A generic process for the development and the implementation of IS maturity models

Mina ELMAALLAM[1], Abdelaziz KRIOUILE[2]

**[1] IMS Team, SIME Lab., ENSIAS, University Mohammed V-Souissi
Rabat, Morocco**

**[2] IMS Team, SIME Lab., ENSIAS, University Mohammed V-Souissi
Rabat, Morocco**

Abstract

Continuous improvement is a process representing an indispensable means even a factor of success for good information systems (IS) governance. It is based more and more on maturity models as self-assessment tool. Indeed, there is increasing importance given to the development of maturity models in the IS discipline. However, the proposed approaches are not generic in terms of architecture choice. There are not sufficiently documented and does not sufficiently support the specific areas to be assessed through the target model. The present paper propose MMDPIS as a generic process for IS maturity model development.

Keywords: *Maturity, Maturity model, Information system.*

1. Introduction

Maturity models are a simplified representation of the evolution that may follow the maturity of an organization [1]. They are also practical ways for the company to do a self-assessment in a given area.

Maturity models allow not only to assure a benchmark with best practices and identify areas for improvement, but also to trace the improvement goals based on the current status and strategy of the organization, and define the optimal way to achieve it.

The interest of the models of maturity in information systems increases both for the researchers and for the professionals of the domain. However, the methods and theories dedicated to their design are not abundant and their use is not frequent enough. Although there are many maturity models reported in the scientific literature and non-scientific approach to develop a maturity model remains largely unexplored.

The objective of this article is to present the generic process MMDPIS designed for the development of new IS maturity models. It represents an improvement of MMDePSI process [2] in terms of maturity generic modeling and development steps.

After the introduction, the second section gives an overview onto the existing approaches for the development of the maturity models. It also presents a comparative study of these approaches.

The third section presents the generic maturity model proposed in the context of this research. The fourth section describes the process MMDPIS. In the fifth section, we conclude our paper.

2. IS Maturity model development approach

The literature shows the existence of a relatively small number of design approaches maturity models in information system research. The use of the DSR (Design Science Research) is dominant in the development of these approaches.

[3] proposes a six-step process for developing a maturity model: (1) defining the scope, (2) design of the model by defining its architecture and deployment process, (3) populating of the model structure by defining "what is to be measured" and "how it can be measured," (4) test the model structure, (5) model deployment, and (6) Maintenance of development and evolution of the model.

[4] build a staged model of maturity, according to a process in three axes: (1) people, (2) processes, and (3) object. This process involves three stages: (1) identification of the problem and motivation, (2) defining objectives, and (3) design and development of the model where the fields, level of maturity, the measuring and deployment are defined.

As for [5] they use the guidelines of design science [6] to define the process of designing a model of maturity. They define the following steps: (1) specification of the problem, (2) comparison of existing solutions, (3) definition of development strategy, (4) development of the model structure, (5) specification of methods of evaluation and deployment, (6) implementation of deployment actions, and (7) evaluation of deployment actions.

[7] provide a guide for the development and implementation "maturity grids for assessing organizational capabilities". The steps for this guide are: (1) planning, (2) development (3) Assessment, and (4) Maintenance.

[8] uses the process DSR proposed by [9] to propose an approach of maturity "focus area model" design. Maturity models based on the Focus Area are originally developed to support the continuous and progressive improvement of software testing ([10], [11]).

A Focus Area is a well-defined coherent subset of a Functional Domain [8]. The total set of focus areas is a partition of the functional domain, i.e. different focus areas are disjoint and the union of all these focus areas is the complete functional domain [8]. In this category of models each focus area has its own number of specific maturity levels. The overall maturity of an organization is expressed as a combination of the maturity levels of these focus areas. The approach proposed by [8] consists of four steps: (1) Scoping: identify and scope domain, (2) design model: determine focus area, determine capabilities, determine dependencies, position capabilities in matrix, (3) Instrument development: develop assessment instrument and define improvement actions, (4) implementation and exploitation: implement maturity model, improve matrix iteratively and communicate results.

The proposed approach (Figure 1) is modeled using the notation presented by [12], which is based on standard UML conventions, with some minor adjustments.

