# Best Practices and New Perspectives in Service Science and Management

Patricia Ordóñez de Pablos
*Universidad de Oviedo, Spain*

Robert Tennyson
*University of Minnesota, USA*

BUSINESS SCIENCE
Reference

Managing Director: Lindsay Johnston
Editorial Director: Joel Gamon
Book Production Manager: Jennifer Yoder
Publishing Systems Analyst: Adrienne Freeland
Assistant Acquisitions Editor: Kayla Wolfe
Typesetter: Christy Fic
Cover Design: Jason Mull

Published in the United States of America by
Business Science Reference (an imprint of IGI Global)
701 E. Chocolate Avenue
Hershey PA 17033
Tel: 717-533-8845
Fax: 717-533-8661
E-mail: cust@igi-global.com
Web site: http://www.igi-global.com

Copyright © 2013 by IGI Global. All rights reserved. No part of this publication may be reproduced, stored or distributed in any form or by any means, electronic or mechanical, including photocopying, without written permission from the publisher. Product or company names used in this set are for identification purposes only. Inclusion of the names of the products or companies does not indicate a claim of ownership by IGI Global of the trademark or registered trademark.

Library of Congress Cataloging-in-Publication Data

Best practices and new perspectives in service science and management / Patricia Ordonez de Pablos and Robert D. Tennyson, Editors.
pages cm
Includes bibliographical references and index.
Summary: "This book provides original research on all aspects of service science, service management, service engineering, and its supporting technology in order to administer cutting-edge knowledge to encourage the improvement of services"-- Provided by publisher.
ISBN 978-1-4666-3894-5 (hardcover) -- ISBN 978-1-4666-3895-2 (ebook) -- ISBN 978-1-4666-3896-9 (print & perpetual access) 1. Service industries--Management. I. Ordonez de Pablos, Patricia, 1975- II. Tennyson, Robert D.

HD9980.5.B47 2013
658--dc23

2012045216

British Cataloguing in Publication Data
A Cataloguing in Publication record for this book is available from the British Library.

The views expressed in this book are those of the authors, but not necessarily of the publisher.

# Chapter 5
# An IT Service Engineering and Management Framework (ITS-EMF)

**Manuel Mora**
*Autonomous University of Aguascalientes, Mexico*

**Mahesh S. Raisinghani**
*TWU School of Management, USA*

**Jorge Macías-Luévano**
*Autonomous University of Aguascalientes, Mexico*

**Rory V. O'Connor**
*Dublin City University, Ireland*

**Ovsei Gelman**
*CCADET-UNAM, Mexico*

## ABSTRACT

*There is a rich amount of literature on services from Information Technology (IT) (Management view) and IT System Engineering (ITSE) (Engineering view) domains. However, such a variety has produced disparate views. Furthermore, given that IT and ITSE service-based systems must be linked to business services (the User view), conceptual interrelationships are increased, causing yet more diversity. This paper identifies that this generates a lack of theoretical conceptual cohesion and leads to multiple practical confusions. To address these issues and to reduce such conceptual gaps, an IT Service Engineering and Management Framework (ITS-EMF) is proposed. ITS-EMF is generated by careful review and examination of the main conceptualizations on IT, ITSE and business services. The paper claims that ITS-EMF is useful for: (1) mapping services concepts from disparate IT literature, (2) reducing service conceptual confusion from the multiple available sources, and (3) providing conceptual links between service constructs used in business services and IT and ITSE services layers. It concludes with the implications, both academic and practical, for engineering and managing IT services in business organizations.*

## 1. INTRODUCTION

Services are distinct from products as main trading items (Farr & Buede, 2003). Services have had a high economic impact in the last 30 years (Quinn, 1992; Lusch & Vargo, 2006). Nowadays, many business organizations are focused on delivering services "*help, utility, experience, information or other intellectual content … account for more than 70% of total value added in the OECD*" (Sheehan, 2006). This shift in economic perspective from product design, manufacturing, and

DOI: 10.4018/978-1-4666-3894-5.ch005

Copyright © 2013, IGI Global. Copying or distributing in print or electronic forms without written permission of IGI Global is prohibited.

distribution towards service design, composition, and delivering, can be explained from a market focus on guaranteed functionalities of systems as products per se, or as systems using products, process, technology and people (Chesbrough & Spohrer, 2006). Furthermore, services are needed to cope with the incremented business process engineering and management complexity in worldwide organizations to perform their daily, tactical and strategic business activities (Sage & Cupan, 2001). Complementary to another business practices, companies have addressed such organizational complexities through large Information Technology (IT) investments (OECD, 2004) and by consequence, these organizations now rely on Complex IT-based Organizational Systems (CITOS) (Hunter & Blosch, 2003; Mora et al., 2008a). Hence, the concept of service emerges as fundamental in the disciplines of both IT (e.g. the management view) and IT System Engineering (ITSE) (e.g. the engineering view), and thus, IT management and IT systems engineering integrated conceptual schemes for IT services are relevant to be elaborated.

Academic and professional efforts in business (Service Science, Management & Engineering (SSME) (Chesbrough & Spohrer, 2006)), ITSE (Service-Oriented Architecture (SOA) software engineering (Bieberstein et al., 2005; Kontogiannis et al., 2007)), and IT domains (service management (OGC, 2007)) have been focused on developing such conceptual schemes. These efforts aim to fill knowledge gaps and/or develop new service system paradigms. Furthermore, the IT service concept has been used from early 1970 and 1980 decades (with different connotations) in the IT literature (Lewis, 1976; Olson & Chervany, 1980; Leitheiser & Wheteber, 1986). However, we identify that because of the complexity and diverse range of disciplines involved (IT, ITSE, and Business Management), the current view of what is an IT service is not integrated. Given that IT technology plays a critical role for the realization of high-quality, cost-effective and trustworthy services (Zysman, 2006), we consider that doing research: (1) to integrate the main perspectives of the concept of IT service, and (2) to formulate a engineering and management framework for IT services (ITS-EMF) is relevant and required.

