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# AN OVERLAPLESS INCIDENT MANAGEMENT MATURITY MODEL FOR MULTI-FRAMEWORK ASSESSMENT (ITIL, COBIT, CMMI-SVC)


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## ABSTRACT


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| Aim/Purpose | This research aims to develop an information technology (IT) maturity model for incident management (IM) process that merges the most known IT frameworks' practices. Our proposal intends to help organizations overcome the current limitations of multiframework implementation by informing organizations about frameworks' overlap before their implementation. |
| Background | By previously identifying frameworks' overlaps it will assist organizations during the multi-framework implementation in order to save resources (human and/or financial). |
| Methodology | The research methodology used is design science research (DSR). Plus, the authors applied semi-structured interviews in seven different organizations to demonstrate and evaluate the proposal. |
| Contribution | This research adds a new and innovative artefact to the body of knowledge. |
| Findings | The proposed maturity model is seen by the practitioners as complete and useful. Plus, this research also reinforces the frameworks' overlap issue and concludes that some organizations are unaware of their actual IM maturity level; |


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| | some organizations are unaware that they have implemented practices of other frameworks besides the one that was officially adopted. |
| Recommendations for Practitioners | Practitioners may use this maturity model to assess their IM maturity level before multi-framework implementation. Moreover, practitioners are also incentivized to communicate further requirements to academics regarding multi-framework assessment maturity models. |
| Recommendations for Researchers | Researchers may explore and develop multi-frameworks maturity models for the remaining processes of the main IT frameworks. |
| Impact on Society | This research findings and outcomes are a step forward in the development of a unique overlapless maturity model covering the most known IT frameworks in the market thus helping organizations dealing with the increasing frameworks' complexity and overlap. |
| Future Research | Overlapless maturity models for the remaining IT framework processes should be explored. |

Keywords IT framework, maturity model, DSR, incident management, overlap, ITIL, COBIT, CMMI

## INTRODUCTION

Information Technology (IT) has become crucial to the support, sustainability, and growth of most businesses (Pereira, Mira da Silva, & Lapão, 2014), by supporting existing business strategies as well as new strategies (Henderson & Venkatraman, 1993). IT has ceased to act simply as a supportive role and has taken on a central position within organizations. Currently, having an IT department is not enough to ensure that an organization is technologically successful.

Due to the high number of services and the different types of organizations, IT grew rapidly and widely. At the same time, IT service managers are under pressure to reduce costs while helping the organization to generate revenue and quickly deliver cost effective services to their customers (Gacenga, Cater-Steel, & Toleman, 2010).

Many IT frameworks have been proposed to help organizations manage and govern IT. Information Technology Infrastructure Library (ITIL), Control Objectives for Information and Related Technologies (COBIT), and Capability Maturity Model Integration for Services (CMMI-SVC) are among the most used and accepted IT Frameworks in the market (Barash, Bartolini, & Wu, 2007; Information Technology Governance Institute, 2007; Sekhara, Medromi, & Sayouti, 2014; Software Engineering Institute, 2010; Yoo et al., 2006).

Yet, in spite of the growing importance of IT frameworks, several problems still remain. For example, IT frameworks are seen as very generic and very complex (De Haes, Van Grembergen, & Debreceny, 2013). Some of these IT frameworks are not mutually exclusive and can be combined in order to provide a powerful IT framework (Information Technology Governance Institute, 2008) but most of them overlap each other (Pereira & Mira Da Silva, 2012b). This becomes a major issue since different frameworks are often used as complementary and most of the times simultaneously, which means that parallel projects imply a duplication of investments, costs, and human resources (Gama, Sousa, & da Silva, 2013).

Despites IT frameworks importance, they have also been criticized, and maturity models are seen as a way to overcome such problems (Trinkenreich & Santos, 2016). Maturity models in IT management have been proposed since at least 1973 (Rocha & Vasconcelos, 2004). More than one hundred different maturity models have been proposed (De Bruin et al., 2005) but most are too general and, as a result, are not well defined or documented (Becker, Knackstedt, & Pöppelbuß, 2009). Plus, despite some researchers pointing out that these IT frameworks overlap each other (Sahibudin, Sharifi, & Ayat, 2008), current maturity models do not address the overlap issue.

Due to the monetary, operational, and image impact that incident management (IM) process can bring to an organization, it is usually one of the most adopted by organizations (Alshathry, 2016). Plus, it is also a key element for IT support (Cusick & Ma, 2010). However, IM implementation is long, complex, expensive, and often fails (Ghrab, Ketata, Loukil, & Gargouri, 2016). Failure of proper operation of the IM process can result in ongoing interruptions by IT support technicians, poorly defined resolution priorities, poor management information, and forgotten, poorly managed events. For example, one of the ultimate measures of an IT support organization's success is the amount of time it takes to resolve an incident (Barash et al., 2007). This means that IM can shape how customers see the entire organization.

An effective incident information management system needs to deal with several organizational challenges to support heterogeneous distributed incident data and to enable decision makers to detect anomalies and extract useful knowledge for problem solving. In this context, decision makers should evaluate the risks, select the appropriate alternatives during an incident, and provide differentiated services to satisfy the requirements of different incident management phases (Peng, Zhang, Tang, & Li, 2011).

As previously stated, IT frameworks can help organizations in such implementation. However, IT frameworks are complex (De Haes et al., 2013), generic (De Haes et al., 2013) and overlap each other (Information Technology Governance Institute, 2008; Pereira & Mira Da Silva, 2012b). Maturity models are seen as a possible mechanisms to overcome frameworks problems but they are seen as incomplete (Becker et al., 2009).

As previously stated, IT has become essential for organizations but it also brings complexity. Several IT frameworks exist to help organizations define and implement the most relevant IT processes. Similarly, some IT maturity models have also been created (some linked with IT frameworks) to help organizations prioritize the IT processes implementation. IM process has been pointed as one of the most early adopted processes (quick win). However, most of these frameworks and maturity models overlap each other leading to a waste of resources. On behalf of such evidences and grounded on the need of further investigation about multi-frameworks implementation and how they can be managed and measured (De Haes et al., 2013), this research intends to provide further information on the following research question: Is it possible to develop an overlapless and complete IT Maturity Model for Incident Management process?

