2009 Fourth International Conference on Software Engineering Advances

Integrating IT Service Management within the Enterprise Architecture

Anacleto Correia
QUASAR/VALSE, CITI, Dep. Informática,
Fac. Ciências e Tecnologia, Univ. Nova de Lisboa &
Instituto Politécnico de Setúbal,
Escola Superior de Tecnologia, Setúbal, Portugal
accorrei@est.ips.pt

Fernando Brito e Abreu
QUASAR/VALSE, CITI, Dep. Informática,
Faculdade de Ciências e Tecnologia,
Universidade Nova de Lisboa
Caparica, Portugal
fba@di.fct.unl.pt

Abstract — *Published work in the IT services area is generally centered on the description of management best practices or specific technological issues. There is a lack of empirical studies the relationship among service level agreements (the quality parameters of service agreed between customer and provider) and the required IT parts to deliver IT services. In the ITIL framework, the service level agreements process is fully described, albeit without a formal representation. Enterprise Architecture frameworks provide a mean for formal description of IT and business parts of organizations and their interrelationships, however without reference to service level agreements. In this research, we intend to derive a formal specification of service level agreements by integrating IT Services Management within an Enterprise Architecture framework. This integration will facilitate the provision of a business-aligned automatic checking of compliance between agreed and provided services.*

Keywords: Software Engineering Management, Software Engineering Process, Software Engineering Tools and Methods, Software Quality

I. INTRODUCTION

Medium to large enterprises operate most times on competitive and unfavorable environments (e.g. rising prices of raw materials and strict regulation), intertwined on complex relationships among suppliers and customers. Since this supply chain is heavily underpinned by Information Technology (IT) systems, the way IT services are managed and provided often conditions those companies' success. Although on some subareas of IT Service Management (ITSM), such as the one of IT infrastructures, there are ongoing initiatives on establishing a body of knowledge [1, 2], those efforts do not yet provide a basis to formal definition and assessment of IT services in general. Most of the work published in the IT services area is either centered on the identification of best practices (e.g. ITIL [3], COBIT [4], and CMMI [5]) or focuses on service oriented architectures (SOA) and web services. We are concerned with a more generic and technology-independent view on IT services, applicable whenever a service can be identified and their quality characteristics can be described.

To fulfill these requirements it is crucial that IT products and services provided by IT departments (or outsourced), support current business operations.

It is our research objective to study the relationship between customer's levels of service and the IT components that jointly provide enterprise's IT services. With this purpose, in section 2, we will explain the state-of-the-art in a set of knowledge domains that intersect each other in our research: (1) customer requirements of IT services, (2) management of IT service levels and (3) IT components organization. These topics fall, in the domains of, respectively, Quality Management (QM), IT Service Management (ITSM) and Enterprise Architecture (EA). Section 3 outlines the research objectives to be pursued. In section 4 we describe the ongoing work and preliminary results achieved. Section 5 describes our research work plan and, finally, section 6 draws some conclusions.

II. STATE-OF-THE-ART

In this section we will summarize the current state-of-the-art in the knowledge domains to be addressed in our research. We will start to review each domain separately and then progress throughout their intersection.

A. *Quality Management*

QM is the knowledge domain that deals with the set of activities related to design, development and implementation of products or services in an effective and efficient way. QM is deployed in organizations through Quality Management Systems (QMS), as defined in the ISO 9000 family of standards [6]. The role of a QMS is to assist the organization in handling customer requirements from project to operation. These requirements, whose guidelines are stated in the ISO 9001:2000 standard itself [7], can be specified by means of a contract or established by the organization, by using methods such as marketing research. Regardless the adopted approach to specify products or services, the acceptability parameters are mostly determined by the user or customer [8].

No matter how the initial definitions of customer's requirements are achieved, customer needs and expectations tend to change. Therefore, a permanent monitoring of customer's demands is required, as well as the continuous improvement of the organization's processes and services.

Therefore, delivering services that meet customer's requirements involves a dual approach. Firstly, services must conform to specified technical specifications that address certain attributes related to service performance and characteristics. Secondly, the organization must ensure that

978-0-7695-3777-1/09 $26.00 © 2009 IEEE
DOI 10.1109/ICSEA.2009.87

these attributes are consistently built into or incorporated in the service.