## 2. A REVIEW AND SYNTHESIS OF IT SERVICE LITERATURE

Consequently, in this paper through a conceptual design research method (Glass et al., 2004; Hevner et al., 2004; Mora et al., 2008b) (see Table 1) we: (1) elaborate on an integrated conceptualization of the IT service concept (ITS); (2) formulate and illustrate the ITS-EMF; and (3) identify the academic and practical implications to engineering and managing such services in business organizations. We claim that this framework is useful for mapping services concepts from disparate literature, reducing service conceptual confusion from the multiple available sources, and providing conceptual links between service constructs used in business services and IT and ITSE services layers.

### 2.1. The Classic IT Management View of Services

The use of the service concept is not new in IT literature. However, we believe that the modern concept of service has not been used in most of this literature, with the exception of the ITIL/ITSM stream (OGC, 2007). While the IT service construct has been used implicitly but not defined in several IT studies (Lewis, 1976; Olson & Chervany, 1980; Leitheiser & Wheteber, 1986; Pitt, Watson, & Kanvan, 1997; Kettinger & Lee, 1997, 2005), several insights are useful to formulate an integrated concept. First definitions on IT service construct are provided by ITIL (the Information Technology Infrastructure Library) v.2, and v.3 models (OGC, 2007) and related models (ITUP, MOF). In related ITSE literature (Bieberstein et

*Table 1. Research activities of conceptual design research (Glass et al., 2004; Hevner et al., 2004; Mora et al.., 2008)*

| Research activity | Inputs | Process | Outputs |
|---|---|---|---|
| **CD.1 Knowledge Gap Identification.** | 1. Initial research goals.<br>2. Conceptual units of study. | 1. Selection of studies by (i) recognition of authors; and (ii) comprehensibility of studies.<br>2. Identification of contributions and limitations in studies regarding the research goals.<br>3. Relevance validity assessment of the knowledge gaps. | 1. The confirmed and refined research goals.<br>2. The relevant knowledge gaps. |
| **CD. 2 Methodological Knowledge Selection.** | 1. Confirmed and refined research goals.<br>2. Relevant knowledge gaps.<br>3. Conceptual units of study. | 1. Definition of the research purpose (conceptual exploratory of full design).<br>2. Assignation of unit of studies between researchers.<br>3. Selection of the design approach (heuristic or axiomatic). | 1. The research purpose.<br>2. The work plan. |
| **CD. 3 Conceptual Design.** | 1. Conceptual units of study. | 1. Designing of the construct, framework/model/theory, method, or system/component (not instanced in a real object) by applying the selected design approach. | 1. The conceptual designed artifact. |
| **CD. 4 Design Data Collecting.** | 1. Conceptual designed artifact. | 1. Identification of conceptual units for testing.<br>2. Application of conceptual units for testing.<br>3. Face validity from a panel of experts (not involved in the design team). | 1. The conceptual designed and tested artifact (initially used with test data).<br>2. The face validity assessment. |
| **CD. 5 Analysis and Synthesis.** | 1. Conceptual designed artifact tested (initially used with test data).<br>2. Face validity assessment. | 1. Analysis (direct insights) and synthesis (emergent insights) of findings derivable from the designed conceptual artifact. | 1. The contributions from the conceptual designed artifact. |

al., 2005; Kontogiannis et al., 2007; Cantor, 2003) the service construct is used and defined. However, the logical links between both constructs (from IT and ITSE literatures) is still missing.

Lewis (1976) introduced the concept of computing service levels as a medium to improve the quality of interactions between computer users and the data processing center which provides such services. During the 1970s, the transition from computing batch services to on-line or real-time interactive computing services changed the user-data center interactions. On-line computing services, where the users interact directly with the system (and all of the IT resources involved), introduced a greater complexity to achieve the expected levels of service than the existent in the batch service (off-line). At present real-time or mission-critical systems are instances of this complexity. For Lewis (1976, p. 329), an IT service can be considered *an integrated set of functionalities provided by an IT system with the essential aim to process a workload into the expected range of metrics.* An IT service level is defined by its description, its ranges of metrics, and a tracking of delivered functionalities. Main service metrics posed by author (Lewis, 1976, p. 330) are: "*availability …, capacity …, utilization …, performance …, reliability …*". To deliver a stable IT service, Lewis reports (Lewis, 1976, p. 332) *the need of planning, design and implementation with adequate resources* (and capabilities from a ITIL v.3 view). In the opposite case "*… the level service tends to fluctuate over time depending on which set of criteria is on top management's priority list*".

A second study (Olson & Chervany, 1980) was focused on investigating the relationship between six characteristics of the organizational structure with three categories of characteristics of the organizational information services functions (systems operations, systems development, and systems management). An IT service construct is not defined. Thus, users need to assume implicitly what is such a construct and ultimately what that are paying to the IS (Information Systems) area. Research indicates that information services functions are delivered by executing several activities - where three of these activities include: (1) Systems operations "*… include physical computer hardware and the operations personnel associated with it*.", (2) Systems development activities "*… include the analysis, design, and programming of new applications, and the maintenance of existing ones*.", and (3) Systems management include "*… administrative aspects of planning, developing, and controlling information system resources.*". Additionally, authors identify core activities that have been rescued by most advanced ITSM (IT service management) best practices like ITIL v2 and v3 at present: "*negotiating user budgets for information services*", "*charging for information services*", and "*overall planning of equipment, data, and people resources, and overall policy setting*" (Olson & Chervany, 1980).

An extension of Lewis's concept called service support level was introduced by Leitheiser and Wheteber's study (1986). While a definition of IT service is not reported, service support levels are defined as (Leitheiser & Wheterber, 1986, p. 340) "*formal divisions of computing responsibility between end users and the MIS department*". This concept increases the organizational demand for end-user computing schemes, for example: IT services directly acquired by users without a direct utilization of IT enterprise resources. Service support levels emanate from four managerial responses to address such end-user computing demand and associated identified risks as follows: *(1) doing nothing, (2) enforcement of policies and procedures, (3) motivation to the adherence of controlled procedures, or (4) development of support services for aiding end-computing users.* Assigning a mutual co-responsibility for the successful provision of IT services from IT function as well as from end-user computing is a logical path in this context. Most comprehensive definitions of the concept service and service systems emphasize such a service customer-provider commitment dimension (Mora et al., 2009a, 2009b). As an example of the service support level approach six services are used as follows: (*1) general consulting, (2) product support, (3) hotline/help desk, (4) technical support, (5) quality assurance, and (6) end-user training*. Leitheiser and Wheteber (1986) contribute to IT service literature with the articulation of a managerial and engineering mechanism for defining, designing, and implementing services provided by an IT department.

