceedings of the 2003 International Conference on Systems, Man & Cybernetics* (pp. 2021- 2028), Piscataway, NJ: IEEE Press.

Bate, R. (1998). Do systems engineering? Who, Me? *IEEE Software*, Jul-Aug, 65-66.

Bertalanffy, L. von (1972). The history and status of general systems theory. *Academy of Management Journal*, December, 407-426.

Boehm, B. (2000). Unifying software engineering and systems engineering. *Computer*, 114-116.

Boehm, B., & Lane, J. (2006). 21st century processes for acquiring 21st century software-intensive systems of systems. *Crosstalk: The Journal of Defense Software Engineering*, May, 1-9.

Checkland, P. (2000). Soft systems methodology: a 30-year retrospective. In P. Checkland (Ed.), *Systems thinking, systems practice*. Chichester: Wiley.

Chesbrough, C., & Spohrer, J. (2006). A research manifesto for services science. *Communications of the ACM, 49*(7), 35-40.

CIO UK Website. (2007). *Late IT projects equals lower profits*. Retrieved May 15, 2008, from http://www.cio.co.uk/concern/resources/news/index.cfm?articleid=1563

Collin, R. (2004). *An introductory overview of ITIL*. London: ITSMF.

Deno, P., & Feeney, A. B. (2002). Systems engineering foundations of software systems integration. In *Proceedings of the OOIS Workshops*.

Demirkan, H., & Goul, M. (2006). AMCIS 2006 panel: Towards the service oriented enterprise vision: Bridging industry and academics. *CAIS, 18*, 546-556.

Ewusi, K. (1997). Critical issues in abandoned information systems development projects. *Communication of the ACM, 40*(9), 74-80.

Farr, J., & Buede, D. (2003). Systems engineering and engineering management: Keys to the efficient development of products and services. *Engineering Management Journal, 15*(3), 3-9.

Forsberg, K., & Mooz, H. (1997). System engineering overview. In R. Thayer & M. Dorfman (Eds.), *Software requirements engineering* (pp. 44-72). Los Alamitos: IEEE Computer Society Press.

Fuggetta, A. (2000). Software process: A roadmap. In *Proceedings of the International Conference on Software Engineering*, Limerick, Ireland.

Garcia, S. (1998). Evolving improvement paradigms: Capability maturity models & ISO/IEC 15504 (PDTR). *Software Process Improvement and Practice, 3*(1), 1-11.

Gelman, O., & Garcia, J. (1989). Formulation and axiomatization of the concept of general system. *Outlet IMPOS (Mexican Institute of Planning and Systems Operation), 19*(92), 1-81.

Gelman, O., Mora, M., Forgionne, G., & F. Cervantes (2005). Information systems and systems theory. In M. Khosrow-Pour (Ed.), *Encyclopedia of information science and technology*, (Vol. 3, pp. 1491-1496). Hershey, PA: Idea Group.

Glass, R., Armes, V., & Vessey, I. (2004). An analysis of research in computing disciplines. *Communications of the ACM, 47*(6), 89-94.

Hecht, H. (1999). Systems engineering for software-intensive projects. In *Proceedings of the ASSET Conference*, Dallas, TX.

Hevner, A. R., March, S. T., Park, J., & Ram, S. (2004). Design science in information systems research. *MIS Quarterly, 28*(1), 75-105.

Hole, E., Verma, D., Jain, R., Vitale, V., & Popick, P. (2005). Development of the ibm.com interactive solution marketplace (ISM): A systems engineering case Study. *Systems Engineering, 8*(1), 78-92.

Honour, E. (2004). Understanding the value of systems engineering. In *Proceedings of the 2004 INCOSE Conference*, 1-16.

INCOSE (1996). *SECAM: Systems engineering capability assessment model* (version 1.5). INCOSE.

INCOSE (2004). *Systems engineering handbook*. INCOSE-TP-2003-016-02. INCOSE.

ISO (in press). *ISO/IEC NP 24748 Systems and software engineering—Life cycle management*. Geneva, Switzerland: ISO/IEC.

ISO (1995). *ISO/IEC 12207: Information technology—Software life cycle processes*. Geneva, Switzerland: ISO/IEC.

