View metadata, citation and similar papers at core.ac.uk
brought to you by CORE
provided by Sapientia

Towards a Maturity Model for Higher Education Institutions

Duarte Duarte, Paula Ventura Martins
CIEO, Centro de Investigação sobre o Espaço e as Organizações
DEEI, FCT, University of Algarve
Faro, Portugal
djduarte@ualg.pt, pventura@ualg.pt

Abstract. The adoption of business process improvement strategies is currently a concern of most organizations. The quest for the benefits of this improvement on resource optimization and the responsiveness of the organizations has raised several proposals for process improvement methodologies. These approaches differ both in the principles that support them, and in the specific area to which they are intended. However, proposals and results of scientific research on process improvement in higher education institutions, extremely complex and unique organizations, are still scarce. This research project aims to propose an extension to a business process maturity model for this particular type of organizations.

Keywords: model; maturity, capability, education, process improvement.

Introduction and Motivation

Higher Education Institutions are complex organizations. Although being autonomous, they have to perform an amount of functions and develop a variety of procedures, so as to ensure the fulfillment of its duties, which inevitably raise constant challenges. The amount of functions they perform and the variety of procedures they develop under its autonomy to ensure the fulfillment of its duties, raise constant challenges to management and administration at different levels. The difficulties on the procedure systematization and on the analysis, evaluation, and optimization of workflows bring problems not only to management itself, but also to information systems design.

Today we can find a broad range of process improvement approaches, distinct from each other, either on its principles and techniques, or on the target area on which the improvements are focused. The most common approaches were initially developed and applied to software development organizations (e.g., Capability Maturity Model (CMM) [1] and Capability Maturity Model Integration (CMMI) [2]). However, inspired by these, other methodologies have been created for wider fields of application, allowing other institutions to reap the benefits of these initial approaches (e.g., Business Process Maturity Model (BPMM) [3]). Others, were created as

extensions of the most recognized models (e.g., Safety and Security Extensions to CMMI [4, 5]) in order to meet the specificities of a particular business area.

This research project aims both, through the analysis of different process maturity models and evaluation of the specific features of higher education institutions, to suggest an extension of one of these models to this type of organization.

Next section presents the concept and the specific characteristics of an academic organization from the point of view of its process areas. Moreover it defines the concept of business, describes the concept of organization, approaches the specificity of the academic organizations and its process areas, defines the concept of business process and describes the main approaches to process improvement. The following section analyzes the main process maturity models and those proposed for the education field. Afterwards we present the research questions, objectives and contributions of this study and finally we present the proposed work.

Academic Institutions and Process Improvement Needs

Laudon and Laudon [6] consider two main approaches to the concept of organization: the behavioral and the technical. In the first perspective, the organization is a balanced collection of rights, privileges, obligations and responsibilities. Individuals in these organizations develop their own ways to do their work, create ways of social networking and informally agree with their superiors and subordinates, shapes, deadlines and conditions for the development of their tasks. Most of these agreements are obviously not documented, because they are informal. From the technical perspective, an organization is a social structure that receives formal and stable environment resources and processes them to produce outputs, which may be products or services.

Higher Education Institutions are complex organizations with multiple power decision centers that bring together a wide range of heterogeneous interests. Mintzberg [7], on his classification of the organization's structural configurations, places universities in the Professional Bureaucracies group, i.e., in the not centralized bureaucratic organizations group. In these organizations, the work developed by professionals is complex and standardized, predictable or predetermined. However, "in the Professional Bureaucracy, often coexist two parallel hierarchies: one for professionals, directed upside, the democratic, and another to the functions of logistics support, directed downside, with the characteristics of a Machine Bureaucracy " [7].

Within a single organization we can thus, identify two structures with totally different attitudes regarding its information management: the first a frame of teachers, which presents a decentralized structure with poorly defined information flows; and the second, a centralized and formalized administration support. The definition of strategies for the management and optimization of processes must be different in each scenario.

How can we describe what a process is? There are various process definitions. Different disciplines characterize this concept in different ways, depending on the type of approach. In the context of information systems, the business process is the set

of procedures or ways to organize the sequence for transforming inputs in outputs. This concept can be defined as how an organization coordinates and organizes a range of work activities, information and knowledge in order to produce a particular product or service [6] or simply as a set of tasks or activities performed to achieve a specific purpose or a particular result [3].