Other IT service literature (Kettinger & Lee, 1997; Pitt et al., 1997; Kettinger & Lee, 2005) have investigated the adaptation of the SERVQUAL instrument - from Marketing literature (Parasuraman, Zeithaml, & Berry, 1988) -, to measure quality of IT services in the context of an IT arena. While this topic is highly relevant for delivering adequate levels of service, it is outside the scope of this paper and potentially warrants further study. We briefly report that IT service quality is measured through five constructs: *(1) tangibles, (2) reliability, (3) responsiveness, (4), assurance, and (5) empathy*. Tangibles dimension account for "*facilities, equipment, and appearance of personnel*". Reliability dimension measures the "ability to perform the promised service dependably and accurately". Responsiveness dimension measures the "*willingness to help customers and provide prompt service*". Assurance dimension measures the "*knowledge and courtesy of employees and their ability to inspire trust and confidence*". Finally, the empathy dimension measures the "*caring, individualized attention the firm provides its customers*". Important insights from this literature include the human-valued assessment perspective of quality of services independently of the physical ICT resources underlying to the final IS services. However, while customers and users may not be aware of these ICT resources, from an IT management perspective, these cannot be ignored.

## 2.2. The Modern IT Management View of Services

ITSM is an approach for delivering value to IT customers through the management of IT services (OGC, 2002, 2007). ITSM is inspired by the ISO 9000 family of standards and the European Foundation for Quality Management (EFQM) model (van Von, Pieper, & van der Veen, 2005; OGC, 2002, 2007). ITSM follows the shift in focus from IT products toward IT services. ITIL is the ITSM *de facto* standard. ITSM *de jure* standards are BS 15000 and ISO/IEC 20000:2005. Recently ITIL v2:2002 has been updated to ITIL v3:2007, through a re-organization of its service core macro-areas to a five stages of services in a life-cycle view. While the ITIL v2:2002 standard is more popular than the ITIL v3:2007 and the ISO/IEC 20000:2005 standard (International Organization for Standardization, 2005a, 2005b), these three standards support the ultimate goal to improve the organizational business process (including the own IT process) via the provision of high quality IT services.

The ITIL document (v2:2002) reports that "*IT Service Management must make a difference to the whole organization. It must make the business processes more efficient and more effective*" (OGC, 2002, p. 7). The ISO/IEC 20000:2005 (International Organization for Standardization, 2005a, p. v) standard reports broadly that its use is attempted to "…*effectively deliver managed services to meet the business and customers requirements*". In turn, the ITIL v3:2007 provides "*a common framework of practices that unite all areas of IT service provision toward a single aim – delivering value to the business*" (OGC, 2007, p.3). Furthermore (OGC, 2007, p. 4) it has been established that ITIL v3:2007's overall objective is "*to provide services to business customers that are fit for purpose, stable and that are so reliable, that the business views them as a trusted utility*". In this way services must be considered as business assets with two core attributes: *utility (fit for purpose) and warranty (fit for use)*. The greater the positive effects of service on the task performance related to the business/customer's objectives, the greater the utility perceived by services customers. Similarly, the greater the availability, capacity, continuity and security of service provision, the greater the provisioned warranty (OGC, 2007).

OGC (2007, p. 5) defines services as "*delivering value to customers by facilitating outcomes customers want to achieve without the ownership of specific costs and risks*", and service management as "*a set of specialized organizational capabilities for providing value to customers in the form of services*" (OGC, 2007, p. 216). Furthermore, the ITIL v3:2007 service design approach "*considers all aspects (business process, service, SLA/SLR/OLA's, infrastructure, environment, data, applications, support services, support teams and suppliers) when designing service solutions to meet new and evolving business needs*" (OGC, 2007, p. 24). Such a process and service-oriented perspective to manage the IT organizational function has emerged directly from industry/practice. Its consideration in the academic arena has suffered a disruption from the IT service 1980's early literature and the modern of present decade (2000-2009) (Zao et al., 2007; Beachboard et al., 2007). In contrast, in the ITSE arena, the early appearance of the service-oriented computing model and computing tools (Bieberstein et al., 2005; Kontogiannis et al., 2007) suggest a greater focus of attention on such a new service paradigm but more of a bottom-up (i.e., technical to business) paradigm. However, some IT studies (Zao et al., 2007; Beachboard et al., 2007) suggest that this service technology-driven paradigm must be accommodated in a broader IT service management paradigm. This harmonization must develop a unified view of the engineering and management issues of IT services.

## 2.3. The IT Systems Engineering View of Services

From the ITSE (including software engineering) literature, the concept of service can be defined as "*an abstract resource that represents a capability of performing tasks that form a coherent functionality from the point of view of provider entities and requester entities. To be used, a service must be realized by a concrete provider agent*" (W3C, 2004, p. 13). Other concepts related to service are: *service interfaces, message, operation, orchestration, choreography,* and *SOA)*. A service interface (W3C, 2004, p. 13) can be defined as "*the abstract boundary that a service exposes. It defines the types of messages and the message exchange patterns that are involved in interacting with the service, together with any conditions implied by those messages*." A message (W3C, 2004, p. 8) can be defined as "*the basic unit of data sent from one Web services agent to another in the context of Web services.*" Operations are (W3C, 2004, p. 9) "*a set of messages related to a single Web service action" or a "single logical units of work*" (Zimmermman et al., 2005; p. 1). Services thus "*represent logical groups of operations*" (Zimmermman et al., 2005, p. 1).

To organize the utilization of software services, orchestration and choreography procedures have been posed. Orchestration can be defined (W3C, 2004, p. 9) as "*the sequence and conditions in which one Web service invokes other Web services in order to realize some useful function*." Choreography is defined as (W3C, 2004, p. 4) "*the sequence and conditions under which multiple cooperating independent agents exchange messages in order to perform a task to achieve a goal state.*". While both approaches have been suggested, orchestration is considered a more high-level abstraction specification level than choreography. SOA (W3C, 2004, p. 14) is defined by W3C as a "*set of components which can be invoked, and whose interface descriptions can be published and discovered*." However, others consider this definition too narrow, and broader conceptualizations have been reported (Marks & Bell, 2006; Sprott & Wilkes, 2004).

