Designing a Process Assessment Model Based on Multiple Sources - A Procurement Case

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Abstract. This paper relates the design of a procurement processes assessment model based on multiple sources. The authors explain the literature on procurement processes, procurement capability determination and maturity models, and the related published frameworks. The paper describes the selected sources and compares them together. Then the Transformation Process used to design the process assessment model, based on the use of goal trees and requirements derivation is detailed and then further discussed. A part of the resulting process assessment model is presented. The originality and the main explorative part of the works resides in the combined use of several sources to build the model.

Keywords: Procurement · Process assessment model
Requirement engineering · Transformation process · ISO

1 Introduction

Procurement is a necessary activity for many organisations, should they be public or private. Dealing with the establishment of contractual relationships between organisations for the provision of works supplies or services, procurement is in the scope of both Regulatory Compliance and Governance, although it tends to be ignored or minimized; for example very few Process Assessment Models (PAM) focused on procurement exists. Among these few, no model is fully compliant with the requirements of the ISO/IEC 33004 standard [1]. Such PAM would allow organisations to determine their capability with regards to their procurement practices, to support the implementation of new practices or processes, or to determine process-related risks.

This paper presents an attempt to design a PAM that is compliant with the ISO/IEC 33004 requirements, that addresses public or private organisations, with the widest possible procurement scope so as to cover either services, supplies or both, and that is not limited to the domain of Information Technology (IT). Previous works related to the elaboration of process assessment models are usually based on a single or a main source. The source is either the reference for the business sector (e.g. the exemplar PAM of the ISO/EC 15504-5 [2] is based on ISO/IEC 12207 standard [3], the TIPA for ITIL PAM [4] is based on the latest version of the IT Infrastructure Library [5]), or, when the PAM is built on purpose, the framework used by the organisation under assessment. In the specific case of procurement, no single or main standard exists, but

X. Larrucea et al. (Eds.): EuroSPI 2018, CCIS 896, pp. 136–146, 2018.
https://doi.org/10.1007/978-3-319-97925-0_11

several frameworks and sources provide partial and complementary views on procurement. The question raised by this paper is then: *how to build a generic PAM, based on multiple sources?* The application case is the domain of procurement.

Section 2 describes the works carried out by the authors and their peers in the fields of procurement and process assessment. Section 3 details the main sources used to build the procurement PAM. Section 4 describes the Transformation Process that we followed in order to build the procurement PAM. Section 5 discuss the variations in the application of the Transformation Process and the limits of the current works.

2 Related Works

A recent literature review [6] shows that the determination of organisations' procurement capability is not sufficiently addressed by the research. Although research has been carried out to develop maturity models for outsourcing [6] or IT procurement capability determination models [7], most stayed at the design or at the experimentation levels. Up to the authors knowledge [8] only few frameworks oriented towards procurement process have been taken up by the market. These few address mainly mature organisations and the IT domain. This led the authors to build a specific IT procurement process framework for small organisations whose deployment was described [9] and whose usage was later analysed [10]. Though, neither this framework proposal for small organisations nor the ones identified in the literature, and further described in the following Sect. 3, do address the capability determination of an organisation with regards to its procurement processes in a domain-independent context and embracing both public and private procurement.

For the International Organization for Standardization (ISO), in the domain of process assessment, the ISO/IEC 330xx series of standards [11] is the reference. It is composed of several documents, both normative (i.e. those providing requirements), and informative (i.e. guidance and examples). Recently revised, the latest version of this standard is now generic, and can been used to assess any quality characteristic (such as capability, security, or safety) of any process of any kind of domains [12–14]. For that, the assessment method relies on well-defined PAMs whose content and structure comply with the requirements defined in ISO/IEC 33004 [1].

In 2008, The Luxembourg Institute of Science and Technology – LIST (previously known as Public Research Centre Henri Tudor) published its own Transformation Process [16] for building ISO-compliant process reference, process assessment, and organizational maturity models from a collection of requirements. Based on Goal-Driven Requirements Engineering techniques [17], this Transformation Process has been widely used to build various process models, such as: a PAM for Management Systems Standards [18], a PAM for ITIL v3 [19], a PAM for ITIL 2011 [4], a PAM for assessing Medical IT networks [20], or a Maturity Model for ISO/IEC 20000-1 [21].