QMS are a tool for continuous improvement and tracking of stakeholders' satisfaction. QMS third party certification conveys an assurance that products and services consistently fulfill specified requirements.

ISO 9001:2000 promotes the use of a process approach when developing and structuring the various QMS activities of an organization [7]. The scope of ISO 9004:2000 [9] is more limited than the one of ISO 9001:2000. It provides guidelines to organizations for performance improvement. It gives guidance on the systematic application of QM to improve organization's processes in order to achieve effective and efficient performance. It assists an organization in establishing, documenting, implementing, maintaining, and improving its QMS, and may be used to evaluate and improve its "maturity". The concept of self-assessment described in ISO 9004:2000 is useful for organizations in evaluating and improving the maturity of their QMS.

ISO 9004 is in fact a bridge between ISO 9001:2000 and a number of recognized assessment frameworks that foster comparative evaluations of organizational performance and facilitate the identification of improvement areas for QMS. Among those frameworks, we emphasize the *Bootstrap* software process assessment method [10], *TickIT* [11] an interpretation of ISO 9001, that takes into account the special requirements of software development, ISO/IEC 15504 (aka *SPICE - Software Process Improvement and Capability dEtermination*) a framework for the assessment of processes initially derived from process lifecycle standard ISO 12207, and, finally, the *Capability Maturity Model Integration* (CMMI) [5] that provides a unified framework for improvement in software engineering, systems engineering, integrated product and process development, and supplier sourcing.

B. IT Service Management

The objective of ITSM processes is contributing to the quality of IT services. ITSM models do not prescribe the type of organization, but instead describe the relationships among the activities in processes, which are relevant to any organization [12].

Organizations that provide IT services are concerned in complying to ITSM standards, such as the *IT Infrastructure Library* (ITIL) [3]. ITIL addresses IT service management, governance, quality and operational issues and has become the *de facto* standard for describing the fundamental processes in ITSM. One of the activities of ITSM addressed by ITIL, which is especially relevant in the scope of our research, is *Service Level Management* (SLM). The goal of SLM is to "*maintain and improve IT service quality, through a constant cycle of agreeing, monitoring and reporting upon IT service achievements and instigation of actions to eradicate poor service, in line with business or cost justification*" [13]. SLM is related with services provided to the customer (customer focus). By creating services based on customer needs (demand pull), instead of merely based in technological feasibility (supply push), allows IT organizations to improve customer satisfaction [14]. Therefore, the objective of SLM is to establish clear agreements with the customer, regarding the type and quality of IT services to be delivered, and to implement these agreements. Consequently, SLM requires a quantitative monitoring on the fulfillment of customer requirements in services provided by the IT organization, using approaches such as the *Six Sigma* [15]. Nevertheless, SLM activity should be properly measured by clear and relevant designed metrics. The latter must be designed in line with customer requirements, their collection must be cost-effective and their values must be monitored to ensure that they keep within desired thresholds, with action taken to correct any problems. Since processes and services are continuously improved, so should be the corresponding metrics.

It is important to note that business objectives are the ultimate target, so it is fundamental that all measuring, monitoring and control tools are aligned with business objectives.

Other ITSM frameworks, with somehow different intent (e.g. COBIT [4], *Six Sigma* [15], *Sarbanes Oxley* [16]), complement ITIL along several perspectives (e.g. governance, auditing quality assurance, conformance detection, and financial). They impose constraints to IT management, and provide managers, auditors, and IT users with a set of generally accepted indicators, processes and best practices to assist them in maximizing the benefits derived through the use of IT and proposing appropriate mechanisms.

C. Enterprise Architecture

An Enterprise Architecture (EA) is a model of the organization that specifies its decomposition into individual functional parts, defines those parts, as well as the orchestration among them [17]. EA is used to manage and align IT assets, people, operations and projects to support business objectives and strategies [18].

A landmark in modeling EA was Zachman's Information Systems Architecture (ISA) framework [19], since at the time of its proposal it represented a new way of addressing concepts, different from the vision of software architecture, more concerned on how a software system is built internally [20]. However, the main reasons for the acknowledgement of this framework were its simplicity and the translation from concepts used in Civil Engineering into Information Systems concepts [21].