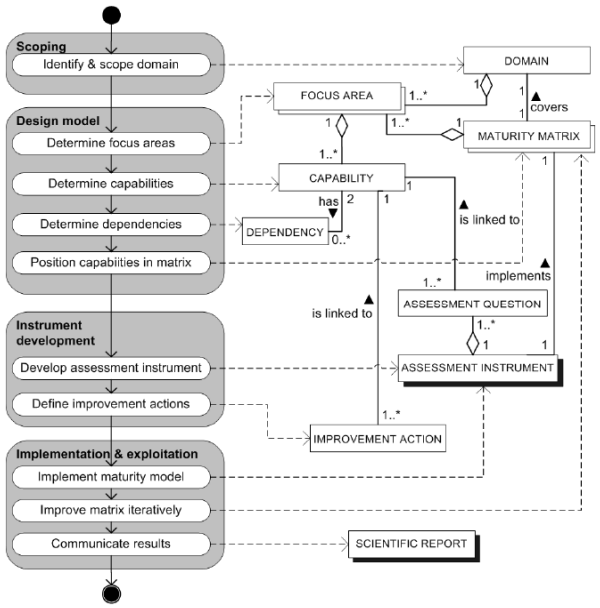

Fig. 1: The development method for focus area maturity models [8]

The maturity matrix is the key deliverable of the design phase. It includes capabilities for FA based on their order and dependencies. It provides the level of maturity once the instrument designed and also defines improvement paths. Figure 2 shows an example of this matrix.

Maturity Scale / Focus Area	0	1	2	3	4	5	6	7	8	9	10	11	12	13
Development of architecture		A			B			C						
Use of architecture			A			B				C				
Alignment with business		A				B				C				
Alignment with the development process			A				B		C					
Alignment with operations					A			B			C			
Relationship to the as-is state					A				B					
Roles and responsibilities				A		B					C			
Coordination of developments							A			B				
Monitoring				A		B		C		D				
Quality management								A		B			C	
Maintenance of the architectural process							A		B		C			
Maintenance of architectural deliverables					A			B					C	
Commitment and motivation		A					B		C					
Architectural roles and training				A		B			C			D		
Use of an architectural method				A						B				C
Consultation			A		B				C					
Architectural tools							A				B			C
Budgeting and planning				A							B		C	

Fig. 2: Example of FA model maturity matrix

An organization reaches maturity level overall 'l' (o <= l <= max levels defined in matrices) If:

- All the capacity of all FA located in the column corresponding to the level 'l' are verified,
- All the capacity of all the FA to the left of the column corresponding to the level 'l' are verified,
- There is at least one capacity on the right column of the column corresponding to the level 'l' that is unverified.

[3] leads his reflection with the introduction of so-called elements “parameters of decision”. It starts from the principle that at each stage of the construction process of the model, the designer needs to decide on some elements before continuing reflection on good foundation.

[13] presents the design process maturity models in two perspectives: development and application. The model is seen in the two roles: designer and user. It considers that the full development cycle consists of four phases: (1) scoping, (2) design of the model, (3) evaluation of the design, and (4) development reflexive. It also considers that the successful application of a maturity model normally goes through four phases: (1) model selection, (2) preparation for deployment, (3) application of the model, and (4) implementation of corrective actions.

For each phase of the two perspectives, it offers decision elements necessary for its accomplishment and success.

The process based on initial work of the authors [14] consists of five steps and is based on a combination of both theoretical and empirical aspects. This model consists of five steps [14]:

- Suggested Stage Model. The initial stage model is based on ideas from both research and practice. Research literature has defined evolutionary aspects of the phenomenon, and practitioners perceive different maturity levels for the phenomenon. [14].

- Conceptual Stage Model. The number of stages and the contents of stages are developed in an iterative cycle involving dominant problems that seem different at various stages. Case studies are applied to illustrate content characteristics of each stage, as well as significant differences between stages, where preceding and following stages have different kinds of dominant problems. [14].
- Theoretical Stage Model. Relevant theories are applied to explain stages, their contents, and the evolution from one stage to the next stage. Benchmark variables are derived from these theories. At the same time, theories and benchmark variables are discussed in focus groups [14].
- Empirical Stage Model. Each benchmark variable is assigned a benchmark value for each stage of growth. A survey is carried out, where stages, evolution, and benchmark values are empirically tested [14].
- Revised Stage Model. Based on the empirical test from survey research, the empirical stage model is revised [14].

A comparative study was conducted following the literature review (table 1). The criteria for this study were defined on the basis of the requirements proposed by [5] as well as the characteristics of a maturity model answering the problem and the requirements of the present research. These criteria are:

- C1: comparison with the existing processes: it is necessary to allow a study of the existing models as first step of the development of a new maturity model.
- C2: iterative Procedure: the proposed method has to provide an iterative development of the new model,
- C3: evaluation: an iterative evaluation must be assured by the development method.
- C4: multi-methodical Procedure: the approach of development has to use a variety of research methods.
- C5: Identification of the relevance of the problem: The approach must incite the demonstration of the relevance of the need which the new model has to answer.
- C6: Problem Definition: The development process should require determination of the domain of prospective application of the maturity model, and the conditions of its application and expected benefits.
- C7: Targeted Presentation of results: The development process must take into account the layout of the model to be developed. This must be targeted regarding the conditions of application and user needs.
- C8: scientific Documentation: the process of conception of the model of maturity must be documented in detail by considering every stage of the process, the concerned parts, the applied methods and the results.
- C9: Phase: action plan for improving the maturity: the approach must include a phase to the maturity model to assist users in defining maturity improvement actions.
- C10: dynamic architecture: the choice of the architecture must be adapted to the objectives and context of the new model.
- C11: continuous improvement of the model: the approach should ensure a continuous improvement of the model.
- C12: Model documented: The approach must provide a documented model (propose canvas whenever possible).

