Towards an encompassing maturity model for the management of higher education institutions

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Abstract: Maturity models (MM) have been adopted in organisations from different sectors of activity, as guides and references for Information Systems (IS) management. In the educational field, these models have also been used to deal with the enormous complexity and demand of IS management. This paper presents a research project that aims to develop a new MM for Higher Education Institutions (HEI) that helps them to address those problems, as a useful tool for the management of their IS (and institutions as well). Thus, the MM in this area are identified, as well as the characteristics and gaps that they present, justifying the need and the opportunity for a new and comprehensive MM. Finally, we discuss the methodology for the development of MM that will be adopted for the design of the new model (called HEIMM) and the underlying reasons for its choice. At the moment, we are developing the HEIMM.

Keywords: stages of growth; maturity models; higher education institutions; management.

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1 Introduction

The Higher Education Institutions (HEI) are complex organisations, usually composed by communities of several thousands of students, teachers, staff and researchers. In recent years, these institutions have seen many changes forcing them to adapt their way of teaching and producing knowledge to be transferred to society. One of these important changes regards to the massification of higher education in terms of growth in the number of students and diversity of the student population (OECD, 2008; Barber et al., 2013). Until two decades ago, due to restrictions in terms of capacity of the number of students, higher education was not as accessible as it is nowadays. This expansion puts HEIs under enormous pressure to accommodate these additional students, considering the services required without losing quality. In addition, new teaching paradigms (Bologna Treaty), the student as a "customer", opening up universities to enterprises, in terms of knowledge transference, and HEI rankings and competition have forced the HEI sector to reinvent higher education and adopt agile management methodologies, in order to adapt to the constant changes in the market environment.

As an answer to those new challenges, the HEI sector invested on Information Technologies (IT), dematerialising almost all of their processes. The increasing use of technology in higher education (Laurillard, 2012; Wheeler and Gerver, 2015) results in a huge growth in terms of complexity, due to the introduction of many new systems, processes and approaches to academic integration, as well as the emergence of new platforms that provide services in this area. In general, these Information Ecosystems (IE) are composed by a large spectrum of platforms, such as: Academic Management ERP (Enterprise Resource Planning), financial ERP, Student Relationship Management (SRM), e-Learning platforms (LMS), Content Management Systems (CMS), Survey platforms, Business Intelligence, among others. Additionally, it is not easy to manage the interactions of systems and processes that are constantly evolving, as it is not easy to manage the impact of processes of low interoperability, security, reliability, efficiency and effectiveness. The lack of standardisation in the HEIS' academic management processes is another problem, each HEI works according to its own internal regulations, putting a strong barrier for the adoption of standard packages of software, as happens in the enterprises with the ERP. Fortunately, nowadays in some areas some commercial and open source products are a de facto standard, the Moodle (https://moodle.org) is a good example. Some initiatives for HEI interoperability (Ribeiro et al., 2016) and online services, such as ORCID (https://orcid.org/), make visible the will to change this scenario, by the need of unified processes among HEI.

Thus, the benefits of modern technology in education, supported by better methods and better tools, cannot be obtained through undisciplined and chaotic processes. In this scenario, it is important for IT managers to know if they are doing a good job on managing these IE on an ongoing basis. For this reason, we consider that the IS management in educational institutions should be carried out with the help of maturity models. Such maturity model could help HEI in their organisational processes, by enabling these institutions to obtain data regarding the maturity of their IS, in several dimensions, regarding the aspects that need to be improved. The external organisations, such as national evaluation agencies and certification agencies, also could benefit from this organisational analytics tool to determine the maturity of the implementation of the HEI's processes.

Since the advent of the maturity model concept, applied on the software development process, several models have been proposed in diverse contexts: the evolution of people, the general evolution of organisations and the particular evolution of the IS function and others. These models differ mainly in the number of stages, evolution variables and focus areas (Mettler and Rohner, 2009a, 2009b; Rocha, 2011; Carvalho et al., 2015). Each one of these models identifies certain characteristics that typify the target at different stages of growth or maturity and are applied in different organisations.