The remainder of this article is organized as follows. The next section provides necessary background about the main IT frameworks and maturity models. Then the research process is presented. Followed by the proposed maturity model grounded on the main IT frameworks for the IM process. Information about the demonstration and evaluation is presented in the section Demonstration and Evaluation. The Discussion section describes the validation of this research contribution. Last but not least, the final section exposes the main conclusions and provides a brief overview of possible next steps of this investigation.

## LITERATURE REVIEW AND RELATED WORK

### *IT FRAMEWORKS*

Many IT frameworks have been created to manage, measure, and align IT objectives with the organization's objectives. Among the most known, important, and used IT management frameworks, ITIL, COBIT and CMMI-SVC stand out. These three IT frameworks are seen as the most used in practice (Barash et al., 2007; Information Technology Governance Institute, 2007; Sekhara, Medromi, & Sayouti, 2014; Software Engineering Institute, 2010; Yoo et al., 2006)

ITIL is a set of publications on best practices (Office of Government Commerce, 2007b) and one of the most widely accepted approaches to IT service management in the world (Office of Government Commerce, 2007a; Saarelainen & Jantti, 2016). The ITIL framework has been used by organizations in all industries and sectors, including large, medium, and small organizations. ITIL can benefit any organization that provides an IT service management (ITSM) product or service. However, ITIL requires too much change in organizational culture, and organizations tend to lack experienced consultants in ITIL (Bovim, Johnston, Kabanda, Tanner, & Stander, 2014).

COBIT is a framework for developing, implementing, monitoring, and improving IT governance and its management practices as well as another of the most adopted worldwide for such purpose. This framework is published by the IT Governance Institute and the Information Systems Audit and Control Association (ISACA) (2012). The COBIT 5 processes are split into governance and management areas.

CMMI is a best practice framework (Software Engineering Institute, 2010). The CMMI model does not describe the processes themselves; it describes the characteristics of good processes, thus providing guidelines for organizations developing or honing their own sets of processes. According to the CMMI framework, a specific goal describes the unique characteristics that must be present to satisfy the process area. A specific practice is the description of an activity that is considered important in achieving the associated specific goal. The specific practices describe the activities that are expected to result in achievement of the specific goals of a process area.

Besides describing the most important, used, and relevant IT Frameworks, this section also intends to present a brief analysis of them (Table 1). All frameworks seem to have information about the IM, which make them possible suitable frameworks to provide inputs to our proposal.

**Table 1. IT Frameworks Comparison**

| | ITIL V3 | COBIT 5 | CMMI-SVC |
|---|---|---|---|
| Founded | *OGC* | *ISACA* | *Software Engineering Institute (SEI)* |
| Last Update | *July 2011* | *April 2012* | *November 2010* |
| Focus | *Service* | *Service* | *Service* |
| IM | *Yes* | *Yes* | *Yes* |
| Name of Process | *Incident Management* | *Manage Service Requests and Incidents* | *Incident Resolution and Prevention* |
| Number of Processes | *26* | *37* | *24* |

## *IT Maturity Models*

Besides the usefulness and relevance of these IT frameworks, they are also seen as complex and difficult to implement by practitioners. As can be seen at Table 1, these IT frameworks have dozens of processes and probably hundreds (or even thousands) of practices. Therefore, some of these IT frameworks have been developing their own maturity models in order to guide and help their users in the framework implementation.

A maturity model consists of a sequence of maturity levels for a class of objects. It represents an anticipated, desired, or typical evolution path of these objects shaped as discrete stages. Typically, these objects are organizations or processes (Becker et al., 2009).

Therefore, organizations use maturity models to have their methods and processes evaluated in accordance with good management practices and with a set of external parameters. Maturity is indicated by the assignment of a particular maturity level. By doing it, organizations taking advantage of maturity models simplicity which facilitates their understanding and communication as well as the fact that they may be used for benchmarking. Considering the purpose of this research, the following paragraphs will analyze the most relevant maturity models. (Both scientific and practitioner's maturity models will be discussed.)

One of the most known and included in COBIT 5 documentation is a maturity model that can be used by organizations to assess COBIT processes maturity (Information Systems Audit and Control Association, 2013). It is called Process Assessment Model (PAM). COBIT PAM is one of the most used and important maturity models. It has two dimensions and six maturity levels.

Another very well-known maturity model is the CMMI which has been the base for many maturity models proposed in the literature (Von Wangenheim, Hauck, Salviano, & Von Wangenheim, 2010). CMMI-SVC use levels to describe an evolutionary path recommended for an organization that wants to improve its processes. Capability and Maturity are the two levels which reflect two improvement paths, defined as two representations and called Continuous and Staged. Both provide ways to improve processes to achieve business objectives. CMMI-SVC has 5 maturity levels. This framework is one of the most used and known among service management community.

The Tudor IT Process Assessment (TIPA) is a framework for IT process assessment. It uses the principles of the ISO/IEC 15504-33000 standard to determine the maturity level within an organization. TIPA has been defined as an interview based assessment methodology. It is considered the most effective way to gather information concerning the process performance, and it helps initiate the organizational change required to later improve the processes.

AXELOS was created in 2013 by the Cabinet Office on behalf of Her Majesty's Government (HMG) to manage, develop, and grow the Global Best Practice portfolio (AXELOS, 2007). AXELOS was an evolution of the Process Maturity Framework. Moreover, AXELOS is responsible for developing, enhancing, and promoting a number of best practice methodologies used globally by professionals working primarily in project, programming, and portfolio management, IT service management, and cyber resilience. AXELOS consists of a set of assessments, in the form of questionnaires, for each process and function across the ITIL service lifecycle.

A brief summarization of the previously described IT maturity models is presented in Table 2 and Table 3 so readers can have a full view of how these maturity models differ from each other.

Almost all the compared maturity models have 5 levels. Two of them ground their theory in ISO/IEC 15504. The most interesting fact is that all the described maturity models have an individual approach by focusing only on their own theory. It should be noted that none of these maturity models solve the IT frameworks overlap issue.