From this ITSE perspective, the service-oriented systems are built via an "*approach to software development where services provide reusable functionality with well-defined interfaces*". Thus, "*… a service infrastructure enables discovery, composition and invocation of services; and applications are built using functionality from available services*" (Bieberstein et al., 2007, p. 1). Nevertheless, Bieberstein et al. (2005) also identify core attributes for service-oriented systems from a customer's perspective as follows: *on-demand, customizable, trusted, compliant (to some standardized pattern), agile, and measurable*. Bieberstein et al. (2007, p. 697) also remark that *"the essential characteristics of an SOA-based service are its levels of abstraction, clear, fully described contractual interface, and easy discovery and invocation*". For these authors (Bieberstein et al., 2005), the SOA approach is considered as a core element in the redesigning of the organizational structure of modern organizations. Thus, under this view, a business organization executes their tasks through the interaction and collaboration of services provided by a team, departmental/business unit, or divisional/group services systems within the organization. This approach can be considered a bottom-up, technically driven approach.

Kontogiannis et al. (2007, p.2) observe different conceptualizations of services in the ITSE, IT and business user service domains. For ITSE engineers "*it is all about functional requirements, components, integration techniques, messaging, tools, development environments, and middleware*". For IT service managers "*it is all about implementing business strategies, enabling leaner IT departments, facilitating agile process models, and driving new service-delivery processes*". Finally, for users "*it is all about transparency, flexibility, ubiquitous access to services, and most importantly applications that ease their lives (e-government, e-health, entertainment)*".

Consequently, to integrate such a disparate perspective in the same business organization (e.g. the IT users, IT managers and system/software engineers), Kontogiannis et al. (2007) suggests the need of a strategy service function that links the organizational problem space with the business, engineering and IT management solution space.

## 2.4. The User View of Services

For completing the review of service constructs from the perspective of the business user layer, it is pertinent to review these concepts from the business management literature (Levit 1972; Quinn, 1992; Schelesinger & Heskett, 1991; Spohrer et al., 2007; Mora et al. 2009a). For Levitt (1972, pp. 41-43) the most accepted view of what is a service from a pre-industrial viewpoint, is based on the following ideas: *"…service is people-intensive" (rather in capital, technology and process), "… service is presumed to be performed by individuals for other individual, generally on a one-to-one basis" (rather from one-to-many as a standardized manufacturing process), "service… is performed out there in the field, by distant and loosely supervised people working on under highly variable, and often volatile, conditions" (rather than in a controlled manufacturing environment), and "service looks for solutions in the performer of the task"* (rather than in the manufacturing tasks done). With respect to the service system construct, there is not a specific definition reported. However, from core ideas reported by Levitt (1972, p. 44, p. 51), a service system can be considered as *"a planned, controlled, automated where possible, audited for quality control, and regularly reviewed for performance improvement and customer reaction production-line approach ("manufacturing in the field") to deliver high-quality, predictable and cost-efficient services rather an people-intensive, discretionary, and motivational-based single or team*". For Quinn (1992, p. 5) services are outputs of service sector business where: *"is not a product or construction, is generally consumed at the time it is produced, and provides added value in forms (such as convenience, amusement, timeliness, comfort, or health) that are essentially intangible concerns of its purchaser"*. To the best of our knowledge, there is not a specific definition reported for the service system construct by Quinn's study (1992). However, from the core ideas reported by author (Quinn, 1992), it can be defined as follows: *a service system is a business focused on creating and delivering business knowledge-intensive functionalities (e.g. services)*. For Schelesinger and Heskett (1991, p. 77) *"Services are [the means to satisfy] the needs and expectations of customers as the customers themselves, [rather than] the operating system and its constrains, [which] define them"*. Also in this study, there is not a specific definition reported for service system construct. However, from core ideas reported by author (1991, p. 77), it can be defined as follows: a service system is a customer-focused system which defines the *"how and where they interact with the company"* to *"create and deliver the things that customers value"*. For Spohrer et al. (2007, p. 72) *"Service is 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"*. In turn, a service system is defined as *"…a value co-production configuration of people, technology, other internal and external service systems, and shared information (such as language, processes, metrics, prices, policies, and laws)."*

Finally in Mora et al. (2009a, p. 17) a service is defined as a 3-dimensional one as follows: *"(i) an agreed integrated flux of actions delivered by a facilitator sub-system to an sub-appraiser system, complemented with a flux of actions of the latter, to co-create an expected value outcome, and affect positively the predetermined status properties in both systems (extended from Spohrer et al.'s 2007 view), (ii) status properties in the facilitator and appraiser subsystems that are affected by the service interactions between both subsystems, and* *(iii) an value outcome (e.g. an emergent property, thus co-generated) that affects to the supra-system (e.g. the service system)."* Finally a service system is *"a system comprised of a service-f sub-system (called facilitator system) and a service-α sub-system (called appraisal system), with the purpose to mutually generate an expected value outcome called service-fα*, and which operates into a supra-system and the environment."*

## 2.5. The Disparate View of Services

From previous studies it is clear that the constructs of service and service systems have different connotations in the IT, ITSE, and business management literature. Figure 1 illustrates this conceptual diversity. However, in synthesis, relevant integrative insights can be derived. For the service concept, this synthesis results in the following key ideas: *(1) a service is an abstract concept uniquely assessed by people through value dimensions; (2) objective and machine-oriented metrics can be also linked to measure the quality of a service; (3) a service can be conceived simultaneously like a flux of actions, a change of attributes or/and like final outcomes; (4) a service is based on an implicit or explicit contract of needs, expectations and sanctions; (5) a service performance must be predictable into a range of values; and (6) services are created and delivered through service systems.*

For the service system concept, the core insights from the synthesis are as follows: *(1) a service system is comprised of a service provider/facilitator and a service consumer/appraiser operating in a supra-system and an environment; (2) a service system is comprised of people, process, technology, information, and agreement/contractual rules, which affects and it is affected by its supra-system and its environment; and (3) a service system can be planned, designed, operated, managed, improved and retired.*

Hence, we consider that our extensive service literature review and core insights provide useful theoretical foundations for elaborating on an integrated definition for IT service and for formulating a ITS-EMF.