The case of organisations in the education sector is not an exception, several maturity models were also proposed in the last years. In order to find the state of the art in this very particular category of maturity models, in the first phase of our research work, we conducted a systematic literature review (Carvalho et al., 2019). This literature review has been carried in order to identify any eventual gaps in existing maturity models of this sector. After following a systematic approach to our literature review methodology, we have considered a selection of 35 maturity models associated to educational ecosystems. From these models, only five (Solar et al., 2013; Manjula and Vaideeswaran, 2012; Gu et al., 2011; Bass, 2011; Rossi and Mustaro, 2015) are focused (or related) on the HEI IS management. After a detailed analysis of these models, it was verified that there is no comprehensive and detailed model that assesses the maturity of the IS of HEI, in its various dimensions. In fact, this analysis also revealed the inexistence of maturity models with dimensions or influence factors, with different weights considering its relative importance. It was also verified that most of the maturity models are still in the

early stages of development and in premature phases of affirmation and consolidation, on account of being proposed by their authors in the course of exploratory studies. Additionally, most of these models are not sufficiently explicit, considering the way they were developed and validated. Furthermore, because they are poorly detailed, they do not provide effective means to determine the maturity stage, nor identify the characteristics to reach a stage of higher maturity. However, it was found that most of the models, besides focusing on the assessment of the system's maturity, pay attention to an improvement path of such maturity. In the case of the adoption of a tool to assess a system's maturity, in only one of the studied works was such a tool found.

This preliminary conclusion enabled us to consider important for the success of any novel proposal of a maturity model a solid and systematic methodology for its conception. Our observation is corroborated by other authors such as de Bruin et al. (2005). According to these authors, the reasons for these sometimes ambiguous results of maturity models stem from the insufficient focus on model validity, reliability and generalisation testing, as well as poor documentation on how to develop and design such a model.

At the end of that first stage of our research work, it was considered opportune to develop a research project that would contribute to an increase of knowledge on the maturity models applied to HEI IS, in order to spread an improvement in the practice of evaluating and promoting the maturity of their IS. Based on the description of the problem, the following research question was formulated:

- *Is there a model, which consists of several maturity-influencing factors and maturity stages, that can be applied to ISs in HEIs?*

Currently, our research is at the end of its second phase. Thus, in this paper we report all our results, with a particular focus on the recent progress, by discussing the chosen approach for the development of our maturity model that is planned for the next phase of our project.

In the next Section, we discuss shortly the maturity models that we found in the literature and present our motivations to propose a new maturity model, which is based on the necessity and opportunity that we identified. In Section 3, we present a short state of the art of the methodologies for the development of maturity models. In Sections 4 and 5, respectively, we discuss one of these methodologies and our arguments to apply it in the development of our model. Finally, we present our conclusions and the next steps of our project.

2 Existing maturity models

In the Higher Education sector, several maturity models have been proposed over the last years. These models were developed involving different types of entities, including national and international education companies, research organisations, as well as academic experts in this domain. In a previous phase of our work, we conducted a literature review (Carvalho et al., 2019) which enabled us to organise the founded models by their scope, as follows:

- e-learning
- Online course
- Strategy and learning
- Student engagement
- Educate senior management
- Intelligence training/education
- IS curriculum
- Learning process
- Project management
- Academic management
- Continuing/quality education
- Engineering/computation education
- Intellectual capital
- Web accessibility
- Accreditation of educational institutions
- Green governance
- ICT in education

Another observation is that the Capability Maturity Model (CMM) (Paulk et al., 1993) and its successor, the Capability Maturity Model Integration (CMMI) (SEI, 2010), are the reference models used by the authors of these models.

The focus of our work is the maturity of the IE as a whole composed by the several platforms that support transversally the entire HEI. Thus, we focused our attention on the models whose scope is the IST.

Solar et al. (2013) developed a maturity model for ICT in School Education (ICTE-MM). This is a holistic model that embraces several domains which have influence on the successful use of ICT in schools. The ICTE-MM considers five leverage domains: Educational Management, Infrastructure, Administrators, Teachers and Students. These domains make the model very comprehensive, since besides the physical ICT resources it considers the administrator's vision, strategies and leadership, as well as personal capabilities of teachers and students, such as digital literacy, collaborative capabilities and initiative, among others. At two other dimensions, the elements of Information Criteria and IT resources are also considered.

In order to detail the five leverage domains, the authors have identified Key Domain Areas (KDA), which provide a fine-grained view of each one. The Critical Variables provide another level of depth in the model. The capacity of these variables to satisfy certain requirements is evaluated based on the structure of the five CMMI stages. Thus, in order to determine the Capability Level of the key domain, a weighted average is calculated using the capacity of the variables that compose that key domain. In the context of this maturity

model, the capability is a measurement of the state of each KDA that contributes to support the school's development. We should notice that this distinguishes between capacity, a characteristic of KDA, and maturity, as a property of the school as a whole.