The application of this Transformation Process to several procurement-related frameworks will be described in detail in Sect. 4.

3 Source Documents for Building the PAM

In order to carry out the building of a procurement PAM, the procurement-related frameworks were watched and candidates were identified to be used as sources.

The Information Services Procurement Library (ISPL) [22] is a set of five books published by EXIN (Dutch editor) in 1999. The aim of ISPL is to define a framework (processes, deliverables, good practices) formalizing the acquisition of IT services. ISPL addresses well-structured organisations performing large-scale IT acquisitions. The main procurement processes described in ISPL are: Acquisition initiation, Procurement that is subdivided into three sub processes (Tendering, Contract monitoring, and Contract completion) and Acquisition completion.

In 2000, the Software Engineering Institute of the Carnegie Mellon University, based on its generic Capability and Maturity Model (CMMi) [23], issued both the e-Sourcing Capability Model and an adaptation of the CMMi for Acquisition projects (CMMi–Acq) [24]. While CMMi-Acq follows the main principles of CMMi but considers the case where the organisation purchases third party components rather than develops in-house, eSCM was built with a view to assess both the capability of suppliers and purchasers in the scope of IT services outscoring. Thus eSCM is published in two versions: one dedicated to services providers (eSCM-SP) [25] and one dedicated to purchasers or so-called clients (eSCM-CL) [26]. Considering the procurement point of view (rather than the point of view of propositions and services provision), the clients' version of eSCM (eSCM-CL) is more relevant for designing the PAM.

In 2016, the Institute of Electrical and Electronics Engineers (IEEE) published 'Recommended Practice for Software Acquisition', under reference IEEE-1062:2015 [27]. Although not a standard, this document provides description of practices for software acquisition that follows the principles of the process description in other IEEE and ISO standards with descriptions of processes, purposes, outcomes and activities.

A last meaningful source of information is the European public procurement directive, whose last version dates back to 2014. The Directive 2014/24 EU [28] establishes the legal and regulatory background for public procurement. It describes requirements in term of Obligations and Rights. Some of them are organized according to the main stages of a procurement process (particularly in the *Chapter III*).

In order to comply with the objective of a PAM addressing organisations either public or private, with the widest possible procurement scope, these four sources should be used together for the design of the PAM.

4 Designing the Process Assessment Model for Procurement

4.1 Analysing the Source Documents

We started the design of our PAM for procurement by comparing the four documents described in Sect. 3. For that, we highlighted their main differences and similarities with regards to their scope, targeted audience, and structure. Thus, the scope was analysed by considering both the purchasing goal (acquisition vs. outsourcing) and the purchasing object. Indeed outsourcing, compared to acquisition, implies a deeper

approach since some activities of the organisation are delegated to a third party in a longer term customer-supplier relationship. Table 1 below provides a comparison overview of the four sources.

Table 1. Main characteristics of the sources used for the procurement PAM

Date	Source	Scope: goal	Scope: object	Audience	Structure
1999	ISPL [22]	Acquisition	Information services	Purchasers	Processes groups/process/activities
2000	e-SCM [23]	Outsourcing	Services	Purchasers Suppliers	Processes group/process/purpose/outcome/practice
2016	IEEE 1062:2015 [27]	Acquisition	Software (supplies & services)	Purchasers	Process/purpose/outcome/activities
2014	Directive 2014/24 EU [28]	Acquisition	Works, Supplies, Services	Public purchasers Member states	Rights and obligations Conditions Exceptions

In summary, ISPL is a domain-specific (IT) procurement processes framework not aiming at capability determination; e-SCM is a domain-specific (IT) procurement process capability model, whose capability determination model is not based on the ISO/IEC 3300x series of standards; IEEE 1062:2015 is a domain-specific (software) procurement processes framework not aiming at capability determination; The Directive 2014/24/EU is a public procurement law (domain independent), but not structured around processes and not aiming at capability determination. As one can notice from the overview of the sources, our sources are quite complementary to each other and no single source emerges as the main source for our PAM.

As explained above, our sources cover slightly different topics and have each a different structure. Therefore we applied a qualitative analysis method by coding each source in order to be able to analyse each source's content on a same basis. We used the NVIVO software [29] to code each source. The purpose of coding is to identify categories from raw text content, so as to be able to later analyse properties, and detect concepts and relationships. Coding requires to have a common coding grid for all sources.