**Table 2. Comparison Maturity Models Frameworks**

| | COBIT PAM | CMMI-SVC | TIPA | AXELOS |
|---|---|---|---|---|
| Number of levels | *0-5* | *SM:1-5*<br>*CM:0-5* | *1-6* | *1-5* |
| Scope | *Services* | *Services* | *Services* | *Services* |
| Based on | *ISO/IEC 15504* | --------- | *ISO/IEC 15504* | --------- |
| Approach | *Individual* | *Individual* | *Individual* | *Individual* |
| Frameworks overlap | *Not addressed* | *Not addressed* | *Not addressed* | *Not addressed* |

**Table 3. Comparison of Maturity Models Levels**

| Level | COBIT PAM | CMMI – SVC | TIPA | AXELOS |
|---|---|---|---|---|
| *Level 0* | *Incomplete* | ----- | ----- | ----- |
| *Level 1* | *Performed* | *Initial* | *Incomplete* | *Initial* |
| *Level 2* | *Managed* | *Managed* | *Performed* | *Repeatable* |
| *Level 3* | *Established* | *Defined* | *Managed* | *Defined* |
| *Level 4* | *Predictable* | *Quantitatively Managed* | *Established* | *Managed* |
| *Level 5* | *Optimizing* | *Optimizing* | *Predictable* | *Optimizing* |
| *Level 6* | ----- | ----- | *Optimizing* | ----- |

The authors of this paper also looked into the literature for the IT maturity models proposed and developed by the scientific community. The next paragraphs will describe the scientific IT maturity models.

In the Flores, Rusu, and Johannesson (2011) research, the authors proposed an IT Service Delivery Maturity Model as a mechanism for formalizing and assessing IT Service Delivery Elements. The authors defined five levels of maturity, like CMMI-SVC. The authors use a scale of 1 to 5 to score the maturity level. With the need to better differentiate maturity states, the authors add a "+" or a "-" if is closer to the level up or down respectively.

Pereira and Mira da Silva's (2010) model is also grounded in CMMI-SVC. This maturity model was completely different from other models in the market at the time since it was specifically designed to help organizations measure their ITIL v3 maturity, guiding organizations in the implementation of ITIL.

On the other side, Vitoriano and Neto's (2016) methodology was based on the Process Maturity Framework (PMF), a maturity model described in the ITIL's (v2) reference model. To use this maturity model, one is required to perform some interviews with questions related to the five maturity levels, such as initial, repetitive, defined, managed, and optimized; the information is collected on five basic processes of ITSM.

In other research performed by Simonsson, Johnson, and Wijkström (2007), an IT governance maturity assessment method was proposed to overcome validity, reliability, and cost problems. One of the major benefits is that the person performing the assessment doesn't necessarily have to be an IT governance expert, since the analysis part is performed automatically. The modeling language was based on what exists in COBIT and allows identification of entities and relations. The entities identified were processes, activities, documents, KPI/KGI, and roles.

## *Literature Review Summary*

After analyzing the main IT frameworks and maturity models from the literature, the authors conclude that most maturity models are grounded on CMMI to build their model. Plus, and even more important, none of the maturity models present in the body of knowledge address the overlap issue. Such findings strengthen the main goal of this research on exploring the possible development of an overlapless maturity model. Additionally, it should be noted that the investigation about multi-frameworks implementation and how it can be managed and measured has been incentivized as possible further investigation (De Haes et al., 2013).

# RESEARCH METHODOLOGY

Design science addresses research through the building and evaluation of artefacts (including IT artefacts, Hevner, , March, Park, & Ram, 2004) designed to meet the identified business needs (Hevner et al., 2004). It involves a rigorous process to design artefacts to solve observed problems, to make research contributions, to evaluate the designs, and to communicate the results to appropriate audiences (Hevner et al., 2004). In contrast with behavior research, design-oriented research builds a "to-be" conception and then seeks to build according to the defined model, taking into account restrictions and limitations (Österle et al., 2011).

Design Science Research (DSR) is appropriate for research that seeks to extend the boundaries of human and organizational capabilities by creating new and innovative artefacts (Hevner et al., 2004). DSR differs from other research paradigms because it tries to develop and develop artefacts that can be proven effective in real-world scenarios (Peffers, Tuunanen, Rothenberger, & Chatterjee, 2007).

Given the scope of this research is also important to note that artefacts are broadly defined as constructs (vocabulary and symbols), models (abstractions and representations), methods (algorithms and practices), and instantiations (implemented and prototype systems) (Hevner et al., 2004). However, some authors claim that artefacts should be seen as systems (Prat, Comyn-Wattiau, & Akoka, 2014). According to Gregor (2010), "IT artefacts are systems (or involved with systems)," and in this scenario, Gregor and Jones (2007) claim that instantiations are clearly different from constructs, models, and methods (the "abstract artefacts").

Grounded on the previous statements, this research followed the DSR approach to design, build, and evaluate the developed IT maturity model. It is claimed by Gregor and Hevner (2013), that DSR can be applied to a broad range of IT-related fields. Indeed, it was recently concluded by De Maere and De Haes (2017), after analyzing a considerable set of DSR articles, that IT governance (which embrace IT management field) has been a well-accepted topic under this research methodology.

## *PRINCIPLES*

Österle et al. (2011) pointed to four principles that design-oriented research must comply with, and that we followed:

- Abstraction. This research proposes an IT IM maturity model; hence it must be abstract in order to generalize the IT IM domain.
- Originality. The artefact proposed is not present in the body of knowledge (BoK) of the domain.
- Justification. The methods proposed to evaluate the artefact should justify it.
- Benefit. A complete and overlapless IT IM maturity model can assist organizations by providing a complete view of the related topic as well as helping with cost reduction and resource (Gama et al., 2013). Plus, it is also an important step forward in the investigation of multi-framework assessment.

## *PRACTICES*

Design Science methodology for Information Systems (IS) provides an understanding of how to conduct, evaluate, and present IS research. Hevner et al. (2004) provide the practice rules for conducting DSR in the form of seven guidelines (Table 4) that describe the characteristics of well carried out research project. According to Venable (2010), Hevner's guidelines should not be applied evenly to all DSR papers, and so they are dependent on the context of each research.