The ICTE-MM is based on international standards for assessing the school's development regarding the use of ICT and not a maturity model for accessing the IS capability for supporting the school's management, teaching/learning processes, as well as the support for research activities. It is a comprehensive model, however issues such as business process definition/documentation and IS capability for supporting such processes are not considered. Software for academic management, financial management and teaching/learning process management is superficially approached, applying only three variables, as well as in School Management, by means of six Critical Variables, none of them covering the business process definition. We consider that there are other missing Critical Variables which are fundamental to achieve a more comprehensive maturity model for accessing the use of ICT in schools. The ICTE-MM is a generic maturity model for school educational processes, not focused in the higher education sector.

Manjula and Vaideeswaran (2012), proposed a framework for quality education assessment and process improvement with five maturity levels. The authors' model, designated as Capability Maturity Model for Quality Education (CMM-QE), evaluates the Education system engineering process from the multi perspectives of academic, infrastructure, administration, facilities etc. The CMM-QE uses critical factors (Key Indicators) to be quantified to assess the maturity level of the educational institutions.

Although the model considers a number of variables grouped in four measurement models, covering several areas of the educational institution referred, none of them has a concise and systematic description. Only an apparently unordered and unrelated list of characteristics is presented. From our point of view, this missing systematisation of the assessed attributes compromises the reader's full understanding regarding the proposed framework, as well as its applicability in the real world practice. This gap in the description of the CMM-QE, is not compensated with any previous work presenting the authors' framework. As far as we know, this model was not adopted in subsequent studies and there were no significant references from the academic community.

The Online Course Quality Maturity Model Based on Evening University and Correspondence Education (OCQMM) (Gu et al., 2011) is focused on the assessment of the quality of online courses in Evening University and Correspondence Education. OCQMM can guide the institutions engaged in adult education to improve the implementation process, so that the implementation quality of online courses will be improved. OCQMM divided online courses quality maturity in evening university and correspondence education into four maturity evolving ladder levels, each low-level is a basis that achieves a higher level.

We consider the proposed maturity model sufficiently comprehensive in terms of key areas, addressing relevant quality issues of online courses: the (1) learning resources, (2) teaching platform, (3) faculty conditions, (4) teaching process, (5) monitoring evaluation and (6) management. However, in this specific subject of online courses, there are important issues missing such as teacher's motivation and pedagogical practices that are not considered. Moreover, we also consider insufficient the level of detail in which the six key process areas are described, making very difficult to replicate the authors' testing experience of the proposed maturity model in other institutions. One cannot get a clear perception of how the maturity of the IS is evaluated, or if it influences the maturity of the online course quality. Regarding the model systematisation, the authors do not provide any methodology or analytic methods to determine the school's maturity level in each key process area. Either they provide a way to determine the maturity level of an online course or the school as a whole. In the literature, we do not find any previous publication of the authors presenting adequately their model.

Bass (2011) focused his work in the education sector of developing countries. He proposed the Maturity Model for ICT in Educational Institutions in Developing Countries (ICTMMEI-DV) that aims to provide guidance for ICT infrastructure planning and to create a reference model to the necessary development phases for the efficient use of these resources. The model defines the ICT infrastructure resource levels required to achieve primary organisational objectives expressed in the form of student learning outcomes. The levels in this model show management, teaching and technical staff, as well as donors how to make the most efficient use of ICT resources by maximising opportunities for student learning.

Despite the lack of discussion regarding those three important levels, we can conclude that this maturity model is strictly focused on ICT. Issues related to management process definition and other relevant aspects of IS are not considered in this model. This maturity model was specially designed for education institutions of developing countries, where the resources are very limited. Such context is very different from the ones that exist in developed countries, making this maturity model not well suited for institutions in these countries. Additionally, this model intends to cover a broad type of educational levels, which have distinct educational goals. In our opinion, the author's proposal is aligned with primary educational levels, and not well suited for HEI.

The eQETIC, A Maturity Model for Online Education, proposed by Rossi and Mustaro (Rossi and Mustaro, 2015) supports the steps that guide the planning, development, and maintenance of digital educational solutions. The eQETIC model follows a continuous process improvement approach, whereas the implementation of processes in an organisation that develops these types of solutions favours the lifecycle development and the quality of these solutions.

The model allows the organisation to implement the processes belonging to each level at a given time, and these levels and processes are organised in six common entities.