Several authors and organizations adapted and enhanced the original Zachman Framework, as well as the methodology based on it.

Some examples of the efforts from industry to adapt the Zachman Framework are the *Federal Enterprise Architecture Framework* [22], the *Department of Defense Architecture Framework* (DoDAF) [23], *The Open Group Architectural Framework* (TOGAF) [2], and the *ArchiMate Project* [17].

Regardless the origin of the proposal, an EA intends to serve the following purposes:

- reduce enterprise's complexity into manageable parts;

- provide a navigation map between enterprise's high level and detailed models;
- provide contextual views, focusing selected aspects of the enterprise;
- prevent an isolated approach to a business or IT requirement, by providing an holistic solution.

An EA is usually split into a few other architectures, that roughly correspond to some of the views of the Zachman framework, for instance in [2, 24]:

- *Business Architecture* - defines the business strategy, governance, organization, and business processes;
- *Data Architecture* - describes the structure of an organization's logical and physical data assets and data management resources;
- *Applications Architecture* - provides a blueprint for the individual application systems to be deployed, their interactions, and their relationships to the organization's core business processes;
- *Technology Architecture* - describes the software infrastructure, intended to support the deployment of core, mission-critical applications.

Different authors have proposed distinct architectural framework decompositions or domains, each as a composition of sub–architectures or domains [25, 26].

D. IT Service Management vs. Quality Management

Service quality is closely related with QM and process control within an organization. Therefore, for implementing a QMS, an organizational structure related to responsibilities, procedures and resources must be set up. Recall that the ISO 9000 series of standards is used to develop, define, assess and improve a QMS. Some of the general quality objectives in ISO 9001 that could be applied to ITSM include [27]:

- procedures that cover all key processes in the business;
- monitoring processes to ensure they are effective;
- keeping adequate records; checking final output for defects, with appropriate and corrective action where necessary;
- regularly reviewing individual processes and the quality system itself for effectiveness; and
- facilitating continual improvement.

A specialization of the ISO 9000 family of standards, the ISO 20000 based on ITIL v2, is a good example of QM in the context of ITSM, since its focus is on the definition of the minimum quality level for IT operations. For ISO 20000 to be effective, it is important that a sound QMS is in place with sufficient maturity. Processes should also be implemented in a consistent, repeatable manner, and the metrics defined within them must be reliable to provide useful measurements.

E. Enterprise Architecture vs. Quality Management

The relationship between EA and QM is twofold. It is concerned with: (1) the adaptability of EA to accommodate different quality frameworks and (2) EA's quality model.

The first issue is relevant since most organizations follow a set of standards to guide their internal processes. However, prospective customers often require different standards compliance in call for tender actions [28]. This compliance is usually not problematic since those standards are often complementary, rather than mutually exclusive. For instance, where ISO 9000 is generic, the CMMI provides detail, and where CMMI is too broad, ISO 9000 can allow focus. Nevertheless, both are based on the same principles of process engineering, continuous process improvement, and customer satisfaction [8].

Standards or frameworks that have been successfully implemented in an organization are periodically updated or revised. If they undergo major changes, this could have an important impact in the EA. Framing the development of QM approaches in the context of an EA framework, helps to mitigate potential side-effects, due to the aforementioned evolution.

Regarding EA's quality model, we need to express its characteristics and ways of evaluating them. A solution to this problem, proposed in [24], used a metamodel to represent the EA modeling constructs and a constraints definition language upon that metamodel to formalize a set of metrics for the quality characteristics. This proposal was based on the M2DM approach, originally published in [29].

F. IT Service Management vs. Enterprise Architecture

When EA is regarded as a fundamental concept for organizational engineering, and ITSM is regarded as the dominant operations model for IT, the latter must be sufficiently integrated into the former [30]. EA guarantees consistency in building new products or services and addresses business requirements. ITSM, on the other hand, guarantees the consistency of services with each other, through the use of standard processes. To accomplish that, EA, as well as ITSM, should be supported by a repository [31].