**Table 4. Design Science Research Guidelines (Hevner et al., 2004)**

| Guideline | Description | This investigation |
|---|---|---|
| Guideline 1: Design as an Artefact | Design science research must produce a viable artefact in the form of a construct, a model, a method, or an instantiation. | The proposed artefact is a model |
| Guideline 2: Problem Relevance | The objective of design-science research is to develop technology-based solutions to important and relevant business problems. | Frameworks overlap and multi-framework implementation investigation |
| Guideline 3: Design Evaluation | The utility, quality, and efficacy of a design artefact must be rigorously demonstrated via well-executed evaluation methods. | Semi-structured interviews |
| Guideline 4: Research Contributions | Effective design-science research must provide clear and verifiable contributions in the areas of the design artefact, design foundations, and/or design methodologies. | A new and innovative artefact absent from the body of knowledge |
| Guideline 5: Research Rigor | Design-science research relies upon the application of rigorous methods in both the construction and evaluation of the design artefact. | Construction: Becker guidelines Evaluation: Semi-structed Interviews |
| Guideline 6: Design as a Search Process | The search for an effective artefact requires utilizing available means to reach desired ends while satisfying laws in the problem environment. | Unknown outcome. Combination of well-known thus pre-defined frameworks with relevant techniques. |
| Guideline 7: Communication of Research | Design-science research must be presented effectively both to technology-oriented as well as management-oriented audiences. | Assessed with practitioners and submitted to a respectful journal |

## *PROCEDURES*

Prior research has introduced principles that define what DSR is and what goals it should pursue, as well as practice rules that provide guidance for conducting (Hevner et al., 2004) and justifying it (Adams & Courtney, 2004). Nevertheless, principles and practice rules are only two out of the three characteristics of a methodology (Kersten, Mikolajuk, & Yeh, 2000).

Peffers et al. (2007) proposed a process model consisting of six iterative activities in a nominal sequence, which are described below.

### Principle 1 - Problem identification and motivation

We have looked into the literature for a problem contextualization to support this investigation motivation. Then, the authors identified the main subjects under study (IT frameworks, IT maturity models, and IM process) and went back to the main literature to analyze which studies and artefacts exist that were developed by practitioners as well as developed by the scientific community.

As part of the literature review, the authors adopted the criteria proposed by Tanriverdi (2006). The authors searched from October 3 to 17, 2016, in databases such as Web of Science, SCOPUS, IEEE, and ACM. Plus, only publications written in English and available in full text were selected and considered by the authors. During the search the authors used the following keywords: "information technology framework", "information technology maturity model", "incident management processes" and "incident management maturity model".

There are several IT frameworks in the market but most of them are recognized as overlapping each other. Plus, despite the agreement on the application of IT maturity models, some authors argue that they are incomplete since as far as the authors could explore none attempt to gather the knowledge provided by the main IT frameworks. These problems were already presented in the Introduction and from now on classified as P1 and P2. The authors decided to build the artefact around the IM process since IM is pointed in the literature as being a quick-win process of IT frameworks.

After all the research work, it became evident that there was a gap in the scientific community that touched all three points simultaneously. There was a need in organizations to apply a complete IT maturity model including information from the main IT Frameworks so overlapping could be avoided.

The development of a more complete and overlapless IT IM maturity model would then be well seen by the community and a welcome artefact to add to the BoK.

### Principle 2 - Definition of the objectives for a solution

The artefact proposed in this research must specifically address the problems (P1 and P2) previously identified, which means that the authors aim to develop an IT IM maturity model capable of being recognized as complete and also addressing the most known IT frameworks (eliminating the overlap among them).

IT frameworks are long documents that contain several IT processes. The authors chose the IM process to develop the proposed artefact by reasons already detailed in the Introduction. Therefore, the main objective of this research is to develop an IT IM maturity model capable of eliminating (or at least mitigating) the problems P1 and P2.

### Principle 3 - Design and Development

To address the problem defined in Principle 1 and the objectives defined in Principle 2, the authors adopted the following process.

First, the authors chose and analyzed the main IT frameworks regarding IM process. Second, after such analysis the authors came out with a set of IM process activities of each IT framework. Third, based on the sets of activities, the authors performed a cross-analysis to eliminate the overlaps (P1). To do that, the authors divided the several activities by areas (log in, closer, metrics, etc.). (More information about this process can be seen in Table 9 later in the paper.) Fourth, having the final list of activities, the authors selected one of the analyzed IT maturity models to use its theory as the foundation to the proposed maturity model. The chosen theory to develop the proposed IM maturity model was the CMMI. It was a crucial step to classify each activity with the correspondent maturity level. Other researchers took CMMI theory as the foundations of their proposed maturity models before (Flores et al., 2011; Pereira & Mira da Silva, 2010).

By using these constructs, one can expect that the widespread shortcomings that the vast majority of maturity models have been accused of having do not appear in this research.

### Principle 4 – Demonstration

The authors will demonstrate the proposed artefact in seven different organizations by using the proposal to assess those organizations' IM process.

### Principle 5 – Evaluation

A design artefact is complete and effective when it satisfies the requirements and constraints of the problem that it was meant to solve. Without evaluation, outcomes of DSR are unsubstantiated assertions that the designed artefacts, if implemented and deployed in practice, will achieve their purpose. Rigorous, scientific research requires evidence (Venable, Pries-Heje, & Baskerville, 2012).

In order to evaluate our artefact, the authors adopted an inductive strategy using qualitative data from semi-structured interviews to collect data from different points of view (Myers, 2013) building upon the practical experiences from key actors given the performed demonstrations of our artefact in their organizations' context (Benbasat, Goldstein, & Mead, 1987). The authors adopted a convenience sampling to select different organizations' contexts with a variation in some factors like size, culture, strategy, and structure in order to reduce contextual bias (Dube & Pare, 2003).

In the Demonstration and Evaluation section the authors present how the artefacts created were evaluated.

### Principle 6 – Communication

The communication step is fundamental since the feedback of experts is required to assess whether the problem and the proposed solution artefacts are important, useful, novel, rigorous, and effective. Usually this step is accomplished with the submission of scientific papers.

## PROPOSAL

To develop our proposal we have ensured compliance with Becker et al.'s (2009) requirements for maturity models development. The following paragraphs describe how the proposed artefact complies with Becker requirements.

1. Comparison of existing maturity models: A comparison with the most known and relevant maturity models is present in the Literature Review and Related Work section.

2. Iterative procedure: During the development of each phase went through several discussion iterations between the authors. Plus, each interview was an iteration considering practitioners' feedback to improve the artefact.

3. Evaluation: Seven semi-structured interviews were performed in order to evaluate the artefact. Despite the iterative process, common criteria were used across all the interviews.

4. Multi-methodological procedure: To develop the maturity model several methods were used including literature review, cross frameworks analysis, and semi-structured interviews.

5. Identification of problem relevance: IT frameworks overlap each other (Pereira & Mira Da Silva, 2012b) and are often used simultaneously, which means that parallel projects imply a duplication of investments, costs, and human resources (Gama et al., 2013). Further investigation about multi-frameworks implementation and how it can be managed and measured (De Haes et al., 2013), is incentivized.