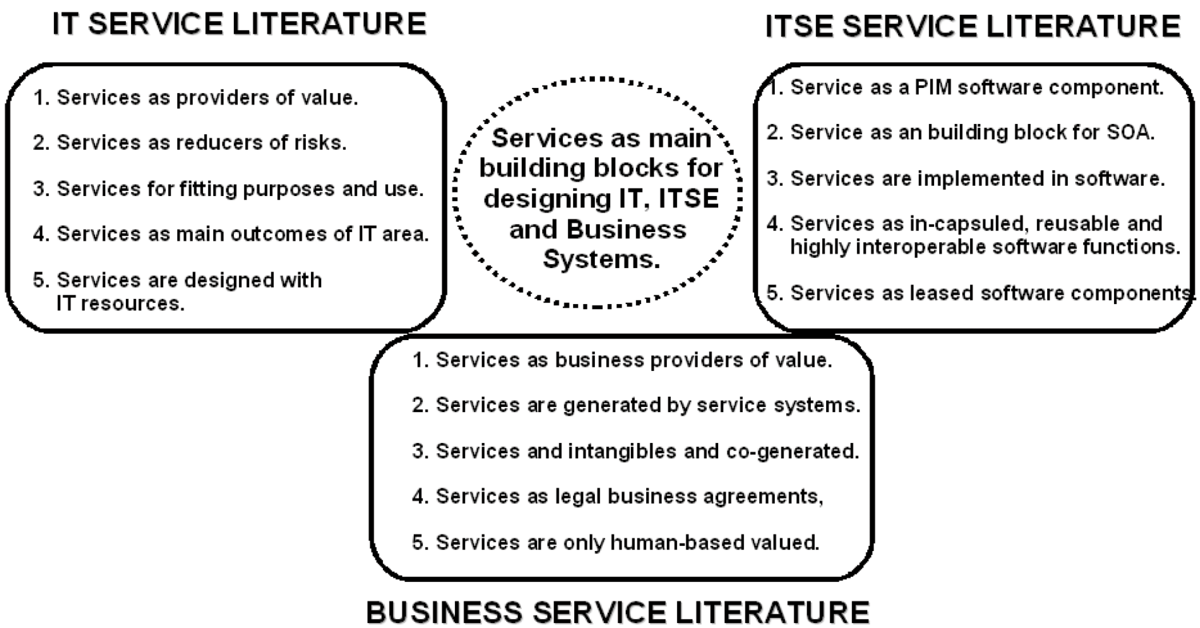
## 3. AN IT SERVICE ENGINEERING AND MANAGEMENT FRAMEWORK (ITS-EMF)

We have reported evidences that a single service literature consideration generates a knowledge gap on how to conceptualize services. As Kontogiannis et al. (2007) establish there are research challenges to be pursued in the three solution spaces (business, IT and ITSE). In this paper, we consider that an integrated view is required to reduce this knowledge gap. For this aim, we consider relevant the formulation of integrated definitions for service constructs, as well as the formulation of an initial ITS-EMF. Hence, the relevant emergent research inquiries from previous studies can be formulated as follows: (a) how Business Services and IT services can be defined?; (b) how can Business Functions and Business Processes be linked to IT services?; (c) how can IT services be engineered (methods) ?; and (d) how IT services can be evaluated? In this paper, we address –from a high level modeling perspective- from the (a) to (c) research inquiries. The (d) inquiry demands an individual study per se.

For (a) to (c) and based on Mora et al.'s (2009a) study, we can pose the following integrative definitions as conceptual base of ITS-EMF:

1. **Service System:** A system comprised of a *facilitator* and *appraiser* systems for generating value through the provision and consumption of *services*;
2. **Business Organization:** A *Service System* for co-generating value, where the *facilitator* system is the *Business Organization* and the *appraiser* system is its Customer's *Business Organization*;

Figure 1. The diversity on service conceptualizations in IT, ITSE and Business literature




3. **Organization:** A *System of Business Functions* for co-generating *Business Services* with its Customer's *Organization*;
4. **System of Business Functions:** A *System of Business Processes*;
5. **System of Business Process:** A system which consumes *IT Services* for generating *Business Services Capabilities* towards the *System of Business Functions*;
6. **System of IT Services:** A *System of IT Components & IT Resources* for co-generating *IT Services* jointly with its supported *System of Business Process*;
7. **IT System of IT Components & IT Resources:** A system comprised of computing (hardware, software, network), data, infrastructure, and people components and resources used for generating *IT Services Capabilities* towards the *System of IT Services*.

To complement such definitions, we add the following ones:

8. **Business Service:** A valued outcome (including a change of value on agreed attributes) which is co-generated by the Organization's *Business Services Capabilities* and the Customer' *Business Services Capabilities* during a well-delimited period;
9. **Business Service Capabilities:** The physical/cognitive actions performed by a *Business Organization* towards its Customer's *Business Organization* with the aim to co-generate *Business Services*;
10. **IT Service:** A valued outcome (including a change of value on agreed attributes) which is co-generated by the Organization's *IT Service Capabilities* and the Organization's *Business Services Capabilities* during a well-delimited period; and an *External IT Service* is an *IT Service* which is co-generated by the Organization's *IT Service Capabilities* and the Organization's IT Suppliers *Business Services Capabilities* during a well-delimited period;

11. **IT Services Capabilities:** The physical/cognitive actions performed by a *System of IT Components & IT Resources* towards its *System of IT Services* with the aim to co-generate *IT Services*;
12. **Service-oriented IT System (SoITS):** A system designed and implemented as an *IT Service*.

Thus, and based on such previous conceptualizations and studies, we can report the generic ITS-EMF in Table 2 (columns from A to E). The column (A) poses the two core domains in organizations: the business domain layer and the IT domain layer (which is divided in IT management and IT engineering views). In column (B) we describe the four view layers. In columns (C) and (D) we report the inputs and outputs/outcomes to each layer. In column (E) we propose the dimension of potential modeling and IT tools for realizing ITS. Finally from columns (G) to (I) we report plausible mappings on the organizational and technical domain layers that the ITSE service literature (MDA (OMG, 2003); Zimmermman et al. (2004, 2005).