We drafted this grid by identifying a set of phases and processes that would be the common denominator. Such identification was based on expert judgement [15] and consensus among the research team. From the structure of each source, we summarized the main concepts and proposed a set of process groups and processes. This common set, (depicted in Fig. 1), was then used as a coding grid to code the text of each source. An example of the results of the coding for two sources is presented in Fig. 2.

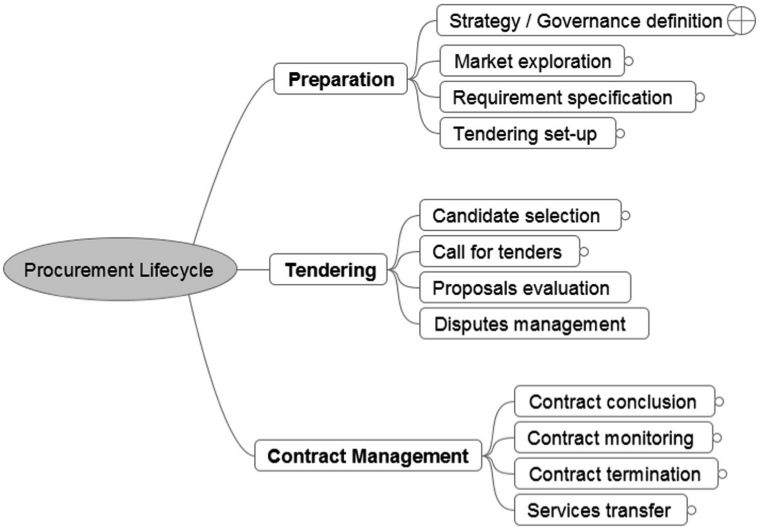

Fig. 1. The candidates' common process groups and processes

4.2 Applying the Transformation Process

For building our PAM, we followed the 9 steps of the Transformation Process described in [16]. The activities conducted during these steps are described below.

Step 1 – Identify Elementary Requirements in a Collection of Requirements. The identification of the elementary requirements were performed during the coding of our selected sources. Indeed, as introduced in Sect. 4.1, we first analysed the content of each document. Thus, during this step, we assigned each individual task, practice, activity, and/or requirement to one of the twelve common processes.

Step 2 – Organize, and Structure the Requirements. For the organization and structuration step, we created one requirement tree per process. With the help of a mind map tool, we obtained a graphical view of all the components coming from our different sources. We also paid attention to keep a record of the origin of each requirement in terms of chapter/section/area. Thus a strict traceability between the elements composing our future procurement PAM and the source document(s) will be ensured. An example of a part of one requirement tree is shown on Fig. 3.

Step 3 – Identify Common Purposes Upon Those Requirements and Organize Them. This step consisted in the semantical analysis of all the requirements attached to a process in order to understand the meaning of each of them. We thus grouped the requirements by common goal, by paying a particular attention to the misalignment of the vocabulary used in the different documents. This allowed us to draft a first version of the overall purpose, and to characterize the scope, of each process.

Step 4 – Identify and Factorize Outcomes from the Common Purposes and Attach Them to the Related Goals. Based on the groups of requirements created during the