6. Problem definition: The proposed maturity model can be applied by all the organizations performing the IM process. The existence of IM practices performed by the organization is the only requirement needed to apply the proposed maturity model. Prior identification of overlapped activities in order to save resources in future frameworks' implementation projects is the main benefit that organizations may expect.

7. Targeted presentation of results: Individual and general reports can be produced based on the results of the maturity model application. Individual reports provide information about the maturity level of the organization, a roadmap for the next steps in order to achieve the next level, and also the identification of which frameworks comply with the already performed activities as well as the missing activities present in the roadmap. That way organizations are able to save resources in future multi-frameworks implementation projects. General reports can be produced only by combining cross-assessments information.

8. Scientific documentation: The authors are aware that full documentation is not provided in this publication due to space limitations. However, the authors are completely available to share any

detailed document if necessary. Regarding the steps and methods used during the maturity model development, reliable and detailed information is provided in this document.

The maturity model development process had three phases: Frameworks' activities identification, overlap elimination, and assignment of maturity level for each activity.

The first phase focused on the identification of all the IM activities present in ITIL, CMMI-SVC, and COBIT frameworks with clear identification of the IT frameworks supporting each elicited activity (Table 5). At the end of this phase 279 activities were collected (Table 6). For space reasons, the authors only present a sample of the activities in Table 5. To achieve the consensual final list the authors have performed five iterations.

With the initial list (pre-overlap) closed, the authors moved to the next phase about overlap identification. At this phase, all the activities were separated by process areas (log in, closer, metrics, etc.) to make it easier to identify overlaps. To exemplify the outcome of this step the authors present Table 7 which is explanatory in the way the overlap elimination was done. At the end of this phase 72 IM activities were identified as being overlapped among the chosen IT frameworks, almost 25% of the first set of activities collected. By merging activities and eliminating overlaps, it was possible to achieve the pos-overlap list of activities with a total of 207 activities (Table 6). To accomplish this phase the authors have performed three iterations.

**Table 5. Sample of Pre-overlap Activities**

| Activity | IT Framework |
|---|---|
| Do you, during the incident investigation:<br>• Establish exactly what has gone wrong or being sought by the user? | ITIL |
| Are the relevant symptoms of the incident identified and described? | COBIT |
| Does the Incident Records include the following information?<br>• Unique reference number | ITIL |
| Is the information about the incident recorded? | CMMI-SVC |
| Is all the relevant information recorded? | COBIT |
| Are some measures and work products used in monitoring and controlling:<br>• Lead time for resolving service incidents versus the lead times defined in the SLAs? | ITIL |
| Is the following data monitored?<br>• Percentage of incidents handled within agreed response time? | CMMI-SVC |
| Do you try to identify during Incidents analysis:<br>• SLA breaches? | COBIT |
| Do you collect work products, measures, measurement results, and improvement information from planning and process execution to support other organizational processes improvements as well as process assets? | CMMI-SVC |
| Is the incidents' information used to continual improvement planning? | COBIT |

**Table 6. IT frameworks IM process activities information**

| | IM process name | Number of activities (nº) | Percentage (%) |
|---|---|---|---|
| ITIL | *Incident Management* | *134* | *48%* |
| CMMI-SVC | *Incident Resolution* | *108* | *39%* |
| COBIT | *Management Services Request and Incidents* | *37* | *13%* |
| Pre-overlap activities | | *279* | *100%* |
| Overlapped activities | | *72* | *26%* |
| Pos-overlap activities | | *207* | *74%* |

**Table 7. Merging Process Exemplification**

| Activity | ITIL | CMMI-SVC | COBIT |
|---|---|---|---|
| Are the relevant symptoms of the incident identified and described? | Do you, during the incident investigation: • Establish exactly what has gone wrong or being sought by the user? | | Are the relevant symptoms of the incident identified and described? |
| Does the Incident Records include the following information? • Unique reference number (a) | Does the Incident Records include the following information? • Unique reference number (a) | Is the information about the incident recorded? | Is all the relevant information recorded? |
| Are some measures and work products used in monitoring and controlling: • SLA breaches? (a) | Are some measures and work products used in monitoring and controlling: • Lead time for resolving service incidents versus the lead times defined in the SLAs? (a) | Is the following data monitored? • Percentage of incidents handled within agreed response time? (a) | Do you try to identify during Incidents analysis: • SLA breaches? (a) |
| Is the incidents' information used to continual improvement planning? | | Do you collect work products, measures, measurement results, and improvement information from planning and process execution to support other organizational processes improvements as well as process assets? | Is the incidents' information used to continual improvement planning? |

(a) these activities have more bullets but only one bullet is presented in each one for simplification reasons.

Finally, to complete the proposal, the authors organized the final set of activities by maturity level. The maturity levels were assigned based on the adherence of each activity content with CMMI-SVC (Table 8) maturity levels description.

Using the same activities presented in Table 7 the authors present Table 9 to demonstrate how the maturity levels were assigned to each activity. An example of each maturity level assignment is presented.

The activity assigned as level two is a basic activity of information identification of the IM process. While activity classified as level three is an activity of record. These activities are usually focused in standards, procedures, and methods. A different situation is the activity ranked as level four which clearly indicates a metric to be measured to control a specific process aspect. Finally, the activity assigned with level five is focused on process improvement and the use of information for this purpose.

**Table 8. Description of CMMI-SVC Maturity Levels (Software Engineering Institute, 2010)**

| Level | Description |
|---|---|
| Level 1- Initial | Processes are usually ad hoc and chaotic. The organization usually does not provide a stable environment to support processes. Success in these organizations depends on the competence and heroics of the people in the organization and not on the use of proven processes. |
| Level 2- Managed | Work groups establish the foundation for an organization to become an effective service provider by institutionalizing selected Project and Work Management, Support, and Service Establishment and Delivery processes. Work groups define a service strategy, create work plans, and monitor and control the work to ensure the service is delivered as planned. The service provider establishes agreements with customers and develops and manages customer and contractual requirements. |
| Level 3- Defined | Service providers use defined processes for managing work. They embed tenets of project and work management and services best practices, such as service continuity and incident resolution and prevention, into the standard process set. The service provider verifies that selected work products meet their requirements and validates services to ensure they meet the needs of the customer and end user. |
| Level 4- Quantitatively Managed | Service providers establish quantitative objectives for quality and process performance and use them as criteria in managing processes. Quantitative objectives are based on the needs of the customer, end users, organization, and process implementers. Quality and process performance is understood in statistical terms and is managed throughout the life of processes. |
| Level 5- Optimizing | An organization continually improves its processes based on a quantitative understanding of its business objectives and performance needs. The organization uses a quantitative approach to understand the variation inherent in the process and the causes of process outcomes. |