Table 1: Evaluation of Maturity model development approaches

Criteria/ Ref.	1	2	3	4	5	6	7	8	9	10	11	12
[3]	-	+	+	+	-	-	+	-	-	-	-	-
[4]	-	-	+	-	+	+	-	-	-	-	-	-
[5]	+	+	+	+	+	+	+	+	-	-	+	-
[15]	+	+	+	+	+	+	+	+	-	-	-	-
[8]	+	+	+	+	+	+	+	+	+	-	-	-
[16]	-	+	+	-	+	+	-	-	-	-	+	-
[13]	-	+	+	-	+	+	-	-	+	-	+	-
[14]	-	+	+	+	-	-	-	-	-	-	-	-

The analysis of assessment results show that no approach meet 100% of the evaluation criteria. The maximum rate verified is 75% recorded by the approach of [5] and [8] followed by the [15] with 67%.

3. Generic conceptual Maturity Model

3.1 Modeling Approach

The modeling approach is inspired by the proposed approach for the construction of a conceptual generic risk management model [17]. It also builds on from that proposed by [1] for the construction of a generic conceptual model for repositories of IT best practices represented according to the four-level architecture of the OMG [18].

There a two steps in the proposed approach.

The first one is the alignment of the concepts of maturity. It consists of the identification of the relevant sources of maturity concepts, definition of this concepts and the description of the equivalences between their components.

The second step is the generic conception of the maturity which consists in the identification of generic maturity concepts, definition of the relations between this concepts

and the elaboration of the generic maturity model under UML.

3.2 Alignment of the concepts of maturity

Following the study of literature, we adopt two main elements as sources of concepts to be considered for the development of generic maturity model. These are approaches to developing new models of maturity and the basic maturity models. The latter are the models whose architectures represent references development of most existing models. We cite in particular the CMMI [19] and the Focus Area model [8].
Among the approaches studied in the literature review, we retain those of: [3], [4], [5], [15], and [8]. Those proposed by [16] and [13] are not considered seen that they are only resuming concepts of other approaches with the introduction of the elements of decisions to each of their phases and according to both perspectives: development and application of the maturity model.

The concepts of maturity are identified through sources defined previously. They are completed by other concepts considered important.
The equivalences are made on the basis of the analysis and of the semantic correspondence of the definitions given by sources to the identified concepts.
We ensured to give a generic definition to every concept grouping all the listed definitions.

3.3 Generic modeling of the maturity concepts

Further to the made alignment, we propose the generic concepts of maturity listed in table 2. Names are deducted from the definitions given to the concepts during the establishment of the equivalences.

Table 2: Maturity generic concepts

Concept	Definition
studied area	Identifies the activity or discipline assessed.
scope	Delimits the scope of the model in terms of domain and the environment of application.
Purpose of the model	Formulate the objective of the creation of the model in a clear and precise way
	Explains the problem that the model must meet or the opportunity motivating its creation.
Development Strategy	Defines the strategy of development of the model
Success factors	Include the model success factors
Implementation scope	Defines the scope of application of the model during its implementation
Reference Documents	Represent the eventual documents on which the development of the new model is based.
Requirements	Define the requirements which the developed model has to satisfy.
users of the model	Lists the users of the model.
Development actors	Group the actors participating in the development of the model.
Responsible	Specify the responsible of implementation
Respondents	Include persons interviewed during evaluations.
Documents	Record the documentation of the model.
Version	Traces and justifies the different versions of the model.
Domains	Include the domains according to which the evaluation of the studied activity is made
Domain group	Groups the domains of the model
Maturity level	Represent degree of maturity of the organization relative to its evolution in the activity studied.
Capacity level	Includes the levels of development of the areas through which the studied activity is evaluated.
Control objectives (CO)	Describe elements necessary to check to ensure the achievement of a level of maturity or capacity.
Measure	Contains result of evaluation
Control elements	Represent the tools of evaluation of the maturity
Axes of evaluation	Represent the axes according to which the evaluation of the maturity is made.
Evaluation elements	Represent a level of finer detail according to which the evaluation can be made.
Improvement actions	Represent the actions to be led to improve the level of maturity or capacity.
Improvement plan	Organizes and plans the actions of improvement
Improvement strategy	Represents the strategy to be followed for the improvement of the maturity.
IS : information System	Defines information system studied in the evaluation of maturity.
Life cycle	Defines the life cycle of studied IS.