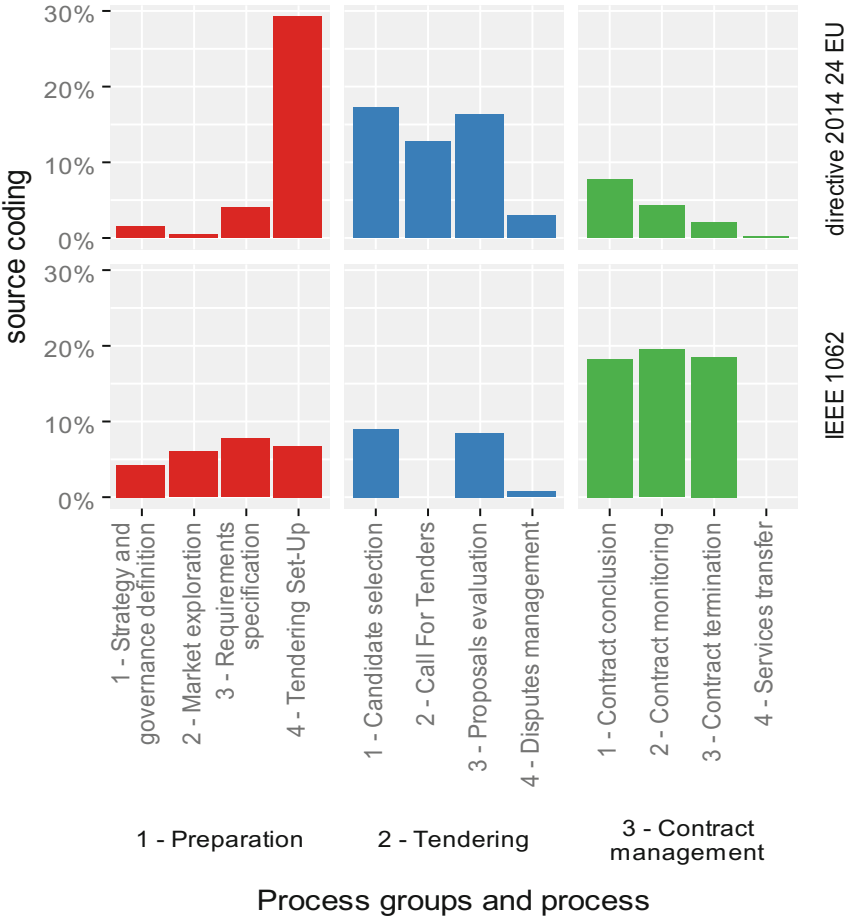

Fig. 2. Example of coding distribution for two sources: % of the coded source text (y) coded to the process (x)

step 3, we drafted the process outcomes. We factorized and/or divided them in order to have between 3 and 7 observable expected results per process (as recommended by ISO/IEC 24774 [30]). Moreover, we designed them in such a way that the whole set of outcomes is necessary and sufficient to ensure the achievement of the process goal.

Step 5 – Group Activities Together Under a Practice and Attach It to the Related Outcomes. For each outcome, we grouped together the tasks and activities that were considered as indicators of the presence of this outcome. For that, we created base practices, by paying attention to exclude the duplicated ones (i.e. similar activities and tasks, coming from our multiple source documents, and using close but different vocabulary).

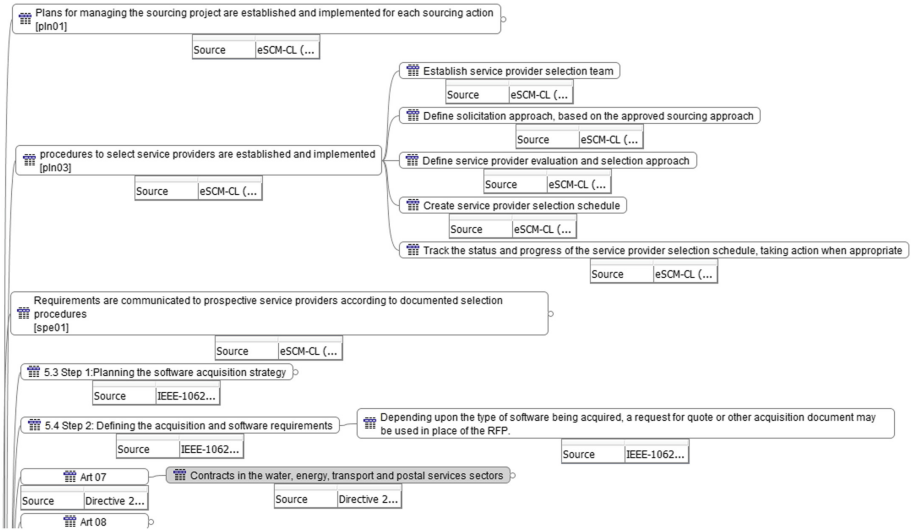

Fig. 3. An example of a part of a requirement tree

Step 6 – Allocate Each Practice to a Specific Capability Level. We analysed the practices designed during step 5, in order to find those that were not directly contributing to the achievement of the process goal. Such practices, which are in fact indicators of a capability attribute above the process performance, were allocated to a level higher than one on the capability scale used in our procurement PAM.

An example of such a higher level indicator is the following practice, coming from the e-SCM framework: *"Establish team for evaluating potential service providers"* and which was allocated to the capability level 2 (Performance Management Attribute).