## 4. DISCUSSION OF THE IT SERVICE ENGINEERING AND MANAGEMENT FRAMEWORK

We pose this initial integrative scheme for a better understanding of the engineering and management of IT services. In this ITS-EMF, we recognize the relevance of the two main domains involved for deploying service-oriented IT-based systems: business and IT domains. The business domain layer accounts for two sub-layers (column B): business functional system and business process system. Business functional system(s) are the top modeling view suggested. A business organization can be modeled firstly through a [System of Business Functions]. This system receives as inputs (column C) the entourage pressures (and also internal ones translated in organizational objectives and goals), as well as the [Business Services Capabilities] provisioned by the [System of Business Processes]. Through the Organization's and Customer's [Business Services Capabilities] interactions, are co-generated [Business Services] (column D). This business organization can be further detailed in a [System of Business Processes]. In this view, the inputs are internal business functional needs, the [IT Services] and another internal services (column B). In this [System of Business Processes], through business process interactions, the [Business Services Capabilities] are generated towards the [System of Business Functions].

From an organizational user view, this model can be considered sufficient. However, from an IT-service oriented view, it is required to model two further views: the [System of IT Services] (e.g. the IT management view) and the [System of IT Components & Resources] (e.g. the IT engineering view). In the [System of IT Services] the inputs corresponds to the business process needs, as well as the [IT Service Capabilities]. Then, through the Organization's [Business Services Capabilities] and the [IT Services Capabilities] interactions are co-generated the [IT Business Services]. This view, can further detailed in the [System of IT Components and Resources] view, where the inputs are [External IT Services] and the IT services needs. Finally the [IT Service Capabilities] are generated towards the [System of IT Services] through the Organization's and external IT suppliers [IT Service Capabilities].

These four views can be mapped to previous IT and ITSE frameworks. With ITIL v3, we consider that the [System of Business Functions], the [System of Business Process], the [System of IT Services], and the [System of IT Components & Resources] views, can be mapped to: business functional market space, business process market space, IT Service Management, and IT Service Engineering views. With Zimmermman et al.'s framework for engineering service-oriented

*Table 2. A generic framework for the engineering and management of IT Services*

<table>
<tr><th colspan="2">A<br>ITS-EMF<br>Domain<br>Layer</th><th>B<br>ITS-EMF<br>View Layer</th><th>C<br>ITS-EMF<br>Inputs</th><th>D<br>ITS-EMF<br>Outputs & Outcomes<br>Layer</th><th>E<br>ITS-EMF<br>Modeling<br>Methods</th><th>G<br>ITIL v.3<br>Mapping</th><th>H<br>Zimmermman<br>et al.'s Model</th><th>I<br>MDA<br>Mapping</th></tr>
<tr><td colspan="2" rowspan="2">Business Domain Layer</td><td>System of Business Functions: a subsystem of the business organization system that is required for the system's mission realization.</td><td>Entourage Pressures + [Business Services Capabilities]</td><td>Business Services</td><td>IDEF0, SSM</td><td>Business Functional Market Space</td><td>Functional Domain</td><td>CIM</td></tr>
<tr><td>System of Business Process: a system of atomic tasks logically articulated that define fully the operational view of a business process or activity.</td><td>[IT Services] + Another Internal Services + Business Functional Needs</td><td>Business Services Capabilities</td><td>BPMN, Use Case and AD (CA =>FR)</td><td>Business Process Market Space</td><td>Business Process</td><td>CIM</td></tr>
<tr><td rowspan="2">IT Domain Layer</td><td>IT management view</td><td>System of IT Services: a system of IT services to support a business function, process or service, which is comprised of IT service components, and where utility and warranty are well-defined attributes.</td><td>[IT Services Capabilities] + Business Process Needs</td><td>IT Services</td><td>SysML and AD (FR = A * DP)</td><td>ITSM Area</td><td>Software Services (partial mapping)</td><td>PIM</td></tr>
<tr><td>IT engineering view</td><td>System of IT Component & Resources: a system of IT service components ((people, technology (H/W, S/W, DBMS, Networks), data, applications, and entourage)).</td><td>External IT Services + IT Services Needs</td><td>IT Services Capabilities</td><td>SysML and AD (DP = B* PV)</td><td>ITSE Area + IT Assets/ Resources & Capabilities</td><td>Software Components (partial mapping)<br>- void -</td><td>PSM</td></tr>
</table>

systems (2004, 2005), the four views can be mapped to: functional domain, business process, and partially to software services and software components. There is a partial mapping because Zimmermman et al.'s framework only addresses the services provisioned by software components and not as full integrated IT services where the software is only a service resource. Finally, regarding the MDA framework, the four views can be mapped as follows: CIM (the two first), PIM (the [System of IT Services]), and PSM (the [System of IT Components & Resources]). The [System of Business Functions] and the [System of Business Process] views are independently from IT or computational details, so their correspondence with CIM (computational independent model) view. The [System of IT Services] view is useful for modeling (as outcomes) the [IT Services] (without technical details) and thus correspond to the PIM (platform independent model). Finally, in the [System of IT Components & Resources] view, engineering detail is required for a suitable model, and it corresponds to the PSM (platform specific model).

In column (E) we report a set of plausible methods for realizing such modeling of ITS. In the business functional domain layer, for the highest level of the organization, we suggest the utilization of IDEF methods (Mayer, 1992). In particular, the IDEF0 method for defining the main business functions in the organization, through the hierarchical definition of functions with inputs, outputs, controls and enabling mechanisms (e.g. human, technological and information/knowledge resources). In the case of complex and socio-technically conflicting ITS, we suggest the addition of soft systems methods (SSM) (Checkland, 2000). In particular, the methods of rich picture (RP), root definition (RD/PQR), CATWOE construct (customers, actors, transformation, Weltanschauung, owners and environmental constraints), 3E's, and Analysis One, Two and Three are suggested. These methods have been widely used for helping to capture a broad view of a problematic and often conflictive situation. The aim is the identification and delimitation of a potential SoITS. For the business process domain, we pose the BPMN method augmented with generic Use Cases. Modelers then can decide the detail level of the BPMN models. Additionally, with the aim to strengthen the quality of the design, some robust design methods from systems engineering can be added. A well-tested design engineering method is Axiomatic Design (Shu, 1998).