ISO (2002). *ISO/IEC 15288: Systems engineering—Systems life cycle processes*. Geneva, Switzerland: ISO/IEC.

ISO (2003). *ISO/IEC 15504-2: Information technology—Process assessment*. Geneva, Switzerland: ISO/IEC.

ISO (2004a). *ISO/IEC 90003:2004 software engineering—Guidelines for the application of ISO 9001:2000 to computer software*. Geneva, Switzerland: ISO/IEC.

ISO (2004b). *ISO/TMB Policy and principles statement global relevance of ISO technical work and publications*. TMB/SC/GR 2004-06-30. Geneva, Switzerland: ISO/IEC.

ISO (2005). *ISO/IEC 20000:2005 Information technology—Service management -- Part 1: Specification*. Geneva, Switzerland: ISO/IEC.

ISO (2006a). *Where ISO 9000 came from and who is behind it*. Retrieved May 15, 2008, from www.iso.org

ISO (2006b). *ISO 9000 and ISO 14000 in plain language*. Retrieved May 15, 2008, from www.iso.org

ISO (2006c). *ISO/IEC 15289: Systems and software engineering—Content of systems and software life cycle process information products (Documentation)*. Geneva, Switzerland: ISO/IEC.

ITGI (2000). *COBIT 3rd edition framework*. Illinois: IT Governance Institute..

Johnson, D. M. (1996). The systems engineer and the software crisis. *ACM SIGSOFT Software Engineering Notes, 1*(2), 64-73.

Johnson, K., & Dindo, J. (1998). Expanding the fcus of software process improvement to include systems engineering. *Crosstalk: The journal of defense software engineering*, 1-13.

Kellner, M., Curtis, B., deMarco, T., Kishida, K., Schulemberg, M., & Tully, C. (1991). Non-technological issues in software engineering. In *Proceedings of the 13th International Conference on Software Engineering*. Retrieved digital library at www.acm.org

Magee, S. (2006). *A successful software quality strategy using ISO/IEC 12207 &15288*. Retrieved May 15, 2008, www.15288.com

Minnich, H. (2002). EIA IS 731 Compared to CMMI-SE/SW. *Systems engineering journal, 5*(1), 62-72.

Mora, M. (2004). *Manual of Conceptual Research* (Internal Tech. Rep. IS-2004-01). Autonomous University of Aguascalientes, Mexico.

Mora, M., Gelman, O., Cervantes, F., Mejia, M., & Weitzenfeld, A. (2003). A systemic approach for the formalization of the information system concept: Why information systems are systems? In Cano, J. (Ed.), *Critical reflections of information systems: Systemic approach* (pp. 1-29). Hershey, PA: Idea Group.

Mora, M., Gelman, O., Cano, J., Cervantes, F., & Forgionne, G. (2006). Theory of systems and information systems research frameworks. In *Proceedings of the 50th Annual Meeting of the International Society for the Systems Sciences*, Somona State Universiy, CA.

Mora, M., Gelman, O., O'Connor, R., Alvarez, F., & Macías, J. (2007a). On models and standards of processes in SE, SwE and IT&S disciplines: Toward a comparative framework using the systems approach. In K. Dhanda & R. Hackney (Eds), In *Proceedings of the ISOneWorld 2007 Conference Track in System Thinking/Systems Practice*, Las Vegas, Nevada.

Mora, M., Gelman, O., & Alvarez, F. (2007b). A systemic model for the description and comparison of models and standards of processes in the SE, SwE and IT disciplines. In *e-Proceedings, International Conference on Complex Systems 2007, NECSI*, Boston, MA.

Mora, M., Gelman, O., Frank, M., Paradice, D., Cervantes, F., & Forgionne, G. (2008). Toward an interdisciplinary engineering and management of complex IT-intensive organizational systems: A systems view. *The International Journal of Information Technologies and the Systems Approach, 1*(1), 1-24.

Nichols, R., & Connaughton, C. (2005). *Software process improvement journey: IBM Australia application management services* (A Report from the Winner of the 2004 Software Process Achievement Award). Technical Report CMU/SEI-2005-TR-002, ESC-TR-2005-002.

Nunamaker, J. F., Chen, M., & Purdin, T. D. (1991). System development in information system research. *Journal of Management Information Systems, 7*, 89-106.