This model is focused on the quality of the product development process, including the learning process, the environment and aspects that condition the success of the education institution in terms of quality of the specific scope of the solutions (distance education, e-learning and learning objects). However, it does not consider other types of teaching such as blended learning and traditional face-to-face teaching, as well as facilities for students, administrative support, or other specific IS aspects of HEI in their full achievement of its mission.

As far as we know, these five models are the existing ones in the literature that specifically embrace the maturity of the IS in HEI, or as one of the dimensions of the ICT. In our opinion, all five models are still in an early development stage and in a premature phase of affirmation and consolidation, being proposed by their authors through exploratory studies. On the other hand, the IT managers of higher education sector need a tool that supports their work, in order to evaluate the maturity of the IS of their institutions. Thus, here we found a need and an opportunity to propose a new maturity model that fulfils this gap.

3 Methodologies for the maturity models' development

The literature in the IS area has shown that over one hundred different maturity models have been proposed in recent years (de Bruin et al., 2005; Becker et al., 2009). The intense publication of new maturity models, often for very similar applications, suggests a certain arbitrariness, as well as a lack of contextualisation and clear definition of requirements that can distinguish the different proposals (Mettler and Rohner, 2009a, 2009b). In fact, authors rarely reveal their motivations and how they develop the model or method of procedure, as well as the results of their evaluation (Becker et al., 2009; Mettler and Blondiau, 2012). Certainly, in order to ensure that the development of a new model is recognised as solid and potentially relevant, both in academia and in society in general, there must be a concern to demonstrate that the model was developed with rigour and that it is subject to debate and verification.

So far, no standard approach describing how to rigorously construct new maturity models has been found (Mettler and Blondiau, 2012). In fact, there are few studies that refer to the process of designing maturity models. The point of view of Poeppelbuss et al. (2011) goes in the same direction, since these authors argue that the development of new models is often based on existing models rather than on development methodologies.

In the few methodological approaches applied in the development of maturity models that were found in the literature, the dominant approach is the Design Science Research (DSR) (Elmaallam and Kriouile, 2013). Indeed, some researchers argue that such models should be conceptualized and constructed as conventional IT artefacts (Donellan and Helfert, 2010). In this context, it will be necessary to consider two iterative steps:

1. *design:* to describe the design of the maturity model in a transparent and traceable way; and
2. *evaluation:* to prove the utility and ability to solve the problem addressed (March and Smith, 1995). Consequently, a robust and recognised research method, namely the DSR, becomes essential for the successful development of this type of models.

Based on the literature review carried out by Elmaallam and Kriouile (2013), a number of important methodologies for the development of maturity models have been identified (de Bruin et al., 2005; Becker et al., 2009; Gottschalk and Solli-Sæther, 2009; Mettler and Rohner 2009a, 2009b; Mettler, 2010a, 2010b). The same study (Elmaallam and Kriouile, 2013), also mentioned the guide for the development and implementation of "maturity grids for assessing organisational capabilities" developed by Maier et al. (2009), as well as the maturity development approach "focus area model" (Steenbergen et al., 2010).