Process improvement is a systemic approach that helps organizations optimize the sequence of activities so that they may improve their results. There are several approaches to process improvement. Kulpa and Johnson [8] summarize the existing approaches into five categories: Business Process Reengineering, Benchmarking, Process engineering/workflow management, Reverse Engineering and Model Based Process Improvement. The approach of this research is the Model Based, as similar to other studies already developed in educational context (e.g., Computing Education Maturity Model [9], E-Learning Maturity Model [10-18]).

Process Maturity Models

The software development perspective defines the capability maturity of an organization as the power to "meet the demands of its customers in a reliable and repeatedly way" [19] or as the degree to which an organization has established its procedures in order to repeatedly offer their clients high quality software within given budget and time [20].

Maturity models are evolutionary roadmaps to the implementation of certain practices that are vital for one or more areas of organization's processes. Maturity levels guide the evolution of an organization from a state in which practices are poorly defined and incoherent to a level of innovation and continuous optimization [3]. Capability maturity models are focused on improving processes in an organization. These models contain the essential components that effective processes must include for one or more disciplines and describe an evolutionary improvement path from immature or ad hoc processes, to mature, disciplined, with improved quality and efficiency [2, 20]. These models allow us to evaluate the maturity level of an organization and, from there, develop a route for improving the capability of their processes.

Process Maturity Reference Models

The number of standards, recommendations, maturity models and other frameworks for process improving that have been developed and then promulgated by governmental and trade organizations has hindered the selection of the best approach to be used by an organization wishing to improve their processes. In 1997, the Software Productivity Consortium created a Web page to help organizations understand which were the most important and how related they were to each other. In 2001, Sheard [21] updated this information and divided the approaches found in categories: Maturity Models and Guidelines, Software Standards, Integrated Maturity Models, Systems Engineering Capability Models, Systems Engineering Standards, Measurement Standards and Quality Standards.

Sheard considered that the most important maturity models were the Capability Maturity Model (CMM), for organizations, and the Personal Software Process and Team Software Process, for project development. The Software Engineering Institute (SEI) in Carnegie Mellon University developed all these models. The integrated models mentioned as the most important were Capability Maturity Model Integration (CMMI) also developed by the SEI, which evolved from CMM, and FAA-iCMM, an integrated version of CMM developed by the United States Federal Aviation Administration.

CMMI is considered integrated, since it contains the necessary practices to maturity in various disciplines: Systems Engineering, Software Engineering, Integrated Product Development and Supplier Sourcing and Process. Currently the CMMI has three versions: CMMI for development, focused on product and service development; CMMI for Services, directed to the processes of service organizations, and CMMI for acquisition, centered on acquisitions and supply of goods and services from others.

These models have two representations: the continuous and the staged. The first allows the focus on specific processes, which are considered important for the organization's immediate goals. The second allows the application of a standardized sequence of improvements, which may serve as a basis for comparison regarding maturity of different projects and organizations.

In 2008, Object Management Group published a process maturity model, based on the same principles of CMM, called Business Process Maturity Model (BPMM). Although this model can be mapped to CMMI, it presents substantial differences. BPMM is geared towards the improvement of larger transactional business processes, for instance those constituting workflows that stretch beyond the boundaries of the organization, while opposed to project-oriented CMMI, more circumscribed [22].

Educational Maturity Models

The need to adopt process improvement strategies is also a global concern in education institutions. Over the past 10 years some investigations have been conducted so as to focus on the search for maturity models in education.

White et al. [23], launched the discussion about the applicability of CMMI to Information Systems Curriculum in the United States. The authors presented a proposal containing the features that educational institutions should develop and a set of key process areas for each of the five levels of CMMI maturity model, applied to the curriculum model.

Neuhauser [24] presented a maturity model for online course design with the aim of providing a tool for planning and evaluate these courses, based on a set of best practices. The maturity model proposed, Online Course Design Maturity Model (OCDMM) introduces in a phased manner, a set of good practices at the institution.