The ITIL framework is underpinned by the *Configuration Management Database* (CMDB) repository, which supports the ITIL services from an operational perspective. The maintenance of the CMDB and its records (*Configuration Items* or CIs for short – e.g. computers, RFCs or SLAs) in ITIL is ensured by the *Configuration Management* process. So, *Configuration Management* should identify, record, and report all IT components, as well as providing a logical model of the infrastructure or a service by identifying, controlling, maintaining, and verifying the versions of the CIs inventory in the CMDB.

The EA repository, on the other hand, is used to store the reference patterns and the architecture building blocks and is used during the architecture development process.

For EA/ITSM integration it is fundamental that the previously mentioned repositories share a common metamodel. Two different approaches could be taken for

building each of the repositories, depending on the ITSM and EA maturity and the tools in place: (1) the CMDB could be aligned with the EA existing repository schema, when the CMDB does not have a predefined meta-data model; or (2) the CMDB metamodel could be extended when it is used to store the architectural assets of the EA, to become its virtual repository.

The integration of ITSM in EA components requires that SLM should be considered, since the definition of EA principles and policies.

III. RESEARCH OBJECTIVES AND APPROACH

By analyzing the contributions of the three above mentioned domains we can emphasize that:

- QM related to IT services should be specialized through ITSM implementation. ITSM defines the minimum quality level for IT operations. For an effective management of quality, a QMS should be set and the SLM process should be implemented in a consistent, repeatable manner, assessed by adequate metrics.
- EA guarantees a consistency for the building of new products or services and addresses business requirements. ITSM, on the other hand, guarantees the consistency of services with each other through the use of standard processes. The alignment between EA and ITSM requires a shared repository and the integration of SLM in EA components, since the definition of EA principles and policies.

In our research, we intended to get answers to the following research questions:

- Q1: Where in the EA models, should SLA specification be located?
- Q2: How to configure SLM process to implement SLAs within the context of the EA?
- Q3: Which key performance indicators should be used to monitor SLAs within the EA?

To answer those questions we plan to pursue the following steps:

- **Define a conceptual framework for IT services**. This framework will be comprised of an ontology for IT Services and a process model of SLM. The latter will capture the dynamic aspects of SLAs.
- **Integrate IT services and EA frameworks**. As seen previously, several EA frameworks were proposed in the literature. We will perform an in-depth analysis of those frameworks to select the most adequate one to be considered for merging our IT services ontology with it. Upon the resulting merge we plan to propose a quality model for SLM.
- **Select a validation strategy.** We intend to validate the SLM quality model by using the scientific method. The planning of experiments will include defining context parameters, formulating detailed research hypotheses (e.g. by defining null and alternative hypotheses), selecting sample subjects and their descriptive variables, defining the experimental design and choosing the appropriate statistical techniques to apply.
- **Data collection**. This will be one of the most critical activities, since for performing an adequate validation, we need to collect data from real EA and SLM implementations, including data on SLA's compliance, and the latter may not be available.
- **Data analysis and interpretation**. Here we will test our research hypotheses, and draw conclusions based on domain knowledge. Validity threats should be identified here, as well.
- **Results packaging and dissemination.** This will be performed by producing well structured experiment reports that will be made available to the scientific community, to enable experiments replication.

IV. CURRENT WORK AND PRELIMINARY RESULTS

Regarding the first step of the adopted methodology (conceptual framework) we have produced an ontology for IT services, following a Model-Driven Development (MDD) approach [34]. Ontologies can play an important role on standardizing and formalizing QM, ITSM and EA concepts. They provide a formal representation of domain concepts and their interrelationships, thus reducing their ambiguity [32]. Common terms, with shared meaning, as well as an agreed QoS model [33], should be used jointly and understood by suppliers (alone or in a consortia) and clients. Our ontology for IT services, is expressed with UML and uses the OCL constraint language to formalize well-formedness rules, thus removing some ambiguities of the diagrammatic notation. This ontology provides an abstract, compact and formal approach that covers services management and implementation through the phases of design, negotiation, provisioning, usage, and uninstall. Upon this ontology we can formalize metrics definitions for ulterior validation with concrete examples.

The proposed ontology is composed of several packages, as represented in Figure 1, where dependencies among packages are shown.