Step 7 – Phrase Outcomes and Process Purpose. We formulated the process purpose and process outcomes as recommended by the ISO/IEC 24774 standard [30]. Thus, the purpose was expressed using a single verb at the active form and describing the high level objective of the process. Then, the outcomes were phrased at the passive form, using one or more verbs, and describing measurable expected results (such as the production of an artefact, a significant change in state, or the meeting of specified constraints, e.g., requirements, goals, etc.).

Step 8 – Phrase the Base Practices Attached to Outcomes. During this step, we phrased the base practices in a generic way, each starting with an action verb at the infinitive. We avoided the use of vocabulary specific to one of the selected sources. For each practice, we also listed the outcome(s) to which it contributes, and we displayed the source documents from which it was derived.

Step 9 – Determine Work Products Among the Inputs and Outputs of the Practices. The inventory of all the inputs and outputs of each process has not been done yet.

4.3 Resulting Model

The design of the procurement PAM, described above, is still ongoing. For the time being, we have completed the description of three processes out of twelve. We have not started the inventory and description of the process inputs and outputs yet. In its current state, our PAM includes all the references to the source documents(s) at the origin of the different process components (purpose, outcomes, base practices). One example of process description is shown below, on Fig. 4, for the "Market Exploration" process.

Process ID	**MAEX**
Process Name	**Market exploration**
Process Purpose	The purpose of the Market exploration process is to decide on whether or not to initiate the procurement based on the understanding of the market opportunities.
Process Outcomes	As a result of successful implementation of the Market exploration process: 1. High level acquisition objectives are defined; [eSCM-CL opa03] 2. Market opportunities (suppliers and their works/services/products) are identified; [eSCM-CL opa04][IEEE 1062 Step 3] 3. Market opportunities are analyzed; [eSCM-CL app04] 4. Decision on whether or not to initiate the procurement is taken and communicated. [eSCM-CL app05][Directive 2014/24/EU Art 40]
Base Practices	**MAEX.BP1: Identify potential sourcing areas.** [Outcome 1] [eSCM-CL opa03] **MAEX.BP2: Define objectives for sourcing in potential sourcing areas.** [Outcome 1] [eSCM-CL opa03] **MAEX.BP3: Gather information on market opportunities** [Outcome 2] [IEEE 1062 Step 3] [Directive 2014/24/EU Art 40] **MAEX.BP4: Filter market opportunities with regards to the high-level acquisition objectives** [Outcome 2] [eSCM-CL opa04] **MAEX.BP5: Analyze risks related to market opportunities** [Outcome 3] [eSCM-CL app04] **MAEX.BP6: Assess potential impact of works / services / products with regards to the high level acquisition objectives** [Outcome 3] [eSCM-CL app04] **MAEX.BP7: Verify if market opportunities answer high-level acquisition objectives within reasonable risks exposure and positive impact** [Outcome 4] [eSCM-CL app05] **MAEX.BP8: Decide to pursue the procurement** [Outcome 4] [eSCM-CL app05] **MAEX.BP9: Communicate the decision to relevant stakeholders** [Outcome 4] [Directive 2014/24/EU Art 48]

Fig. 4. An example of process description

5 Discussions

Transformation Process is a thematic analysis of qualitative data. Such analysis looks across all qualitative materials available to identify common themes. It can be achieved by using different reasoning methods. The ones that structures Transformation Process is inductive reasoning. Also referred as Grounded Theory [31], it consists in making broad generalization from specific observations. Applied to PAM design, Themes (step 3) should emerge from elementary requirements identification and analysis (steps 1 and 2). Inductive reasoning have been successfully applied to the design of PAM from single source [18–20], but does not really fit where there is multiple sources. Procurement PAM is built from 4 distinct sources hence elementary requirements to be processed are numerous (we counted more than 2000) and their analysis requires long effort (step 2). In order to ensure Transformation Process efficiency, it is necessary, prior to elementary requirements extraction (step 1), to define a first version of the expected Process map (step 3). From a methodological point of view, this Process Map is a coding scheme [32]; and introducing such kind of scheme refers to deductive reasoning. It implies to begin with thinking up a theory about the topic of interest and then continue with testing it by collecting evidences from qualitative materials. Procurement PAM design has started by defining a coding scheme that illustrates procurement process mapping as defined by expert judgement [15] (3 groups, 12 processes).