Formalization of the generic model in UML is made taking into account the relationship between different generic concepts:

- Charter: the charter model includes its characteristics. It can be constituted by the following elements: model name, studied activity, scope, purpose of the model, development strategy, success factors, scope of application, requirements, existing models, reference documents, stakeholders (users of the model, development actors, responsible of implementation, respondents).

- Version: A maturity model can change in one or more versions as part of its continuous improvement over time. Creating new versions should be justified.
- Document: for every model corresponds a set of documents drawing its various development stages.
- Domains and Domain Groups: a maturity model is structured in a variety of domains reflecting the activity studied. These areas can be grouped into domain groups.
- Control objectives: for each domain, a set of requirements is identified. These requirements are called in this paper: control objectives. An objective of control can depend on one or on several other objectives belonging to the same or to another domain.
- Levels of maturity/ levels of capacity: for each domain are defined a set of levels to assess its capacity. Every level of capacity is reached via the validation of a subset of control objectives corresponding to this domain. The levels of maturity measure the degree of achievement of the maturity by the organization with regard to the studied activity. They are identified according to predefined domains depending on the adopted architecture.
- Elements and axes of evaluation: The evaluation axes are the items according to what an assessment can be made. An axis evaluation can be composed of one or several evaluation items.
- Element of control (EC): Determining the maturity or capacity level, depending on the architecture maturity model, is done by evaluating all control objectives concerned. This evaluation is performed through the definition and evaluation of other items called control elements. Each control objective is then linked to one or more EC. Control elements can be formulated for example as questions.
- Measure: The result of the evaluation of a control element is represented by the concept "measure". This assessment is made by an evaluation component with regard to a given information system which is in one of its life cycle stages.
- Strategy and Plan of Improvement: Following the evaluation of the activity, an improvement plan is established for each domain. A plan of improvement is constituted of a set of improvement actions and can follow a given improvement strategy.

Following the definition of the relationships between the proposed generic maturity concepts, we derive the generic conceptual maturity model formalized in UML and illustrated in figure 3.

4. Stages of the process MMDPIS

The conception of the process MMDPIS is based on the study of the literature as well as on the proposed generic conceptual modeling.
Both theoretical and practical aspects are considered. The process is also based on the requirements proposed by [5] as well as the other criteria used for the evaluation of the steps of development of new maturity models.
The stages of the process MMDPIS are described in the figure 4.
The process is structured in three blocks: (1) design, (2) implementation, and (3) continuous improvement.

4.1 Block 1: Design

The first block presents the design stages.
Establish charter: The establishment of the charter is the first step in developing the maturity model.
Establish the structure: The aim is to structuring the concepts of maturity depending on the purpose and scope of the model to develop and also defining the architecture or the representation according to which the evaluation will be made. In contrast to the other approaches cited in the literature review the definition of architecture at the MMDPIS process takes into consideration the purpose and requirements of the model to be developed.
This architecture can be of type: (1) staged, (2) continuous or (3) "Focus Area". The choice must be justified and documented.
The staged architecture is adapted when it is a question of estimating the global maturity of the organization with regard to a given activity. This choice is recommended for example in case of benchmarking study.
The objective of the continuous architecture is to evaluate domains or process according to predefined levels of evolution, called "levels of capacity ". This choice is recommended when it is question of making a comparative study between these domains in a perspective to prioritize improvement axes.
As for the third architecture "Focus Area", it defines control objectives specifically for each area of activity studied depending on its life cycle phase. It enables to take into account the interdependencies between these control objectives.
Fulfill the structure: This step begins by identifying the elements of the model according to the structure adopted.
The explanation of these elements can be based on different approaches. The choice of method depends on the context of the model development.