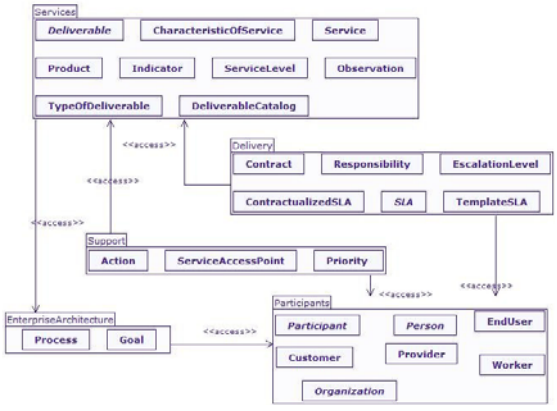

Figure 1. ITS ontology packages

We will briefly describe here only services and delivery packages (for more details see [34]). Since services can be associated with product deployments, we have generalized

the concept of deliverable, to include both services and products (Figure 3). Deliverables can (i) be chosen from a catalogue of services, (ii) be hierarchically composed and (iii) be categorized according a set of types. Deliverables can also be characterized by a set of characteristics (e.g. performance, availability). The latter can be hierarchically decomposed and be quantitatively evaluated by means of a set of indicators (e.g. response-time, downtime). Each SLA defines the acceptable values of some statistics calculated upon the indicators. Those values are compared with the corresponding ones obtained from the observations of the indicators on the context of the same SLA.

In real world, service designers usually define a set of standardized SLAs, for instance creating different cost/benefit alternatives (e.g. platinum, gold). These alternatives can be used as a template for specific SLAs to be contractually set between a client and a provider (see Figure 4). A set of deliverables can be explicitly included (automatically or under request) or excluded from a contract. All the services covered by an SLA have responsibilities that must be assumed by the customer or by the provider. The escalation level provides a basis, both on the provider and clients sides, for solving conflicts on services delivery.

V. WORK PLAN AND IMPLICATIONS

The research work plan takes into account the following main tasks (Figure 2):

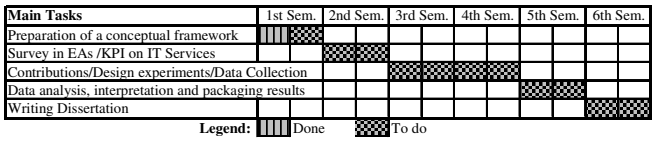

Figure 2. PhD work plan

In the first semester we built the Services Domain Ontology (Figure 1), and now we are currently finishing a survey on the state of the art of EA/ITSM/SLAs. In parallel we are working on a process model for SLM whose intent is capturing the dynamic aspects of SLAs. In other words, we are formalizing service's delivery by using business process modeling techniques. In the next semester we will survey existing EA frameworks, to select the one that will better accommodate our IT services ontology. Upon the resulting merge we expect to propose a quality model for SLM, based on a set of key performance indicators for IT services provision. We also plan to organize and promote an international workshop about the quality of IT services provision in the scope of EA, co-located with the QUATIC'2010 conference. This will hopefully be a good occasion to receive feedback on our work, since we expect to meet the most relevant domain experts during this event.

In the second year we will be able to make innovative contributes by formalizing SLAs upon EAs. Moreover, we will design and plan the experiments to validate our contributions. We will do so by defining context parameters, formulate hypotheses, and select variables and subjects. The design of experiments will be done by defining collecting process and analysis techniques. Finally we will make experiment execution by data collection, and data validation. We intend to instantiate our model with real-world SLA contracts and observations of indicators describing service characteristics, to assess large-scale SLA compliance. As we previously stated, data collection will be the most critical task, since it will depend on the availability of real data. Even under strict non-disclosure agreements, these data will probably be hard to obtain. In the end of this year we planned to organize and promote a 2nd edition of the previously mentioned workshop.

In the last year we will make the data analysis and hypotheses testing, followed by results packaging (results interpretation, validity threats identification, inference, and summarize conclusions). A 3rd edition of the workshop will be organized during this year. Dissertation writing and revising should be done by the end of the third year.