**Table 9. Merging Process Exemplification with Maturity Levels**

| Activity | Maturity Level | ITIL | CMMI-SVC | COBIT |
|---|---|---|---|---|
| Are the relevant symptoms of the incident identified and described? | 2 | Do you, during the incident investigation:<br>• Establish exactly what has gone wrong or being sought by the user? | | Are the relevant symptoms of the incident identified and described? |
| Does the Incident Records include the following information?<br>• Unique reference number (a) | 3 | Does the Incident Records include the following information?<br>• Unique reference number (a) | Is the information about the incident recorded? | Is all the relevant information recorded? |

| Activity | Maturity Level | ITIL | CMMI-SVC | COBIT |
|---|---|---|---|---|
| Are some measures and work products used in monitoring and controlling:<br>• SLA breaches? (a) | 4 | Are some measures and work products used in monitoring and controlling:<br>• Lead time for resolving service incidents versus the lead times defined in the SLAs? (a) | Is the following data is monitored?<br>• Percentage of incidents handled within agreed response time? (a) | Do you try to identify during Incidents analysis:<br>• SLA breaches? (a) |
| Is the incidents' information used to continual improvement planning? | 5 | | Do you collect work products, measures, measurement results, and improvement information from planning and process execution to support other organizational processes improvements as well as process assets? | Is the incidents' information used to continual improvement planning? |

(a) these activities have more bullets but only one bullet is presented in each one for simplification reasons.

More details about the demonstration of the artefact as well as the evaluation is presented in the next section.

## DEMONSTRATION AND EVALUATION

Following DSR procedures, after developing the artefact a proper demonstration of the artefact must be performed. Therefore, the authors invited several organizations to test the artefact. Being aware that practitioners' time is valuable and limited the authors haven't applied any specific criteria to select the organizations to be interviewed despite the existence of IM process. Until the submission of this article, seven organizations accepted our invitation. More information about the result of the assessments can be seen in the following sections.

The authors have also used semi-structured interviews with the respective organizations' experts to evaluate the proposed artefact. The detailed information about the experts' opinion is also described in the following sections.

### *DATA COLLECTION*

The authors carried out the interviews with IT Leaders, IT Coordinators, and IT Directors since these were, at the time, the most suitable decision-makers responsible for the IM process. Interviewees' details can be seen in Table 10.

**Table 10. Information about interviewees**

| Country | Position | Experience in IT (years) | Duration of interview | Interview form |
|---|---|---|---|---|
| *Portugal* | *Director of Infrastructure Computing and Communications Services* | *18* | *1h35m* | *Presential* |
| *Portugal* | *IT Director* | *15* | *1h* | *Presential* |
| *Portugal* | *IT Operations Manager* | *10* | *50m* | *Presential* |
| *Portugal* | *IT Director* | *18* | *1h10m* | *Presential* |
| *Portugal* | *IT Director* | *30* | *45m* | *Presential* |
| *Portugal* | *Area Manager Support Field Services* | *23* | *1h30m* | *Presential* |
| *U.S.A* | *APP Support Lead* | *25* | *1h* | *Skype* |

The duration of the interviews varied considerably. The longest took 1h35m and the shortest 45m in a total of 8 hours (470 minutes). The interviews were conducted between April and June of 2017. To support the interviewers during the interview, a questionnaire was developed. The questions were randomly ordered to avoid bias responses.

A copy of the questionnaire was delivered to the interviewees before the beginning of the interview, so the interviewee could be able to properly follow the interview. In the case of the American organization, the questionnaire was sent by email. During the interview, specific explanations of the activities were given to clarify them for the interviewees. The interviews were carried out by the same person to ensure scientific rigor at the results. The questionnaire was divided in three main sections:

- Header: containing questions to collect information about the interviewee, industry, and the IT department/team.
- Main body: containing questions about the execution of the activities.
- Global questions: containing questions about the perception and opinion of the interviewee about the IM maturity model.

In order to promote the generalization of our results by further researchers, the authors also included in the header some questions about specific factors (Pereira & Mira Da Silva, 2012b). This information can be seen at Table 11.

The main body had four possible answers ("Yes", "No", "in implementation" and "not applicable" (N/A)).

The chosen organizations differ in several factors. The authors aimed since the beginning of the research to approach different organizations' contexts to achieve some heterogeneity. In Table 12 such organization's details can be seen.

All the interviewed organizations have more than 1000 employees and sizable IT Departments. In the telecommunication company, it was not allowed to publish their information. Organizations' culture designation was assigned grounded on Matthyssens and Wursten (2002) theory.

**Table 11. Header Factors**

| Factors | Literature |
|---|---|
| Industry | (Pereira & Mira Da Silva, 2012a; Tanriverdi, 2006) |
| Number of employees | (Pereira & Mira Da Silva, 2012a; Sambamurthy & Zmund, 1999) |
| Culture | (Fink & Ploder, 2008; Hosseinbeig, Karimzadgan-Moghadam, Vahdat, & Moghadam, 2011) |
| IT Strategy | (Pereira & Mira Da Silva, 2012a; Simonsson, Johnson, Ekstedt, & Rocha Flores, 2008) |
| IT Structure | (Adams, Larson, & Xia, 2008; Gallagher & Worrell, 2008; Gao, Chen, & Fang, 2009; Goeken & Alter, 2008; King, 1983; Peak & Azadmanesh, 1997; Pereira & Mira Da Silva, 2012a; Sambamurthy et al., 1999) |
| Maturity Level | (Guldentops, Van Grembergen, & De Haes, 2002; Information Technology Governance Institute, 2005; Van Grembergen & De Haes, 2007, 2008) |

**Table 12. Information about Organizations**

| Industry | Size | IT employees | Multinational | IT Strategy | IT Structure | Culture |
|---|---|---|---|---|---|---|
| *Education* | *1.287* | *20* | *No* | *Flexibility and Efficiency* | *Centralized* | *The pyramidal organization* |
| *Retailing* | *6.000* | *4* | *Yes* | *Efficiency* | *Federal* | *The pyramidal organization* |
| *Conglomerate* | *360.000* | *7500* | *Yes* | *Efficiency* | *Decentralized* | *Well oiled machine* |
| *Electricity, Telecommunications and Automation* | *1.300* | *9* | *Yes* | *Flexibility* | *Decentralized* | *The pyramidal organization* |
| *Health* | *2.700* | *9* | *No* | *Flexibility and Comprehensiveness* | *Centralized* | *The pyramidal organization* |
| *Telecommunications* | ----- | ----- | ----- | *Comprehensiveness and Efficiency* | *Decentralized* | *The pyramidal organization* |
| *Pharmaceuticals* | *42.000* | *1320* | *Yes* | *Efficiency* | *Federal* | *Contest* |

The identification of organizations' maturity level was an important goal as well as the identification of IM process gaps to counsel organizations with a proper implementation road map to the next level. By achieving such goals, the authors argue that the demonstration of the artefact was successfully achieved.