Thompson [25, 26] proposed a Learning Process Maturity Model (LPMM), based on CMM, to help students identify strengths and weaknesses in their learning activities and select the most appropriate strategies for learning.

Wang and Zhang [27] proposed an IT service management model for Chinese universities based on ITIL (Information Technology Infrastructure Library).

Lutteroth et al. [9] proposed a maturity model for computer science teaching, also inspired by CMM, called Computing Education Maturity Model (CEMM), that helps computer science teachers by providing a set of best practices and strategies to improve teaching. While CMM points out five stages for software project development, CEMM presents five stages for computer course development. The authors believe that, as the project in CMM, the course is a well-defined entity, usually with restricted costs and suffering few variations in time.

Dounos and Bohoris [28] suggested the combined use of Total Quality Management (TQM) principles and the key concepts of CMMI for process improvement in higher education institutions. At all the five levels suggested in this model, the authors propose the use of TQM benchmarking techniques.

Marshal and Mitchel [10-18] proposed a model of process maturity for e-learning, E-Learning Maturity Model (EMM), also adapted from the CMM. EMM divided the capacity of institutions to support and provide e-learning in thirty-five processes, grouped into five broad categories or process areas. In the latest version the authors proposed a method for process evaluation where the performance of each practice is rated based on compliance, performance, and their relevance on the process.

Petri, Garcia and Giraldo [29] proposed a model for higher education institutions certification based on CMMI, so that the capacity of processes in engineering and technology institutions, faculties and students could improve. The model called Engineering Education Capacity Maturity Model (EECMM) uses the same levels of CMMI and identifies the capabilities and processes that are focused at each level of maturity.

Bass [30] developed a Maturity Model for Information and Communication Technologies in Educational Institutions in Developing Countries. The study aims to provide guidance for ICT infrastructure planning and create a reference model to the necessary development phases to the efficient use of these resources. The model, which features eight levels of maturity, is not based on any reference to software development.

Most models found are based on CMM or on the staged representation of CMMI. Although the various proposals intend to facilitate process maturity in different business areas, most of the presented models have the same five levels of maturity. They all suggest attributes that the organization should have to be positioned on each stage. However, unlike the model in which they were based in, most teaching maturity models do not identify explicitly any key process areas. Only the models developed by Dounos and Bohoris and by Marshal and Mitchel provide these areas as well as the methodologies and evaluation techniques to assess the requirements fulfillment, to effectively place an organization in a certain level of maturity.

Moreover, the studied models give an insight of the processes of isolated business areas, i.e., they relate only to an informational entity such as the student, the course, the online course or the IT resource. None of these models present maturity practices that encompass the various entities or units, or approach the processes that are crosswise to higher education institutions. On the other hand, most of the models present ‘what to do’ but none of them, perhaps with the exception of the model proposed by Duonos and Bohoris, presents ‘how’ an organization can effectively improve their processes allowing it to climb through the maturity ladder proposed.

Investigation Problems, objectives and contributions

In order to limit the scope of this study and explain the major issues that this problem raises, this section describes the research problems, objectives and expected contributions. The main problems identified where the following:

- The existing reference models have a too broad spectrum, i.e., they are too general and ignore important specific characteristics of higher education organizations, since they do not meet their business areas;
- The developed or adapted models in the educational field are focused on an isolated entity, sector or very specific business area, ignoring other academic institutions areas;
- Most educational maturity models proposed do not suggest any process areas and its related goals and practices or the proposed process areas, goals and practices do not fit the reality of higher education institutions;
- The maturity models that focus on teaching processes do not give indications of ways of aligning the processes of management and administration of the institution with the processes related to the area of education that is the target of their attention;
- Existing reference models indicate which attributes an organization must show at each level of maturity and what best practices to be followed in each of them, but do not indicate how they can or should be implemented so as to accomplish the improvement of processes within the organization.

This research aims to develop, adapt or extend one of the reference models presented in order to meet the following objectives:

- Review and compare the different existing business process maturity models and to highlight its inadequacy to the business areas of higher education institutions;
- Propose a business process maturity model which align management and teaching practices that coexist in academic institutions;
- Develop a set of new or adapted methodologies to provide 'how' an academic organization can improve its business processes and thus moving from one level to another in the proposed maturity model;
- Enhance the provision of educational maturity models;
- Validate the proposed maturity model in a typical higher educational organization.