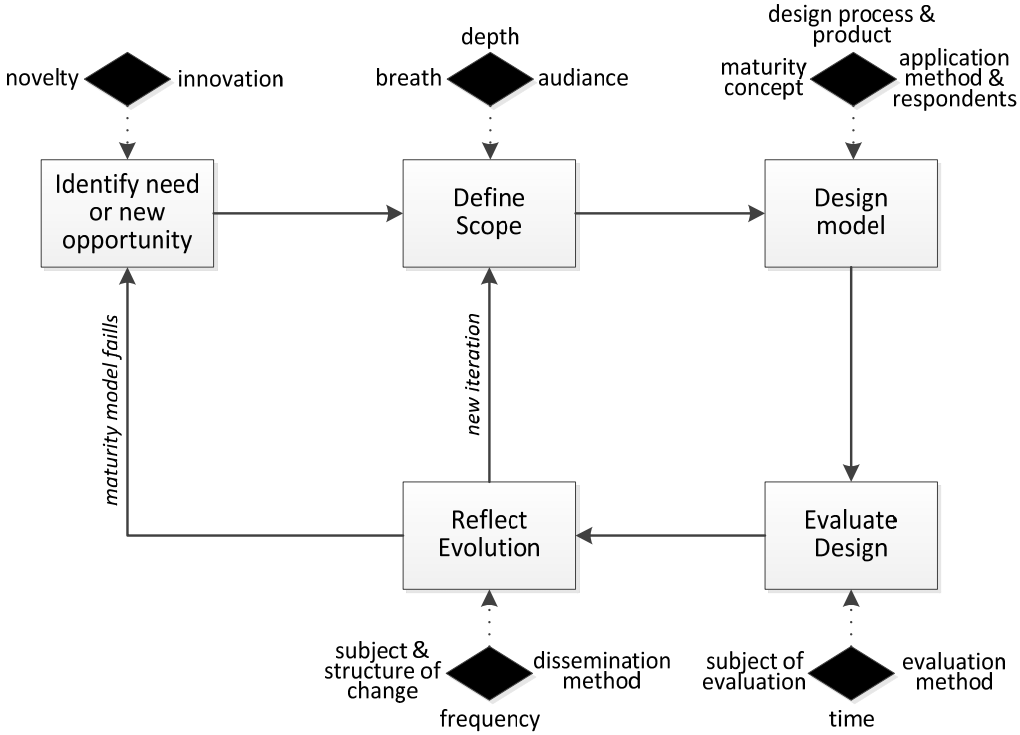
4 Methodology proposed by Mettler

In order to identify the best methodology for the development of maturity models, Mettler carried out a comparative study that considered three methodologies (de Bruin et al., 2005; Becker et al., 2009; Mettler, 2010a, 2010b). This comparative study enabled Mettler to present a new approach that introduced the so-called "decision parameter" elements (see Figure 1). This approach is based on an interactive design process that consists of five steps or design activities (white boxes). In this proposal, several decisions must be taken in each of its five steps (black diamonds), that is, at each stage of the model construction process, the designer must choose a number of elements before proceeding.

For the definition of these decision parameters, Mettler relied on his own experience, as well as on the literature review he conducted in this area (Mettler, 2010a, 2010b). A description of the various decision parameters and the possible options that each one can offer for the five steps of the development process of a maturity model, are given below:

1. *Identify need or new opportunity*: In this first step, two parameters are considered. Firstly, it will be important to highlight the novelty of the theme covered by the maturity model, since it determines if there is a need to be filled by this model. The emergence of this new model must be duly grounded by theoretical assumptions about maturity levels. Second, innovation is another parameter of decision to consider, before starting to develop a maturity model. In this context, the designer has to decide whether to design a completely new model, a variant, or a version of an existing model.

Figure 1 Methodology decision parameters (Mettler, 2010a, 2010b)



2. *Define scope*: While defining the maturity model scope, the author is confronted with a very important decision-making. The first decision is related to the magnitude of the phenomenon to be studied, that is, whether the model addresses a generic topic (e.g., entire HEI) or a more specific one (e.g., academic management). In addition, the detail conditions of the maturity model should be considered. Finally, respecting one of the constituent guidelines of the DSR (Hevner et al., 2004), some reflections on the potential "audience" of the maturity model should be made. There might be a need to adapt the model to the particular necessities of an audience, whether it has a technological orientation or a management orientation, or both.

3. *Design model*: After the scope has been defined the model development process begins. At this stage, one of the key decisions to be made has to do with the definition of "maturity" in the context of the model that is intended to be developed. In this context, three different concepts of maturity appear (Mettler, 2010a, 2010b) in the most recent literature. These different concepts are distinguished by the focus that is associated to them, that is, being more focused on the process, the object or the people. After clarifying the concept of maturity, the functional objective of the model (that is, how maturity will progress) is tacitly defined. For example, efficiency is often the underlying purpose of the maturity process-oriented, while increasing satisfaction can be a goal of a people-centred maturity model. However, a maturity model can be targeted for multiple purposes. So, another important decision to be discussed is related to the advancement of maturity if it is one-dimensional (i.e., focused only on a measure associated with the efficiency) or multidimensional (i.e., focusing on several, sometimes divergent, goals). In addition, the nature of the design process (theory-driven vs. practitioner-based or a combination of both) must be determined, in order to determine the knowledge base to identify maturity levels, metrics and corresponding improvement recommendations.

   Another important decision parameter is the format of the model. This decision is particularly important in defining the development team (e.g., good writers are needed when the maturity model is disseminated in manual form, on the other hand, specialised software developers are needed when the maturity model is instantiated as software). This decision certainly has an effect on the choice of model application method (i.e., whether data collection is based on a self-assessment or third-party evaluation such as outsourcing by certified professionals), as well as of its adoption by the respondents for data collection (e.g., managers, employees, business partners or a combination of all) (de Bruin et al., 2005).