VI. CONCLUSIONS

In this research we intend to provide a formal specification of ITSM within EA, which allow automatic checking of compliance of SLAs. To do so, we are defining a conceptual framework for IT Services and a process model of SLM in EA. This integration will facilitate the provision of a business-aligned automatic checking of compliance between agreed and provided services.

To check the usefulness of our approach we plan to design experiments, in order to validate our contributions with an empirical approach. To do so we will need to collect data from real organizations providing IT services. This will allow to instantiate our model with real data.

The data collection step will require a strategy to face potential donators. We believe that this will be possible within an adequate framework where the latter will value the return they will obtain by getting the hands on the methods and techniques to be proposed in the context of this dissertation.

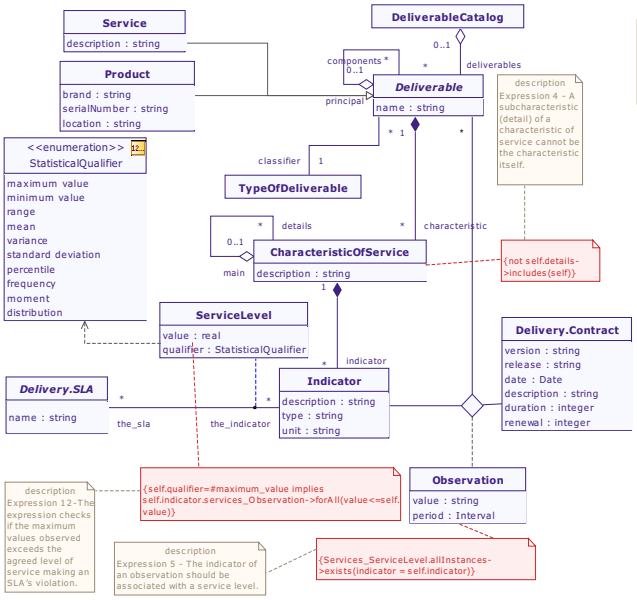

Figure 3. Services package

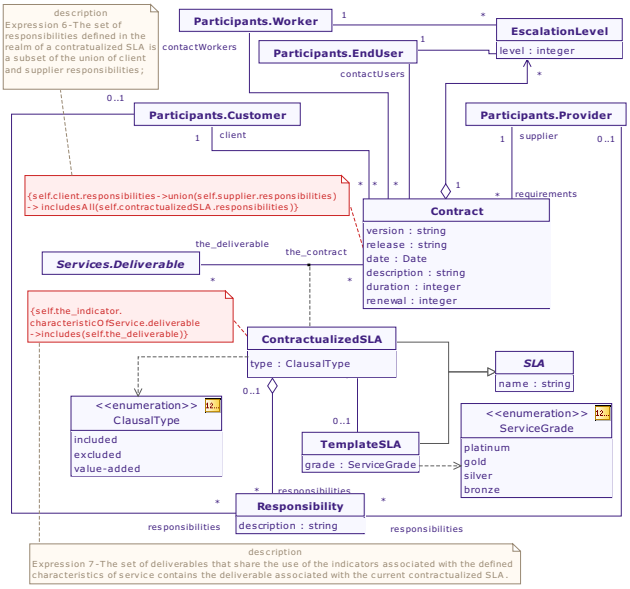

Figure 4. Delivery package

REFERENCES

[1] OGC, Office of Government Commerce: *Summary, ITIL Version 3*, ITSMF- IT Service Management Forum, 2007.

[2] OG, The Open Group: *TOGAF™ Version 8.1 - Enterprise Edition*, 2007.

[3] OGC, Office of Government Commerce: *Service Strategy, ITIL Version 3*, ITSMF- IT Service Management Forum, 2007.

[4] ITGI, T.I.G.I.-. *COBIT® 4.1 - Framework, Control Objectives, Management Guidelines, and Maturity Models*, 2007.

[5] SEI, S.E.I.-. *CMMI® for Development,Version 1.2 - CMMI-DEV, V1.2*, SEI - Carnegie Mellon University, 2006.

[6] ISO9000-1, International Organization for Standardization: *ISO 9000-1:2005 - Quality management systems -- Fundamentals and vocabulary*, 2005.