The pursuit of the presented objectives aims to provide the following scientific contributions:

- Contribute to the state of the art, by providing a maturity model for higher education organizations;
- Contribute to process improving in higher education institutions by introducing a methodology that allows the improvement of effective practices, suggesting ways of doing and not just what to do;

– Present a maturity model based on empirical validation methodology that allows, in an agile and circumscribed way, the collection of indicators of the usefulness of the model.

Present and Future Work

This work began with the study of the organizational structure of Algarve University, followed by the modeling of all business processes of one of its services - the Academic Services. Around fifty of the processes were analyzed and modeled using Business Process Model and Notation (BPMN) [31] graphical representation. Process analysis enabled the identification of some improvement possibilities and demonstrated the variety of connections between this service's sections, and the links connecting them to the other units of the university and to outside entities.

The work also included an analysis of the business areas within academic institutions from the review of the functionalities of three information systems used by Portuguese universities. The modules integrated in these systems and the procedures they aim to systematize or automate, allowed the determination of a set of business process areas associated with this type of organizations. The analysis of FenixEdu, developed and operated by Instituto Superior Técnico (IST), Student Life Cycle (SAP) recently acquired by Algarve University and PeopleSoft Enterprise Campus Solutions, developed and commercialized by Oracle, allowed the identification of 13 business areas: student admission; teaching/learning; student assessment; student progression; tuition management; student course change and transfer; scientific activity; scholarship; Human resources; physical resources; Finance; Internal Assessment and Community Relationship.

The methodology that will be used to create a maturity model suitable to these institutions is still being defined. However it will necessarily include a more detailed analysis of the existent maturity models both for education and wider areas.

Finally we propose to undertake a review of key process areas, goals and practices used in each model in order to determine which ones apply to academic organizations and which ones should be excluded, added or extended.

One possible approach is to select a set of well defined informational entities that encompass all the academic activities, to limit the analysis to each of them separately, as Lutteroth et al. [9] did with the *course* entity in CEMM.

The model validation will be developed at a later stage, through its application to two or more units of the same university, in order to verify the feasibility of its application, either individually or on the relationship between them. Alternatively, if we choose an approach based on informational entities, monitoring the use of the model on two defined entities can do validation.

This research is being carried out within the doctoral program in Informatics Engineering of the Electrical Engineering and Computer Science Department of the Science and Technology Faculty of Algarve University and is supervised by PhD Paula Ventura Martins.

Acknowledgments

This article was partially financed by Fundação para a Ciência e a Tecnologia.

References

1. SEI, *The Capability Maturity Model: Guidelines for Improving the Software Process*. 1995, Reading, MA: Addision-Wesley.
2. SEI, *CMMI for Development, Version 1.3*, S.E.I.-C.M. University, Editor. 2010.
3. OMG, *Business Process Maturity Model, Version 1.0*, O.M. Group, Editor. 2008.
4. Bofinger, M., N. Robinson, and P. Lindsay. *Experience with Extending CMMI for Safety Related Applications*. in *12th International Symposium of the International Council on Systems Engineering (INCOSE'02)* 2002. Las Vegas, Nevada.
5. Ibrahim, L., et al., *Safety and Security Extensions for Integrated Capability Maturity Models*, U.S.F.A. Administration, Editor. 2004.
6. Laudon, K. and J. Laudon, *Management Information Systems: Managing the Digital Firm*. 10 ed. 2007, New Jersey: Person Prentice Hall. 645.
7. Mintzberg, H., *Estrutura e Dinâmica das Organizações*. Terceira Edição ed. 1999.
8. Kulpa, M. and K. A., *Interpreting the CMMI: a process improvement approach*. Second ed. 2008: Auerbach Publications. 403.
9. Lutteroth, C., et al., *A maturity model for computing education*, in *Proceedings of the ninth Australasian conference on Computing education - Volume 66*. 2007, Australian Computer Society, Inc.: Ballarat, Victoria, Australia. p. 107-114.
10. Marshall, S. and G. Mitchell. *An E-Learning Maturity Model?* in *19th Annual Conference of the Australian Society for Computers in Learning in Tertiary Education*. 2002.
11. Marshall, S. and G. Mitchell. *Potential Indicators of e-Learning Process Capability*. in *EDUCAUSE in Australasia 2003 Conference*. 2003. Adelaide, Australia.
12. Marshall, S. and G. Mitchell, *Applying SPICE to e-learning: an e-learning maturity model?*, in *Proceedings of the sixth conference on Australasian computing education - Volume 30*. 2004, Australian Computer Society, Inc.: Dunedin, New Zealand. p. 185-191.
13. Marshall, S.J. and G. Mitchell. *E-Learning Process Maturity in the New Zealand Tertiary Sector*. in *EDUCAUSE in Australasia 2005 Conference*. 2005. Auckland, NZ.
14. Marshall, S. and G. Mitchell. *Assessing Sector E-Learning Capability With an E-Learning Maturity Model. In D. Whitelock and S. Wheeler, Eds.* in *13th International Conference of the Association for Learning Technology*. 2006. Edinburgh, Scotland.