4. *Evaluate design*: Once the development of the model is completed, the aim of this step focuses on verification and validation. According to Conwell et al. (2000), verification is the process of determining that a maturity model "*represents the developer's conceptual description and specifications with sufficient accuracy*" and validation is the degree to which a maturity model is "*an accurate representation of the real world from the perspective of the intended uses of the model*". Therefore, it is very important to define a strategy to specify "what", "when" and "how", that is, to test the developing model process or the model itself, at what time (ex-ante or ex-post or both) and in what form, whether artificial (*e.g.,* laboratory

experimentation, simulation) or natural (e.g., case study, reflection groups).

5. *Reflect evolution*: Finally, in the last step of the methodology, the designer has to deal with the mutability of the maturity model. In fact, although often neglected, the eventual mutability of the model is particularly important and should be considered. Indeed, the maturity of the phenomenon under study, can be dynamic and therefore, the stages of the model, characteristics, dimensions and improvement activities should be rectified periodically (due to the permanent emergence of systems and technologies, as well as best practices, it may be necessary to modify the requirements to reach a certain level of maturity). On the other hand, changes in the form and function of the model may be required to ensure its standardisation and global acceptance. Finally, in the possibility that the maturity model becomes increasingly mature, it must be decided whether the model will be available for free or if its dissemination and the dissemination of its results will be restricted to an exclusive group of people and/or organisations.

5 Methodology for the development of the Maturity Model HEIMM

In the context of the development of Higher Education Institutions Maturity Model (HEIMM), a deep analysis and reflection was carried out regarding the methodological approaches adopted in the development of maturity models. After this reflection, the choice fell on the Mettler methodology (Mettler, 2010a, 201b) for the reasons that will be listed next.

- This methodology is the result of a comparative study and systematisation carried out by its author, work that is among some of the most referenced methodologies in this area.
- The methodology (or mental model) presented by this author is consistent with the DSR guidelines.
- This methodology respects the iterative nature of the development process of the maturity model.
- This methodology takes into account the need to combine theoretical and empirical research, as recommended by other maturity model researchers (de Bruin et al. 2005; Von Wangenheim et al., 2010; Mettler, 2011).
- This methodology is consistent with the type of maturity model intended for this project.

In Table 1 are marked (ellipses) the decisions taken in the development process of the new Maturity Model for HEI IS Management.

The options indicated in Table 1, refer to the HEIMM development and will be justified in each one of the following steps of Mettler's development methodology.

Table 1 Decisions made when developing the HEIMM (Adapted from Mettler (2010a, 2010b))

Design activity	*Decision parameter*	*Characteristic*			
1. Identify need or new opportunity	Novelty	Emerging	Pacing	Disruptive	Mature
	Innovation	New	Variant	Version	
2. Define scope	Breadth	General issue		Specific issue	
	Depth	Individual/Group	Organisation	Inter-organisational	Global/Society
	Audience	Management oriented	Technology oriented	Both	
3. Design model	Maturity concept	Process-focused	Object focused	People focused	Combination
	Goal function	One-dimensional		Multi-dimensional	
	Design process	Theory-driven	Practitioner based	Combination	
	Design product	Textual description of form	Textual Description of form and functioning	Instantiation (software)	Combination
	Application method	Self-assessment	Third-party assisted	Certified professionals	
	Respondents	Management	Staff	Business partners	Combination
4. Evaluate design	Subject of evaluation	Design process	Design product	Both	
	Point of time	Ex-ante	Ex-post	Both	
	Evaluation method	Naturalistic	Artificial	Combination	
5. Reflect evolution	Subject of change	None	Form	Functioning	Form and functioning
	Frequency	Non-recurring		Continuous	
	Structure of change	External/open		Internal/exclusive	
	Dissemination	Open		Exclusive	

5.1 Identify need or new opportunity

In the "identify need or new opportunity" step, two parameters are considered. First, the novelty of the topic covered by the maturity model plays a key role, since it determines if there is a need that this model is able to fulfil. In fact, the development of a new model (*emerging*) is justified by the fact that the existing maturity models in this field have weaknesses, both in their affirmation and their adoption by the HEI (Carvalho et al., 2019). Second, innovation is another parameter that needs to be considered before beginning the development of a maturity model. In the context of the HEIMM, we consider it to be completely new (*new*), because none of the models identified in the literature referred previously is fully focused in the IS of the HEI.