On the other hand, the team could have chosen to use one of the source as a reference for the groups and processes and to map the other sources to this reference. Two facts prevented the team to do so: first the vocabulary discrepancy, second the risk of bias in the Transformation Process. Indeed each source uses its own terminology to name concepts (like actors, work products, activities …) that seem common within the scope of the procurement PAM. Within each source, some concepts are referred to with specialized terms while other concepts are referred to with more generic terms. So using a common set of groups and processes helped to identify under the same umbrella concepts expressed with different terms in each source. Also should one source had been used as the reference to code the other sources, the steps of the transformation would have probably been interpreted primarily from the perspective of the coding source, thus resulting in a risk of bias (favouring the reference source and lowering the differences of perspective provided by the other sources). In summary, defining a common and specific set of groups and processes helped to generalise both the vocabulary used in the PAM and then to make the design decisions with such genericity in mind.

Procurement PAM's coding scheme has just been used to cluster elementary requirements in order to avoid having to process too large volume of requirements together. But, the deeper analysis of each cluster has been conducted according to inductive reasoning methods. The reasoning method that might be used to design PAM from multiple sources is a combination of deductive and inductive reasoning, also called abductive reasoning method. Abductive reasoning usually starts with incomplete knowledge about a topic and proceeds to its extension through evidences collected at the ground. PAM Procurement Design actually leads to the extension or, at least, to the consolidation of knowledge about procurement.

6 Conclusion and Next Steps

This paper presented the design of a generic procurement PAM, based on several complementary source documents. For the time being, the design work is ongoing, and the expected PAM is thus still under development. In the coming weeks, the authors plan to finalize a first version of this process assessment model. Then, they plan a review and validation phase, where experts in the process assessment domain (members of ISO/JTC/SC7/WG10) will be appealed to make comments and to suggest improvements. After that, a first experimentation is expected, in order to test the procurement process assessment model in a real case study. Last, both the procurement process assessment model and the feedback from the experimentation will be analysed and presented to the community of interest active in the field of procurement for validation. Because the number of sources related to a field of application (i.e. a topic) will continue to increase, the PAM design method have to be adapted accordingly. As discussed in the previous section, analysis of a large volume of elementary requirements implies to modify the step-by-step procedure in order to comply with abduction reasoning principles. But, it also requires to adopt technologies to support the PAM designers in carrying out the analysis process. Achieving PAM design "digitalization" supposes to define and explore function and features of existing and emerging technologies as Natural Language Processing.

References

1. ISO/IEC: ISO/IEC 33004. Information Technology—Process assessment—Requirements for process reference, process assessment and maturity models (2015)
2. ISO/IEC 15504-5:2012. Information Technology—Process assessment—An exemplar software life cycle process assessment model (2012)
3. ISO/IEC/IEEE 12207:2017. Information Technology—Systems and software engineering—Software life cycle processes (2017)
4. TIPA for ITIL 2011 r2 v4.1 (2015). http://bit.ly/23camL4. Accessed 21 Mar 2018
5. The Cabinet Office: ITIL Lifecycle Publication Suite. TSO Edition (2011)
6. Ahmad, E.A.: Maturity models of IT outsourcing: a systematic literature review. Int. J. Adv. Appl. Sci. **4**(12), 52–56 (2017)
7. Dalberg, V., Angelvik, E., Elvekrok, D.R., Fossberg, A.K.: Cross-cultural Collaboration in ICT Procurement. In: Proceedings of the 2006 International Workshop on Global Software Development for the Practitioner, New York, pp. 51–57 (2006)
8. Renault, S.: IT systems and services procurement: a framework-based support for buyers in retrospect. In: Presented at the Eurospi^2 2014, Luxembourg (2014)
9. Renault, S., Barafort, B., Dubois, E., Krystkowiak, M.: Improving SME trust into IT consultancy: a network of certified consultants case study. In: EuroSPI 2007 Industrial Proceedings, Potsdam, pp. 10.1–10.8 (2007)
10. Renault, S.: Organisational software and IT services purchasing. In: Presented at the 25th International Purchasing and Supply, Education and Research Association Conference, Dortmund (2016)
11. ISO/IEC: ISO/IEC 330xx. Information Technology - Process Assessment (2013, 2017)