## Data Analysis

In order to reach a certain maturity level, organizations had to have implemented at least 75% of the activities at the specific level (Pereira & Mira Da Silva, 2012b). As can be seen in Figure 1, on average, level two, three and five are the most implemented by organizations. On the other hand, level four fell below 60%.

Overall, organizations applied most of the activities of planning and execution but neglected metrics and measures for possible continuous improvement and predictive analysis.

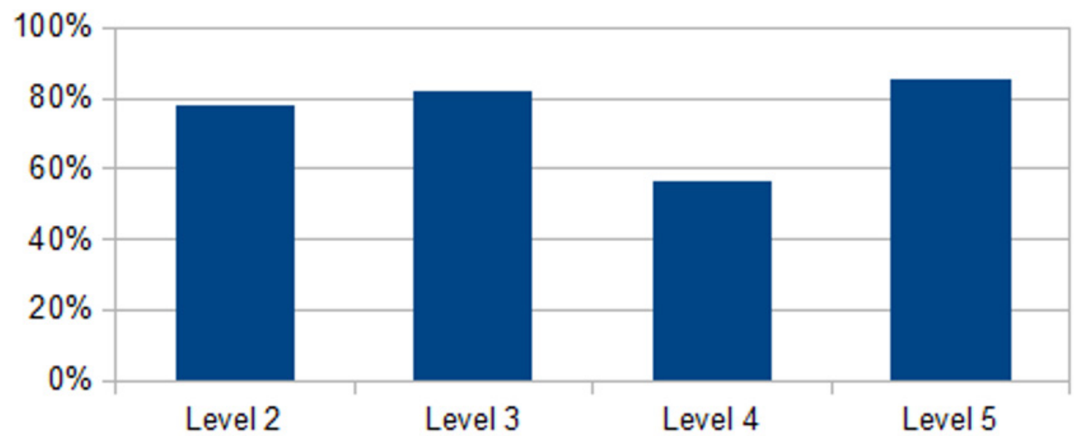


**Figure 1. Average of activities completed**

Figure 2 presents the percentage of activities implemented for each maturity level of all the interviewed organizations. Once again, and aligned with information presented in Figure 1, it was possible to conclude that maturity level four was the lower one in general.

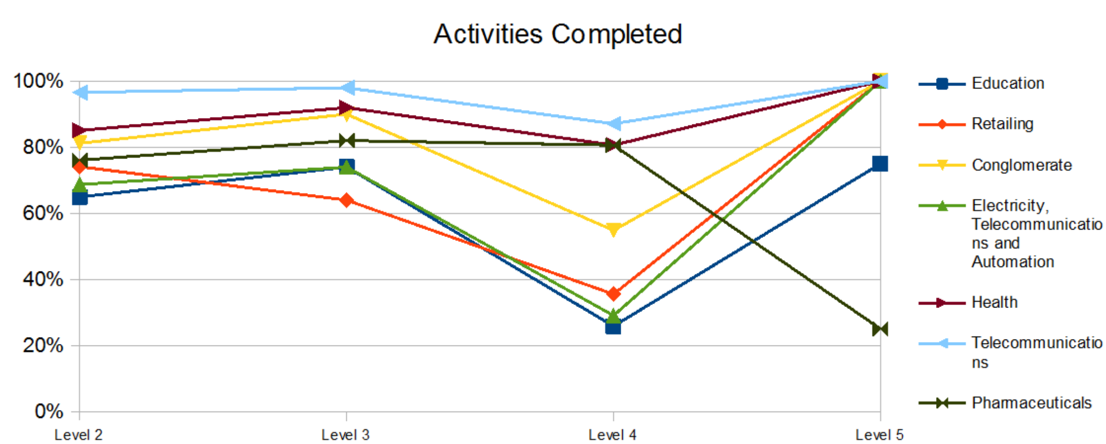


**Figure 2. Activities Completed by Maturity Level**

As level two is the lowest maturity level the authors expected it to be the most implemented by the organizations. However, it was not the case. In average organizations tend to have a stronger level three when compared with level two.

The authors also found particularly interesting the fact that, although the low implementation of level four, level five was the most implemented level. The authors find it an unnatural result since level four is usually used as an input to understand where organizations/departments must improve (level five), so it should be further explored.

Some interesting insights can also be drawn regarding the main IT frameworks. Before each maturity assessment, the authors asked the interviewees which IT frameworks were officially adopted. Overall (Figure 3), ITIL was the most adopted IT framework with four out of the seven. The remaining organizations argued that they weren't following any IT framework officially. Such result is aligned with previous studies recognizing ITIL as one of the most adopted IT frameworks in the market (Office of Government Commerce, 2007a; Saarelainen & Jantti, 2016).

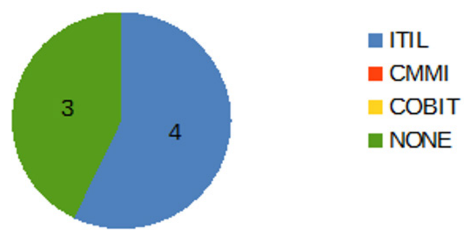


**Figure 3. IT framework distribution**

In Figure 4 it is possible to verify that the distribution of activities is similar in the ITIL and CMMI-SVC framework. The total amount of activities that includes ITIL framework is 54,6%, 55,5% for CMMI-SVC and 28% for COBIT.