5.2 Define scope

In the second step, the first decision involves defining the magnitude of the phenomenon to be studied, i.e., we must decide whether the model addresses a generic or a more specific topic. In the case of the HEIMM, the model is only applied to HEI, particularly to its IS, and for this reason, the choice is "*specific issue*". The detailed conditions of the maturity model must be then considered. The HEIMM model focuses on *intra-organisational,* as well as *inter-organisational* aspects. In fact, this model incorporates aspects that are related to the internal processes of organisations and also aspects that represent the processes of cooperation with external organisations. This decision is based on the observation that many of the HEI's processes, such as research, relationships with enterprises and other HEI, involve external entities.

Finally, considering one of the DSR guidelines (Hevner et al., 2004), the potential "*audience*" of the maturity model must be considered. In the case of the HEIMM, the target audience includes HEI managers who have decision-making authority. These can either be CEOs or department directors with responsibilities in the management field, such as CIOs or the directors of Information Systems and Technologies (IST) area of HEI. In this case, the choice of the "*audience*" parameter falls under the option "*both*".

5.3 Design model

The construction of the model itself begins in the "design model" step. Here, one of the major decisions involves the definition of "maturity" in the context of the intended model. Mettler (2010a, 2010b) resorts to the literature to justify the emergence of three different maturity concepts according to whether they focus more on the process, the object or the people. The HEIMM presents a multi-faceted approach (*combination*) to measure the maturity, in order to increase the overall efficiency of the HEI in terms of processes (*process-oriented*) and people (*people-oriented*), as well as the technologies that support them. In addition, the HEIMM assesses analytical capabilities, both organisational and technical.

A maturity model can have multiple goals, as in the HEIMM's case. Therefore, another important decision relates to the maturity level: *one-dimensional* (that is, focusing on one measure as an efficiency target) or *multi-dimensional* (i.e., focusing on several, sometimes divergent, objectives). In fact, in the case of the HEIMM, the objective of the maturity measurement encompasses several influence factors (*multi-dimensional*), being able to measure the global maturity of the IS (calculated according to the different weights of each influence factor), but also the maturity of each sub-area of HEI represented by its influence factor. It should be noted that the identification of the main influence factors that will be part of HEIMM will be done in a first phase, based on a literature review and later, complemented by a questionnaire carried out to Portuguese and international IS specialists in the education area (mainly HEI managers and IT managers). International standards and guidelines in the higher education sector must also be taken into account. Subsequently, the nature of the design process (e.g., *theory-driven* versus *practitioner-based* or a combination of both) has to be determined, in order to identify the knowledge base with regard to the maturity levels, the metrics and the corresponding improvement recommendations. The HEIMM model uses a *combination* of both.

Another important decision parameter concerns the model format. Here too, there is a combination of two options, namely, the "*instantiation software*", in respect of developing a tool to evaluate the HEI maturity, and the "t*extual description of form*" as the HEIMM will be available in text format with a description of its applicability. This decision certainly affects the selection of the application method (i.e., whether data collection is based on self-assessment or third-party assessment, such as outsourcing by certified professionals). We consider that this model would essentially be implemented by managers of the HEI whose maturity is to be assessed (*self-assessment*) since they are the ones who know better the reality of their organisation.

Finally, in the data collection process for HEI maturity assessment, it is important to define the actors (*respondents*) in this collection. In the HEIMM model, data collection can be diversified and although it is essentially carried out by managers, other educational and IS professionals may be involved. Thus, the "*combination*" option is the most suitable for this final parameter of the "*design model*".

5.4 Evaluate design

The "*evaluate design*" step concerns the verification and validation of the developed maturity model. With regard to the HEIMM, two parameters ("*design process*" and "*design product*") were initially considered in the context of the object to be evaluated (*subject of evaluation*). The HEIMM should be evaluated in terms of form and content and, therefore, the choice lies with "*design product*". Additionally, this new model should be evaluated before it was implemented, that is, in the "*point of time*" option, the choice falls to "*ex-ante*". Finally, the evaluation method must be "*naturalistic*" since the evaluation of the HEIMM should be based on the experience

and reflection of real users. In this context, semi-structured interviews will be conducted with a diverse group of international HEI managers in order to validate the HEIMM. We will ensure that they have considerable experience in managing HEIs and that they are managers of different types of HEIs, whether private or public, universities or polytechnics, involving as many countries as possible.

5.5 Reflect evolution

In the final step, "*reflect evolution*", the designer has to consider the eventual mutability of the maturity model over time. In the context of this research project, this step will be performed after the HEIMM validation is completed. Later, we intend to implement the model in several HEIs (these should be representative of the private and public sectors in Portugal but also in other countries), and the feedback obtained from its implementation will serve as input for the accomplishment of this final step. In fact, we expect to have the support of several European HEIS, in order to test our model in the context of research projects or institutional collaborations. We believe that such strategy will provide the conditions to improve the model, as well as its standardisation and global acceptance.