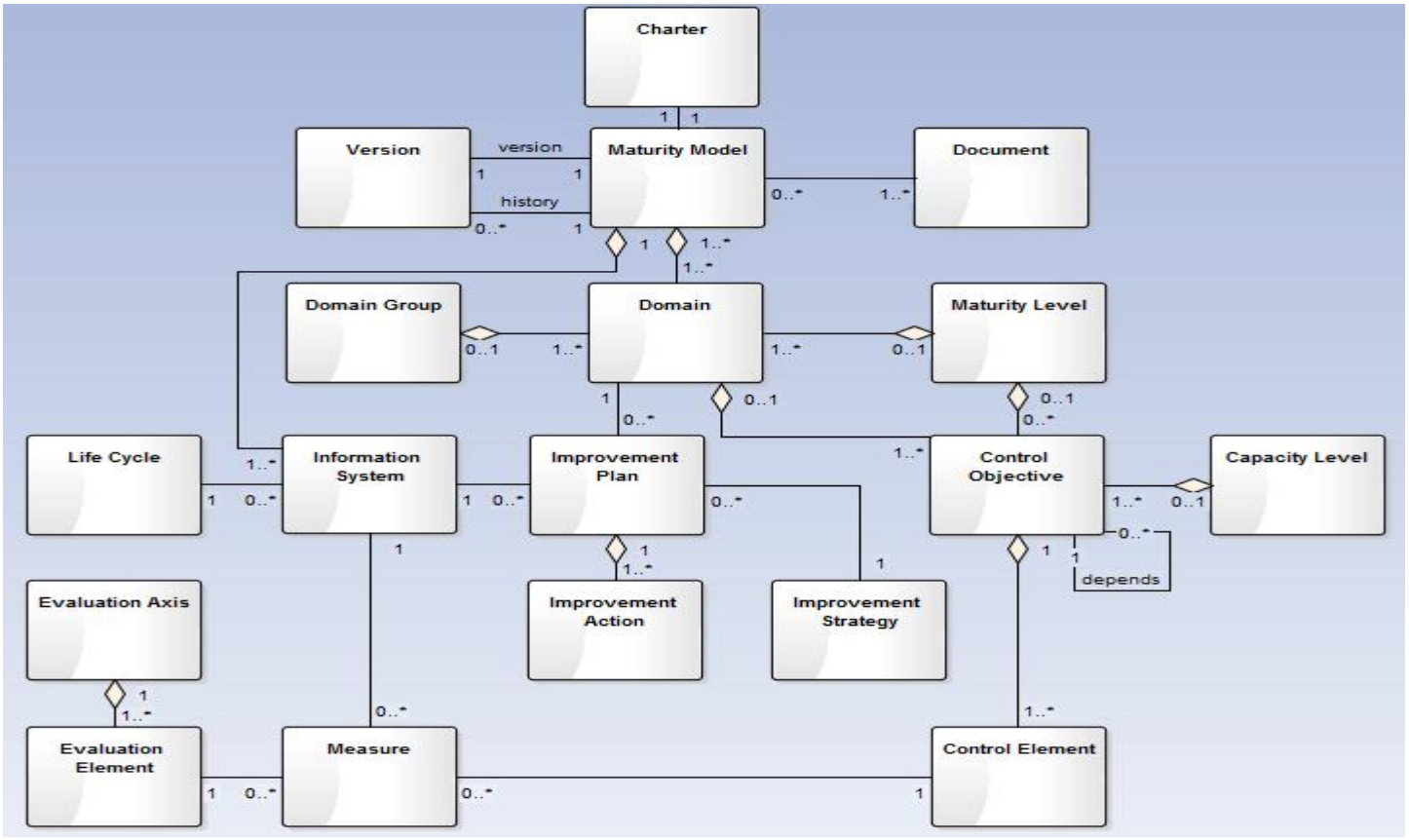

Fig. 3: UML modeling of the *generic maturity model*

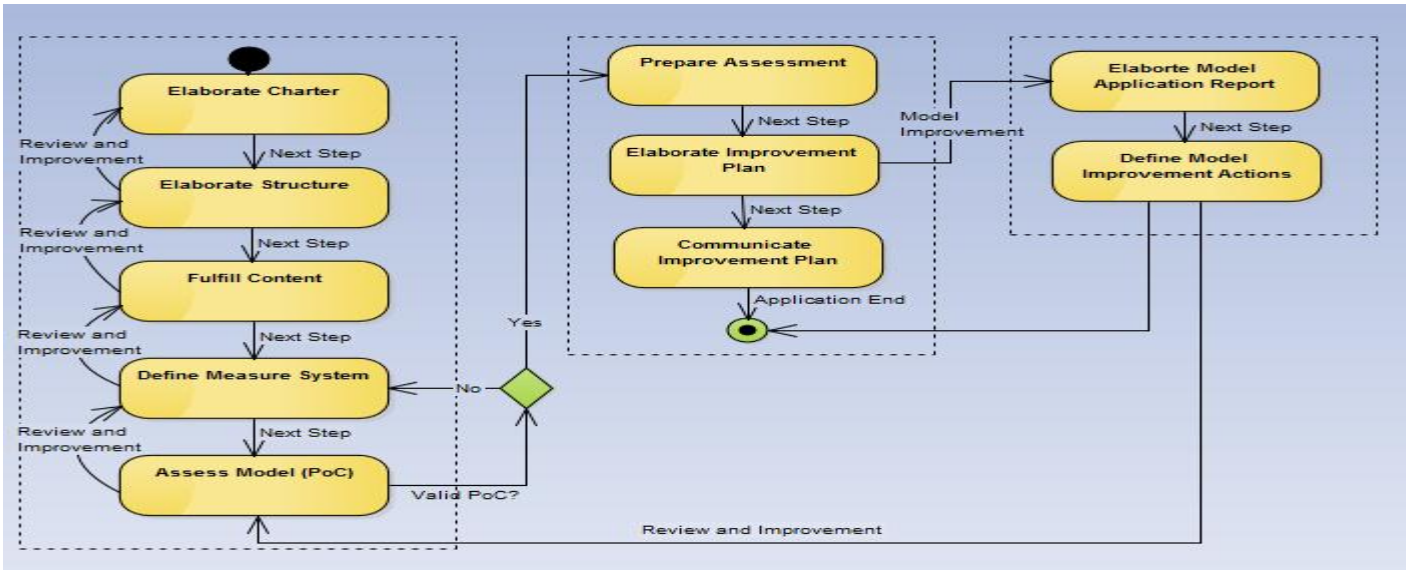

Fig. 4: Steps description of the *MMDPSI*

Indeed, the most common and recognized approach of the methods of maturity models development is the literature review along with interviews of experts in the field. This approach is complete for some items when needed, especially for complex or new areas by exploratory methods such as Delphi technique, Focus group or case study.

The elements to be defined for all the types of structures are:

- Axes and elements of evaluation.
- Domains and groups of domain: the identified domains must be mutually exclusive and collectively exhaustive. The link domain / Group of domain can be established according to an approach Top-Down or Button-up according to the context of model development.
- Objectives of control: for every domain, define the objectives of control.

Specific elements of each structure are:

- Maturity levels for staged architecture: define the maturity levels of the model and control objectives required for each domain to reach a given level.
- The capacity levels for continue architecture: define the capacity levels and control objectives required for each domain to reach a given capacity level.
- The interdependencies and ranks of control objectives (CO) for FA architecture: define for each control objective a rank and dependencies on other control objectives. If the CO is independent of any other CO, then rank (CO) = 1. If the CO depends on a number of other CO: {CO1, CO2, ... COn}, then the rank is calculated as rank (CO) = Max (COi) +1, 1 <= i <= n. These two elements are used to determine the maturity matrix and define maturity levels.

Defining the measurement system: In this stage are defined the elements of the measurement system:

- Elements of control: for every control objective define the corresponding control elements,
- Method and evaluation tools: it is necessary to define the method according to which the evaluation will be made and which tools to use for the collection of the measures and their exploitation,
- Evaluation Team: the human element is central to the measurement system. It is important at this stage to identify the requirements for this element or detail them if they are already identified in the model charter. These requirements may be under three aspects: skill, function, behavioral component. The latter can result in motivation, commitment and adherence to continuous improvement project.

Evaluate the model (PoC: Proof of Concept): The purpose of this evaluation is to check whether the model designed meets the predefined requirements. Evaluation can be done through the progress of a case study example.

If the evaluation is satisfactory, the maturity model developed is implemented. Otherwise, a second iteration is started. The recovery was made from the stage representing the source of the problem or dissatisfaction.

4.2 Block 2: Implementation

The second block guides the implementation of the designed maturity model.

Prepare evaluation: The proposed evaluation process involves the following steps:

Constitution of the evaluation team: It consists on constituting the team of evaluation according to the requirements predefined in the charter and the measurement system. The participation in this exercise must be accepted and not present an additional or hidden responsibility for the evaluation team. The communication and the raising awareness of the team are important. A Quiz can help to do this and also to measure the adhesion of the team before beginning the evaluation.