OMG (2005). *Software process engineering management: The unified process model (UPM)*. Document ad/2000-05-05. Object Management Group

OMG (2006). *Business process modeling notation (BPMN) specification*. Document dtc/06-02-01. Object Management Group.

Paulk, M., Chrissis, M., Weber, C. & Perdue, J. (1987). *The capability maturity model for software, Version 2B*. SEI/CMU Presentation. Retrieved May 15, 2008, from a www.sei.cmu.edu

Sage, A. P. (1992). *Systems engineering*. New York: Wiley.

Sage, A. P. (2000). Systems engineering education. *IEEE TSMC-Part C, 30*(2), 164-174.

Sage, A. P., & Amstrong, J. (2000). *Introduction to systems engineering.* New York: Wiley.

Sheard, S., & Lake, J. (1998). *Systems engineering and models compared*. retrieved May 15, 2008, from www.software.org

SEI (2006). *CMMI for development, version 1.2: CMMI-DEV, V1.2. Software engineering institute. CMU/SEI-2006-TR-008, ESC-TR-2006-008.* retrieved May 15, 2008, from www.sei.edu

Sommerville, I. (1998). Systems engineering for software engineers. *Annals of Software Engineering, 6*, 111-129.

Spohrer, J., Maglio, P., Bailey, J., & Gruhl., D. (2007). Steps toward a science of service systems. *IEEE Computer*, January issue, 70-71.

Standish Group International (2003). *The extreme CHAOS report*. Retrieved May 15, 2008, from www.standish-group.com

Succi, G., Valerio, A., Vernazza, T., & Succi, G. (1998). Compatibility, standards and software production. *Standarview, 6*(4), 140-146.

Tantara (2001). *History and relationship of process standards/models*. Retrieved May 15, 2008, from www. tantara.ab.ca

Teboul, J. (2007). *Service is front stage: Positioning services for value advantage.* Paris: INSEAD.

Thayer, R. H. (1997). Software systems engineering: An engineering process. In R. Thayer & M. Dorfman (Eds.), *Software requirements engineering* (pp. 84-106). Los Alamitos: IEEE Computer Society Press.

Thayer, R. H. (2002). Software systems engineering: A tutorial. *IEEE Computer*, April, 68-73.

Tripp, L. (1996). International standards in system and software integrity. *Standardwiew, 4*(3), 146-150.

Wright, R. (1998). Process standards and capability models for engineering software-intensive systems. *Crosstalk*, October, 1-10.

ENDNOTES

[1] A standard is a " ... *document, established by consensus and approved by a recognized body, that provides, for common and repeated use, rules, guidelines or characteristics for activities or their results, aimed at the achievement of the optimum degree of order in a given context*." (ISO, 2004b)

[2] Most recent standards have incorporated such improvement purpose (e.g., ISO 15504).

[3] The initial results from such a premise have been reported in Mora et al (2007a) and final findings will be reported in a further study.

[4] In particular, Fuggetta (2000, p. 28) points out that ".. rather, we (e.g., the software process community) must pay attention to the complex interrelation of a number of

organizational, cultural, technological and economic factors."

5 SE is an older discipline than SwE that copes with the definition, development/acquisition and deployment of large scale systems comprised of multiples components of people, facilities, hardware, software, mechanical, and so forth.

6 SwE is defined as the discipline to generate software components or systems on time, on budget and with the expected technical requirements achieved.

7 CMMI-SVC will be the constellation focused on the management and engineering of process for delivering services. It is planned be released in 2007. Other CMMI-ACQ constellation for acquisition process is also being developed for 2007.

8 In this chapter is analyzed the version 3.0 released in 2000. The new version 4.0 has been recently released ending 2006.

9 This standard is derived from the BS15000 standard. In turn, the later evolved from the ITIL V.2.0 (1995) Model. Because the ITIL V.3.0 was liberated during the ending of this study, this is not considered. Major change realized is a lifecycle approach to arrange the previous main six categories of processes.

10 Other IS standards (e.g., Computer standards) are oriented to computer sciences and these are not considered in this chapter. ICT security standards can be considered hybrid but are out of the scope of this research.

11 These definitions are based in Gelman & Garcia (1989), Mora et al. (2003), Gelman et al. (2005) and Mora et al. (2006, 2007b).