Thus, in this final step, the first decision to be made refers to the subject of change (the form or/and the functioning). In this case, change the structure ("*form*") if it is justified to modify the dimensions, taking into account the volatility of the HEI area and academic management. For this reason, any changes in HEIMM will be carried out continuously over time. Another important decision parameter concerns the structure of change. That is, it has to be determined if the modifications can be openly induced by model users or exclusively by the developer himself. In the case of HEIMM, the eventual changes will be made by their authors, after analysing the conditioners that are associated with them. Finally, as the maturity model itself gets more mature, stable and recognised, its adoption will be entirely free, especially by the academic community and IS practitioners in the HEI area.

6 Conclusions and future work

In this paper we report the current state of our project, discussing its two early exploratory phases. We started our project doing a systematic literature review in order to identify and classify the existing maturity models focused on the evaluation of the IS capability to support the HEI's processes. From a large list of found models, we selected a small set of five according to formal assumptions and constraints. Next, we focused our work on these five models, which are focused on the ICT and IS dimensions of HEI.

The studied models are still in an early development stage and in a premature phase of affirmation and consolidation, being proposed by their authors through exploratory studies, as well as they are not adopted in a large scale, or significantly referenced by the academic community. We consider that this results from the fact that they are not sufficiently explicit in the way they were developed and validated, and especially because they are poorly detailed and they do not provide tools to determine the maturity stage or a structure with characteristics of maturity stages. In the case of the adoption of a tool to assess a system's maturity, in only one of the studied works was such as such tool developed. It was found that most of the models, besides focusing on the assessment of the system's maturity, pay attention to an improvement path of such maturity. However, not all have a properly systematised process to move to a higher maturity level. Also, the authors did not apply weights to each one of the influencing factors (or dimensions), that is, in the assessing process of the overall maturity of education IST, all influencing factors have the same importance. Based on the analysis, it was possible to verify that no model was developed based on the guidelines of the development of methodologies for maturity models.

Concerning the focus of our research work, we observed that these studied maturity models are highly focused on technology itself and not in its capability to provide services for efficient information management in the HEI (as well as other types of educational institutions) in several dimensions, such as: management, teaching, research and knowledge management. We are convinced that all these dimensions can benefit if their information ecosystem stays optimised. Such optimised system empowers the capabilities of the HEI and its human capital: the administrators, staff, teachers, researchers and students.

Thus, as far as we know, none of the identified models in the literature is sufficiently focused on the capability of the IS support complex, diversified, interoperable and dynamic organisational processes of HEI. In this perspective, there is an opportunity to propose a new model to fill the gap. On the other hand, HEI managers need tools to evaluate the stage of maturity of their IS. These two ingredients, the opportunity and the need, are the starting point that according to Mettler's methodology (Mettler, 2010a, 201b) justifies the initiating of the conception of a new maturity model.

We intend to develop the HEIMM applying rigorous scientific methods. Additionally, it will apply international standards for management of IS and HEI, as well. These two requirements are very important for the success of such maturity model in terms of recognition, strength and relevance, in both the academic sector and in the society in general. Thus, in this paper we present the results of the second phase of our project, in which we discuss our options in terms of which methodology will be applied for the conception phase of the HEIMM.

To support our decision regarding the methodology to be applied, we conducted another literature review, in order to find the state of the art on methodologies to apply in the conception of maturity models. The approach proposed by Mettler was our option due to its characteristics, which we consider are appropriated for our model.

Next, as designers of the new model, we discuss the decision parameters of the Mettler's methodology that must be taken before initiating this interactive methodology.

Our work is not complete, on the contrary, it is starting because we just identified the necessity and opportunity for

a new maturity model, decided the methodology to apply on the design process of such model, as well as its design parameters. The chosen methodology is iterative and continuous. Thus, in each iterative cycle, we can identify limitations of the model and introduce the necessary adjustments in order to refine it.

Our work is now at that third step of Mettler's methodology, the design stage of the maturity model. We expect to have a first version of the HEIMM in the next months, in order to be submitted to an evaluation as proposed by Mettler.

In the perspective of the acceptance and adoption of the model by HEI, we intend to develop an automatic tool to assess HEI maturity. This tool should be built based on the principles established in HEIMM and should be made available on the internet, enabling managers to perform HEI maturity assessments and simultaneously make comparisons with their competitors, as well as understand the evolution of their maturity over time.

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