15. Marshall, S. and G. Mitchell, *E-Learning Maturity Model Version Two: New Zealand Tertiary Institution E-Learning Capability: Informing and Guiding E-Learning Architectural Change and Development Project Report. Report to the New Zealand Ministry of Education*. 2006.
16. Marshall, S.J. and G. Mitchell. *Benchmarking International E-learning Capability with the E-Learning Maturity Model*. in *EDUCAUSE in Australasia 2007*. 2007. Melbourne, Australia.
17. Marshall, S. and G. Mitchell. *What are the key factors that lead to effective adoption and support of e-learning by institutions?* in *HERDSA*. 2008. Rotorua, New Zealand.
18. Marshall, S. and G. Mitchell. *Using the e-Learning Maturity Model to Benchmark Institutional Learning and Teaching Plans and Capabilities*. in *Educause in Australasia Conference*. 2009. Perth, Australia.
19. Poppendieck, M., *Measuring Maturity*, in *Software Development Magazine*. 2004.
20. Chrissis, M., M. Kourad, and S. Shrum, *CMMI - Guidelines for process integration and product improvement*. 2003, Boston: Addison Wesley.
21. Sheard, S.A., *Evolution of the frameworks quagmire.* Computer, 2001. **34**(7): p. 96-98.
22. Curtis, B. and J. Alden, *The Business Process Maturity Model (BPMM): What, Why & How.* BPTrends, 2007.
23. White, B., et al. *Applicability of CMMI to the IS Curriculum: A Panel Discussion*. in *Information Systems Education Conference (ISECON 2003)*. 2003. San Diego, CA.
24. Neuhauser, C., *A maturity model: Does it provide a path for online course design.* The Journal of Interactive Online Learning, 2004.
25. Thompson, E., *Towards a learning process maturity model.* 2004.
26. Thompson, E., *Using a subject area model as a learning improvement model*, in *Proceedings of the 8th Austalian conference on Computing education - Volume 52*. 2006, Australian Computer Society, Inc.: Hobart, Australia. p. 197-203.
27. Wang, Z. and X.-y. Zhang. *An ITIL-based IT Service Management Model for Chinese Universities*. in *Software Engineering Research, Management & Applications, 2007. SERA 2007. 5th ACIS International Conference on*. 2007.
28. Dounos, P. and B. G. *Exploring the interconnection of known TQM process improvement initiatives in Higher education with key CMMI concepts*. in *10th QMOD Conference. Quality Management and Organiqatinal Development. Our Dreams of Excellence*. 2009. Helsingborg, Sweden: Linköping University Electronic Press.
29. Petrie, M., V. García, and G. Giraldo. *Modelo de Registro y Acreditación de Instituciones de Educación Superior basado en el Modelo CMMI*. in *Seventh LACCEI Latin American and Caribbean Conference for Engineering and Technology (LACCEI'2009)*. 2009. San Cristóbal, Venezuela.
30. Bass, J.M., *A New ICT Maturity Model for Education Institutions in Developing Countries*. 2010, Centre for Development Informatics, Institute for Development Policy and Management, SED, University of Manchester.
31. OMG, *Business Process Model and Notation Beta 1 for Version 2.0*. 2009.