[7] ISO9001, International Organization for Standardization: *ISO 9001:2000 - Quality management systems -- Requirements* International Organization for Standardization, 2000.

[8] Landry, P.D.: *The ISO 9000:2000 Essentials - 3rd Edition*, Canadian Standards Association, 2001.

[9] ISO9004, International Organization for Standardization: *ISO 9004:2000 - Quality management systems -- Guidelines for performance improvements*, International Organization for Standardization, 2000.

[10] BI, Bootstrap Institute *Bootstrap Methodology - version 3.0*, 1997.

[11] BSI: *TickIT Guide (5.5) - A Guide to software quality management system construction and certification to ISO 9001:2000* 2007.

[12] Thiadens, T.: *Manage IT! - Organizing IT Demand and IT Supply*, Springer, 2005.

[13] OGC, Office of Government Commerce: *ITIL Service Delivery Version 2.0*, 2003.

[14] Bon, J.v., Pieper, M., and Veen, A.v.d. (eds.): *Foundations of IT Service Management: Based on ITIL, ITIL Version 2*, Van Haren Publishing, 2005.

[15] Persse, J.R.: *Process Improvement Essentials*, O'Reilly Media, Inc., 2006.

[16] Lander, G.: *What is Sarbanes-Oxley?*, McGraw-Hill, 2003.

[17] Lankhorst, M., Iacob, M.-E., Jonkers, H., and al.: *Enterprise Architecture at Work - Modelling, Communication, and Analysis*, Springer-Verlag Berlin Heidelberg 2005.

[18] Ross, J.W., Weill, P., and Robertson, D.C.: *Enterprise Architecture as Strategy* McGraw-Hill Europe, 2006.

[19] Zachman, J.: 'A Framework for Information Systems Architecture': (1987).

[20] IEEE1471-2000: *IEEE Recommended Practice for Architectural Description of Software-Intensive Systems - ANSI/IEEE Std 1471-2000*, 2000.

[21] Zachman, J., and Sowa, J.F.: 'Extending and formalizing the framework for information systems architecture': (1992), pp. 590–616.

[22] Chief Information Officer Council, C.: *A Practical Guide to Federal Enterprise Architecture, Version 1.0*, 2001.

[23] DoD, Department of Defense: *DoD Architecture Framework, Volume I: Definitions and Guidelines - Version 1.5*, 2007.

[24] Vasconcelos, A.: *Arquitecturas dos Sistemas de Informação: Representação e Avaliação*, Universidade Técnica de Lisboa - Instituto Superior Técnico, 2007.

[25] Berg, M.v.d.: *Dynamic Enterprise Architecture: How to Make it Work*, John Wiley & Sons Inc., 2005.

[26] Hoogervorst, J.: 'Enterprise Architecture Enabling Integration, Agility and Change Agility and Change.' *International Journal of Cooperative Information Systems*, 2004, 13(3), pp. 213–233.

[27] Schlickman, J.J.: *ISO 9001: 2000 Quality Management System Design*, Artech House 2003.

[28] Chrissis, M.B., Konrad, M., and Shrum, S.: *CMMI®: Guidelines for Process Integration and Product Improvement*, Addison Wesley, 2003.

[29] Brito e Abreu, F.: '*Using OCL to formalize object oriented metrics definitions'*, Technical Report ES007/2001, INESC - Portugal, June, 2001.

[30] Braun, C., and Winter, R.: 'Integration of IT Service Management into Enterprise Architecture', *Proc. of SAC'07*, Seoul, Korea, March 11-15, 2007.

[31] Thorn, S.: 'TOGAF™ and ITIL®': (2007).

[32] Habrias, H., and Frappier, M. (eds.): *Software Specification Methods*, ISTE Ltd, 2006.

[33] OMG, Object Management Group: *UML Profile for Modeling Quality of Service and Fault Tolerance Characteristics and Mechanisms - Version 1.0*, The Object Management Group, 2006.

[34] Freitas, J., Correia, A., and Brito e Abreu, F.: 'An Ontology for IT Services', *Proc. of 13th Conference on Software Engineering and Databases (JISBD'2008)*, Gijón, Spain, 2008.