12. Automotive Spice. http://www.automotivespice.com/fileadmin/software-download/Automotive_SPICE_PAM_30.pdf
13. Lepmets, M., Clarke, P., McCaffery, F., Dorling, A., Finnegan, A.: Development of MDevSPICE® - the medical device software process assessment framework. J. Softw.: Evol. Process (2015). (Special Issue - EuroSPI 2014)
14. Enterprise SPICE (2010). http://enterprisespice.com/page/publication-1. Accessed 21 Mar 2018
15. An introduction to public procurement, Office of Government Commerce, UK (2008)
16. Barafort, B., Renault, A., Picard, M., Cortina, S.: A transformation process for building PRMs and PAMs based on a collection of requirements – example with ISO/IEC 20000. In: 8th International SPICE 2008 Conference, Nuremberg (2008)
17. Rifaut, A.: Goal-driven requirements engineering for supporting the ISO 15504 assessment process. In: Richardson, I., Abrahamsson, P., Messnarz, R. (eds.) EuroSPI 2005. LNCS, vol. 3792, pp. 151–162. Springer, Heidelberg (2005). https://doi.org/10.1007/11586012_15
18. Cortina, S., Mayer, N., Renault, A., Barafort, B.: Towards a process assessment model for management system standards. In: Mitasiunas, A., Rout, T., O'Connor, Rory V., Dorling, A. (eds.) SPICE 2014. CCIS, vol. 477, pp. 36–47. Springer, Cham (2014). https://doi.org/10.1007/978-3-319-13036-1_4
19. Cortina, S., Picard, M., Valdés, O., Renault, A.: A challenging process models development: the ITIL v3 lifecycle processes. In: The International Conference SPICE (2010)
20. MacMahon, S.T., McCaffery, F., Eagles, S., Keenan, F., Lepmets, M., Renault, A.: Development of a process assessment model for assessing medical IT networks against IEC 80001-1. In: Mas, A., Mesquida, A., Rout, T., O'Connor, R.V., Dorling, A. (eds.) SPICE 2012. CCIS, vol. 290, pp. 148–160. Springer, Heidelberg (2012). https://doi.org/10.1007/978-3-642-30439-2_14
21. Picard, M., Renault, A., Barafort, B.: A maturity model for ISO/IEC 20000-1 based on the TIPA for ITIL process capability assessment model. In: O'Connor, R., Umay Akkaya, M., Kemaneci, K., Yilmaz, M., Poth, A., Messnarz, R. (eds.) Systems, Software and Services Process Improvement. CCIS, vol. 543, pp. 168–179. Springer, Cham (2015). https://doi.org/10.1007/978-3-319-24647-5_14
22. EXIN, Ed.: Introduction to ISPL, vol. 1 (5 vols). SDU, The Hague (1999)
23. Chrissis, M.-B., Konrad, M., Shrum, S.: CMMI: Guidelines for Process Integration and Product Improvement. Addison-Wesley, Boston (2006)
24. Ritcher, K.: CMMI® for Acquisition (CMMI-ACQ) Primer, Version 1.2. Software Engineering Institute, May 2008
25. Hyder, E.B., Heston, K.M., Paulk, M.C.: ESourcing Capability Model for Service Providers (eSCM-SP). Van Haren Publishing, Zaltbommel (2010)
26. Hefley, B., Loesche, E.A.: ESourcing Capability Model for Client Organizations (eSCM-CL). Van Haren Publishing, Zaltbommel (2010)
27. IEEE Recommended Practice for Software Acquisition, IEEE Computer Society, Standard IEEE-1062-2015, February 2016
28. Directive 2014/24/EU of the European Parliament and of the Council of 26 February 2014 on public procurement and repealing Directive 2004/18/EC Text with EEA relevance (2014)
29. http://www.qsrinternational.com/nvivo/what-is-nvivo. Accessed 26 Mar 2018
30. ISO/IEC TR 24774. Systems and software engineering – Life cycle management – Guidelines for process description (2010)
31. Glaser, B.G., Strauss, A.L.: The Discovery of Grounded Theory: Strategies for Qualitative Research. Aldine, Chicago (1967)
32. Timmermans, S., Tavory, I.: Theory construction in qualitative research: from gounded theory to abductive analysis. Sociol. Theor. **30**(3), 167–186 (2012)