Axiomatic design enhances the classic heuristic design methods based in satisfaction constrain iterations and best practices, with the formal utilization of design axioms. Two axioms are fundamental according to Axiomatic design: (1) the independence axiom, and (2) the information axiom. In general terms, the first design axiom establishes that a good design should have independent functional requirements (design goals) such that the solution for any of them does not affect the other components. When this happens, alternative designs must be pursued. The second axiom establishes that the best design is one that produces the highest probability to satisfy the functional requirements, and this is achieved when such a design demands the minimum information for its design. Under such an axiom Suh (2005, p. 58) also defines complexity as "*a measure of uncertainty in achieving the specified FRs (functional requirements)*". Axiomatic design has been successfully applied in the design of manufacturing systems, machines, space ships, materials, hardware and software (Suh, 2005). Axiomatic Design is congruent with the MDA approach, through a design based in the transformation of models. The first model is realized in the customer domain (CA), where the users or customers define the expected attributes of the system to be designed. Then, this CA model is mapped in a set of functional requirements (FRs) and constrains (Cs) in the functional domain. Once identified the FRs and Cs, these must be mapped to design parameters (DP) through an equation design F = A * DP, where A is called the design matrix, in the physical domain. Next, other equation of design (DP = B * PV) that maps the design parameters to process variables (PV) must be resolved in the process domain. Finally the DPs and PVs can be considered high and low level building blocks respectively in the solution space, and the CAs and FRs can be considered also high and low level building blocks in the problem solution. In the facilitator IT service system layer as well as in the IT resource system one, we suggest the jointly consideration of the Axiomatic Design method, and the emergent system engineering modeling language SysML (SysML, 2005), which extends the traditional UML methods, to consider a systems engineering approach. While SysML is based in UML and shares its advantages, it also adds enhancements for modeling systems with software-intensive components (of a higher-level of abstraction). Since SoIT-S is considered to be among such kind of systems, SysML would appear to be an appropriate modeling tool.

Hence, we consider that this ITS-EMF framework presents an integrated theoretical view of the main approaches reported in the IT, ITSE, and business service literature for engineering and managing ITS. This ITS-EMF framework is useful for mapping services concepts from disparate literature, reducing service conceptual confusions from the multiple available, and providing conceptual links between service constructs used in business services and IT services layers. Thus, based on such findings we can establish the following core recommendations for academicians: (1) engineering and management of ITS demands an interdisciplinary enhancement of the curriculum of Information Technology, Systems Engineering, and Management Science to incorporate the teaching of IT development tools oriented to ITS as well as of service-oriented engineering and management methods (Mora et al., 2009b); (2) research on service systems development life-cycles is required for this new engineering and management paradigm from IT and ITSE views (OGC, 2004; Zimmermann et al., 2004, 2005); and (3) given the vast resources (human, time, financial, and others) required to deploy this new service-oriented approach, research focused in valuation methods by its deployment is strongly suggested.

We can suggest also the following implications for practitioners: (1) the demand for ITS will be raised and stimulated by the new service-valued economy; (2) the incorporation of the service-based engineering and management will demand a better quality control of applications under legal service-level agreements as well as this has been usually required for product development; and (3) the provision of ITS in a real data center environment will demand multiple expertise from ICT and ITSE technical views as well as of ITSM and business management ones.

Finally, the overall philosophy of ITS, and in general of a service-valued economy will demand the objective measurement of the efficiency, efficacy and effectiveness of the service system. The IT discipline is a complex one which is in constant change and accordingly the generation, learning and application of new knowledge is mandatory.

## 5. CONCLUSION

In this conceptual study, we have pursued the research goals of formulating: (1) an integrated conceptualization IT, ITSE and business management services concepts; and (2) an ITS engineering and management framework (called ITS-EMF). Such integrated concepts and an initial ITS-EMF has been reported. We believe that this study sets forth a shared vision of ITS and helps to delineate needed research avenues. However, while the initial theoretical validity of the ITS-EMF (e.g. suggested layers, models, inputs, outputs, and modeling tools) is adequate, we encourage to researchers to further develop and test its empirical validity (e.g. utility) through subsequent studies.

## ACKNOWLEDGMENT

This research was supported by the Autonomous University of Aguascalientes (Project PI-INF-08-2), the Science and Technology Mexican Council (CONACYT) (Project P49135-Y), and the PROMEP research netwok RIGSTI (UAA-CA-96, and UNAM-CCADET-SSIO).

## REFERENCES

Beachboard, J., Conger, S., Galup, S., Hernandez, A., Probst, J., & Venkataraman, R. (2007). AMCIS 2007 panel on IT service management: IT service management in the IS curriculum. *CAIS, 20*(35), 555-566.

Bieberstein, N., Bose, S., Walker, L., & Lynch, A. (2005). Impact of service-oriented architecture on enterprise systems, organizational structures, and individuals. *IBM Systems Journal*, *44*(4), 691–708. doi:10.1147/sj.444.0691

Cantor, M. (2003). *Rational unified process for systems engineering*. Retrieved from http://www.therationaledge.com/content/aug_03/f_rupse_mc.jsp

Checkland, P. (2000). Soft systems methodology: A 30-year retrospective . In Checkland, P. (Ed.), *Systems thinking, systems practice*. Chichester, UK: John Wiley & Sons.

Chesbrough, H., & Spohrer, J. (2006). A research manifesto for services sciences. *Communications of the ACM*, *49*(7), 35–40. doi:10.1145/1139922.1139945

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.

Glass, R., Armes, V., & Vessey, I. (2004). An analysis of research in computing disciplines. *Communications of the ACM*, *47*(6), 89–94. doi:10.1145/990680.990686

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

Hunter, R., & Blosch, M. (2003). *Executive summary: Managing the IT risks*. Stamford, CT: Gartner Company.

International Organization for Standardization. (2005a). *ISO/IEC 20000-1: Information technology – service management, part 1: Specification* (pp. 1–16). Geneva, Switzerland: ISO/IEC.