Define IS to evaluate: At this stage, we have to define the list of IS objects of evaluation. For each IS, the new elements of the WSF and the corresponding phases of life cycle, must be described and the weight reflecting its importance in the body should be calculate. We propose to calculate the weight based on three elements: (1) consumption of the cost, (2) consumption of the load, and (3) contribution to the strategy. Table 3 provides an example calculation of this weight. Column 1 provides the name of IS. Column 2 gives the rate of annual consumption compared to the total annual load. Column 3 shows the annual rate of consumption relative to the overall annual cost. Columns 4 to n describe the contributions of IS in organization strategic objectives (SO). This qualification is made on a qualitative scale to which corresponds a quantitative scale: F: Strong 3, M: Medium 2 and Fb: Low 1. The first part of the column n+1 calculates the contribution according to predefined quantitative scale. It is equal to [(3 * F value) + (2 x number M) + (1 x number Fb)] (for example for IS 1 is equal to 3 * 2 = 6). The second part of this column gives the contribution in the form of rate with regard to the global contribution (for example for IS 1 is equal to 67% = 6 / (3 + 6)). The last column n + 2 is dedicated to the calculation of the overall weight of the IS based on the three elements previously defined: load consumption, consumption cost and contribution in the strategy. This weight is given by the formula: weight = (Val_col 2+ Cal_col3 + Val_part2(Col n+1)) (IS)/ Total (Val_col 2+ Cal_col3 + Val_part2(Col n+1))(all IS).

Table 3: Example of calculating the weight of an SI

IS	load Cons.	cost Cons.	Col.4 S.O	…	Col.n S.O.	Col.n+1 Cont. S.O.		Col.n+2 weight IS
IS 1	25%	40%	F		F	6	67%	44%
IS 2	75%	60%			F	3	33%	56%

Establish an evaluation plan: An evaluation plan depends on the adopted evaluation system. However, it usually contains: sessions of presentation and explanation of the model/ system evaluation tools, evaluation Workshops and outcomes discussion sessions.

Develop the Improvement Plan: The development of the improvement plan first requires an analysis of assessment results.
Once this analysis made, a list of the scenarios of improvement is established. These scenarios represent the possible paths of improvement. The person responsible for implementing the maturity model should select the most optimal path answering the objectives and constraints of the organization. Optimization paths for improvement may require the definition of the elements of calculating the improvement effort. He can involve in particular the knowledge of the cost and the load estimated as well as of the impact of implementation of the improvement actions.
Communicate the improvement plan: the improvement plan should be communicated to all stakeholders in an objective of validation, implementation and monitoring of improvement actions.

4.3 Block 3: continuous improvement

The third block is dedicated to the model continuous improvement. It is a question of defining the improvement actions of the model developed after its implementation.
Develop the application report: This report serves to register reports and remarks resulting from the phase of implementation.
Define the model improvement actions: is an input for the improvement of the model. It can give rise to a new iteration for its development.

4.4 MMDPIS Assessment

The evaluation of MMDPIS is based on the criteria previously defined. Table 4 describes the elements of this evaluation.

Table 4: Evaluation of MMDPIS

Criteria	Evaluation
C1: Comparison with existing maturity models	This is assured in the first phase of establishment of the charter. At this stage are studied the existing models and the strategy adopted for the development of the new model
C2: Iterative Procedure	The process builds the new maturity model in a iterative way. This is made through to the intermediate evaluations as well as to the third block dedicated to the continuous improvement.
C3: Evaluation	Except for the intermediate reviews allowing elementary evaluations, two evaluations are assured by the proposed process: "estimate the model (PoC) " and " Develop the application report of the model ".
C4: Multi-methodological Procedure	A variety of methods are proposed during the model development phases: - literature Review - Exploratory approach: quiz, interview, focus group, - Proposed use of optimization approach to the definition of improvement paths.
C5: Identification of Problem Relevance	The process allows developing models of maturity specific and adapted to the studied domain. The relevance of the problem and the added value of the developed model are defined at the first step: "Establishing the Charter."
C6: Problem Definition	The problem is defined in the first step: "Establishing the Charter."
C7: Targeted Presentation of Results	This is ensured in the definition of requirements in step "Establishing the Charter."
C8: Scientific Documentation	Documentation is assured for all phases of the process. This provides all the elements necessary to document the development of the maturity model.
C9: Elaboration of the action plan for the maturity improvement	The development of maturity improvement plan is represented by the phase called: "develop improvement plan ". It is included in the second block "implementation."
C10 : non-static architecture	The architecture is established according to the purpose of the model developed. This is done through phase "Building structure" of Block "design". The proposed model supports all types of existing architectures: staged, continuous and FA.
C11: Continuous improvement of the model	The third block of the process is dedicated to the continuous improvement of the model developed through two phases: "Develop the application report" and "Define the model improvement actions."
C12: Documented model	The conceptual model and the generic description of the stages of MMDPIS process provide all the elements for the documentation of the new model.

5. Conclusion

The maturity assessment is an important tool of self-assessment. It is a good means for IS continuous improvement process. However, existing methods for development maturity models have limitations such as their insufficiency of the generic aspect, the poor documentation

and not taking into account the specific characteristics of the areas concerned. In this paper we proposed the MMDPIS process to address this issue. Before describing the MMDPIS steps, we propose a generic conceptual maturity model to align, standardize and model the maturity concepts in a IS context.