International Organization for Standardization. (2005b). *ISO/IEC 20000-1: Information technology – service management, part 2: Code of practice* (pp. 1–34). Geneva, Switzerland: ISO/IEC.

Kettinger, W., & Lee, C. (1997). Pragmatic perspectives on the measurement of information systems service quality. *Management Information Systems Quarterly*, *21*(2), 223–240. doi:10.2307/249421

Kettinger, W., & Lee, C. (2005). Zones of tolerance: Alternatives scales for measuring information systems service quality. *Management Information Systems Quarterly*, *29*(4), 607–623.

Kontogiannis, K., Lewis, G., Smith, D., Litoiu, M., Müller, H., Schuster, S., & Stroulia, E. (2007). The landscape of service-oriented systems: A research perspective. In *Proceedings of the IEEE International Workshop on Systems Development in SOA Environments* (pp. 1-6).

Leitheiser, R., & Wheteber, J. (1986). Service-support levels: An organized approach to end-user computing. *Management Information Systems Quarterly*, 337–349. doi:10.2307/249187

Levitt, T. (1972). Production-line approach to service. *Harvard Business Review*, 41–52.

Lewis, L. (1976). Service level: A concept of the user and the computer center. *IBM Systems Journal*, *4*, 328–357. doi:10.1147/sj.154.0328

Lusch, R., & Vargo, S. (Eds.). (2006). *The service-dominant logic of marketing: Dialog, debate, and directions*. New York, NY: M.E. Sharpe.

Marks, E., & Bell, M. (2006). *Service-oriented architecture: A planning and implementation guide for business and technology*. Hoboken, NJ: John Wiley & Sons.

Mora, M., Gelman, O., Frank, M., Cervantes, F., & Forgionne, G. (2008a). Toward an interdisciplinary engineering and management of complex IT-intensive organizational systems: A systems view. *International Journal of Information Technologies and Systems Approach*, *1*(1), 1–24. doi:10.4018/jitsa.2008010101

Mora, M., Gelman, O., Paradice, D., & Cervantes, F. (2008b, May 18-20). The case for conceptual research in information systems. In *e-Proceedings of the International Conference on Information Resources Management*, Niagara Falls, ON, Canada (pp. 1-10).

Mora, M., O'Connor, R., & Macias, J. (2009b, June 14-16). Toward an engineering and management framework for service-oriented IT organizational systems. In *e-Proceedings of the GITMA Conference*, Mexico.

Mora, M., Raisinghani, M., O'Connor, R., & Gelman, O. (2009a). Toward an integrated conceptualization of the service and service system concepts: A systems approach. *International Journal of Information Systems in the Service Sector*, *1*(2), 36–57. doi:10.4018/jisss.2009040103

OECD. (2004). *Highlights of the OECD information technology outlook 2004*. Retrieved from http://www.oecd.org

OGC. (2002). *Planning to implement service management*. London, UK: TSO.

OGC. (2007). *The official introduction to the ITIL service lifecycle*. London, UK: TSO.

Olson, M., & Chervany, N. (1980). The relationship between organizational characteristics and the structure of the information service function. *Management Information Systems Quarterly*, 57–68. doi:10.2307/249337

Parasuraman, A., Zeithaml, V., & Berry, L. (1988). SERVQUAL: A multiple-item scale for measuring consumer perceptions in service quality. *Journal of Retailing*, *64*(1), 12–40.

Pitt, L., Watson, R., & Kavan, C. (1997). Measuring information systems service quality: Concerns for a complete canvas. *Management Information Systems Quarterly*, *21*(2), 209–221. doi:10.2307/249420

Quinn, J. (1992). *Intelligent enterprise*. New York, NY: Free Press.

Sage, A. P., & Cuppan, C. D. (2001). On the systems engineering and management of systems of systems and federations of systems. *Information Knowledge Systems Management*, *2*, 25–345.

Scheselinger, L., & Heskett, J. (1991). The service-driven service company. *Harvard Business Review*, 71–81.

Sheehan, J. (2006). Understanding service sector and innovation. *Communications of the ACM*, *49*(7), 43–47. doi:10.1145/1139922.1139946

Spohrer, J., Maglio, P., Bailey, J., & Gruhl, D. (2007). Steps toward a science of service systems. *IEEE Computer*, 71-77.

Sprott, D., & Wilkes, L. (2004). *Understanding service-oriented architecture.* Retrieved from http://msdn.microsoft.com

Suh, N. (1998). Axiomatic design theory for systems. *Research in Engineering Design*, *10*, 189–209. doi:10.1007/s001639870001

Suh, N. (2005). *Complexity: Theory and applications*. Oxford, UK: Oxford University Press.

Sys, M. L. (2005). *Systems modeling language (SysML) specification*. Retrieved from http://www.sysml.org

van Bon, J., Pieper, M., & van deer Veen, A. (2006). *Foundations of IT service management based in ITIL*. San Antonio, TX: Van Haren.

W3C. (2004). *Web services glossary: W3C working group.* Retrieved from http://www.w3.org

Zhao, J., Hsu, C., Jain, H., Spohrer, J., & Tanniru, M. (2007). Panel on: Bridging service computing and service management: How MIS contributes to service orientation. In *Proceedings of the Twenty Eighth International Conference on Information Systems*, Montreal, QC, Canada (pp. 1-4).

Zimmermann, O., Doubrovski, V., Grundler, J., & Hogg, K. (2005, October 16-20). Service-oriented architecture and business process choreography. In *Proceedings of the OOPSLA Companion to the 20th Annual ACM SIGPLAN Conference on Object-oriented Programming, Systems, Language, and Applications*, San Diego, CA (pp. 301-312).

Zimmermann, O., Krogdahl, P., & Gee, C. (2004). *Elements of service-oriented analysis and design: An interdisciplinary modeling approach.* Retrieved from http://www.128-ibm.com

Zysman, J. (2006). The algorithmic revolution–the fourth service transformation. *Communications of the ACM*, *49*(7), 48–48. doi:10.1145/1139922.1139947

*This work was previously published in the International Journal of Service Science, Management, Engineering, and Technology, Volume 2, Issue 2, edited by Miguel-Angel Sicilia, pp. 1-15, copyright 2011 by IGI Publishing (an imprint of IGI Global).*