The MMDPIS is in accordance with predefined requirements based on criteria developed by [5] and the seven lines of the Director DSR [6].

References

[1] R. Deguil, "Mapping entre un référentiel d'exigences et un modèle de maturité : application à l'industrie pharamceutique", Ph.D. thesis, Institut National Polytechnique de Toulouse, Toulouse, France, 2008.

[2] M. El maallam, A.Kriouile,"Toward a Maturity Model Development Process for Information Systems (MMDePSI)". International Journal of Computer Science Issues (IJCSI), Vol 10, No. 3, 2013, pp. 118-125.

[3] T. De Bruin, R. Freeze , U. Kulkami, and M. Rosemann, "Understanding the Main Phases of Developing a Maturity Assessment Model". In Proceedings Australasian (ACIS), 2005.

[4] T. Mettler, and P. Rohner, "Situational maturity models as instrumental artifacts for organizational design", in Proceedings of the 4th International Conference on Design Science Research in Information Systems and Technology DESRIST'09, 2009, No. 22, pp. 1-9.

[5] J. Becker, R. Knackstedt, and J. Pöppelbuß, "Developing Maturity Models for IT Management – A Procedure Model and its Application", Vol. 1, No. 3; 2009, pp. 213-222.

[6] A.R. Hevner, S.T. March, J. Park, and S. Ram,. "Design Science in Information Systems Research". MIS Quarterly, Vol. 28, No. 1, 2004, pp. 75-105.

[7] A. Maier, J. Moultrie, and P.J. Clarkson, "Developing Maturity Grids for Assessing Organisational Capabilities: Practitioner Guidance", in 4th International Conference on Management Consulting conference, 2009.

[8] M.V. Steenbergen, R. Bos, S. Brinkkemper, I.van. Weerd, and W. Bekkers, "The Design of Focus Area Maturity Models", in Proceedings of the 5th International Conference on Design Science Research in Information Systems and Technology, pp. 317-332, 2010.

[9] K. Peffers, T. Tuunanen,M.A. Rothenberger, and S. Chatterjee, "A Design Science Research Methodology for Information Systems Research". Journal of Management Information Systems, Vol. 24, No. 3, 2008, pp. 45-77.

[10] T. Koomen, and M. Pol, Test Process Improvement, a practical step-by-step guide to structured testing, Addison-Wesley Professional, Britain, 1999.

[11] T.Koomen, R. Baarda, TMap Test Topics, UTN Publishers, 2006.

[12] I.van de. Weerd, and S. Brinkkemper, Meta-modeling for Situational Analysis and Design Methods. Handbook of Research on Modern Systems Analysis and Design Technologies and Applications, pp. 38-58, 2008.

[13] T. Mettler, "Maturity assessment models: a design science research approach". International Journal of Society Systems Science, Vol. 3, No. 1/2, 2011, pp. 81-98.

[14] P. Gottschalk and H. Solli-Sæther,"Towards a stage theory for industrial management research". Industrial Management & Data Systems, Vol 109, 2009, pp. 1264-1273.

[15] A.M. Maier, J. Moultrie, and P.J Clarkson, P. J, "Assessing Organizational Capabilities: Reviewing and Guiding the Development of Maturity Grids". IEEE Transactions on Engineering Management, Vol 59, No 1, 2012, pp. 138 - 159.

[16] T.Mettler, "Thinking in Terms of Design Decisions When Developing Maturity Models". International Journal of Strategic Decision Sciences (IJSDS), Vol. 1, No. 4, 2010, pp. 76-87.

[17] Mayer, N. "Model-based Management of Information System Security Risk". Ph.D. Thesis, University of Namur, Namur, 2009.

[18] Group, O. M. Meta Object Facility (MOF) specification, 2002.

[19] Basque, B, "CMMI 1.3 - Guide complet de CMMI-DEV et traduction de toutes les pratiques CMMI-ACQ et CMMI-SVC", Dunod, 2011.

Mina ELMAALLAM received the graduate of Ph.D in information system from the ENSIAS school in 2013. She also received the degree of engineer of state from the same school in 2000 (option: management system and supporting decision-making). Her research interests are Information System, Information System Risk Management, and Maturity Model for Information System.

Abdelaziz Kriouile is a full Professor in the Software engineering Department and a member of SI2M Laboratory at National Higher School for Computer Science and Systems Analysis (ENSIAS), Rabat. He is also a Head of the SI3M Formation and Research Unit. His research interests include integration of viewpoints in Object-Oriented Analysis/Design, Service-Oriented Computing, and speech recognition by Markov models. He has directed several Ph.D thesis in the context of Franco-Moroccan collaborations.