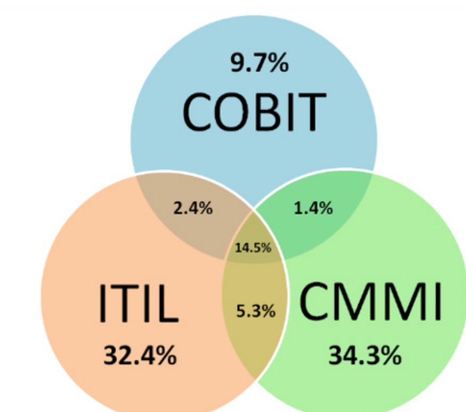


**Figure 4. Distribution of activities by framework**

Figure 5 shows us that the most used framework, is CMMI-SVC. Exclusive activities used by CMMI-SVC framework represent 27,1% in a total of 34,3%. On the other hand, the total of activities that cover CMMI-SVC framework represent 44,4% (Figure 5) and 40,5% to ITIL (Figure 5). This means a percentage drop in ITIL relative to CMMI-SVC. In other words, CMMI-SVC is the framework most used by organizations, although none of them have mentioned that it uses it.

From possible 9,7% of COBIT framework was completed on 7%. On the other hand, the total of activities completed that includes this framework was 21,7% in comparison of the total of 28%. In a total of 207 activities, only 1 wasn't implemented by all the 7 organizations (exclusive level four activity of CMMI-SVC).

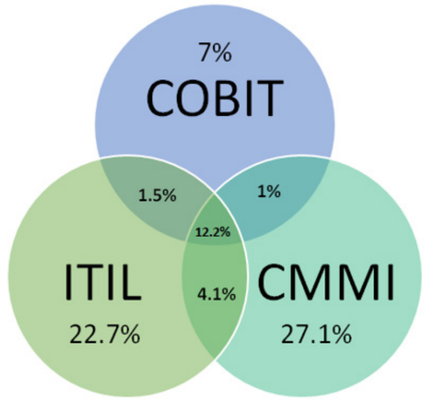


**Figure 5. Distribution of activities completed by framework**

Even though none of the organizations indicated that they use the CMMI-SVC framework, they all carry out, on average, more exclusive activities of this framework. This can also be influenced by the fact that the total amount of activities is higher in CMMI-SVC. In fact, the distribution of completed activities is most similar to the distribution of total activities by framework. Table 13 presents a different view of IT frameworks information and adoption from which similar conclusions can be drawn.

**Table 13. IT Frameworks adoption information**

| | ITIL | CMMI-SVC | COBIT | ITIL& CMMI-SVC | ITIL& COBIT | CMMI-SVC & COBIT | All | Total |
|---|---|---|---|---|---|---|---|---|
| Overall activities (nº) | *67* | *71* | *20* | *11* | *5* | *3* | *30* | *207* |
| Overall activities (%) | *32,4%* | *34,3%* | *9,7%* | *5,3%* | *2,4%* | *1,4%* | *14,5%* | *100%* |
| Average implemented activities (nº) | *47* | *56* | *14* | *9* | *3* | *2* | *25* | *156* |
| Average implemented activities (%) | *22,7%* | *27,1%* | *7%* | *4,1%* | *1,5%* | *1%* | *12,2%* | *75,6%* |
| Overall/average implemented (%) | *70,1%* | *79%* | *72,2%* | *77,4%* | *62,5%* | *71,4%* | *84,1%* | *75,6%* |
| IM process overlap | | | | *5,3%* | *2,4%* | *1,4%* | *14,5%* | *23,6%* |

At the beginning of the questionnaire interviewees were asked about their expected maturity level regarding IM process. The analysis of the organizations' expectations against the achieved maturity level can be seen in Figure 6.

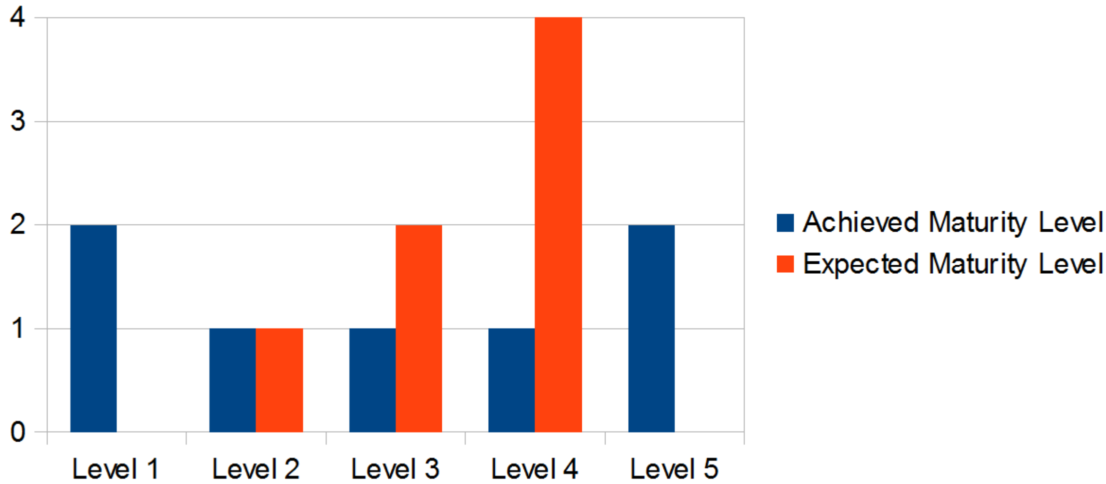


**Figure 6. Expected vs achieved maturity level**

### *EVALUATION*

Some open questions were asked to collect interviewees' opinion about the artefact. These questions are important to assess the validity of our proposal and consequently the research question under study. As can be seen at Table 14, the overall opinion of the interviewees about the proposed IM maturity model is positive.

It is consensual among the interviewees that the proposed artefact is useful while addressing a complete vision of the three main IT frameworks regarding IM process. In the next section, the authors provide information about the main conclusions of the research as well as the identification of possible future work.

**Table 14. Interviewees' opinion about IM process maturity model**

| | Completeness | Missing activities | Usefulness |
|---|---|---|---|
| Interview 1 | *Exhausting* | *No* | *Yes* |
| Interview 2 | *Very* | *No* | *Yes* |
| Interview 3 | *Yes* | *Differentiate the 2nd from the 3rd line* | *Very* |
| Interview 4 | *Very* | *No* | *Yes* |
| Interview 5 | *Yes* | *No* | *Yes* |
| Interview 6 | *Yes* | *No* | *Yes* |
| Interview 7 | *Yes* | *No* | *Yes, very curious about the result* |

## DISCUSSION

In this research the authors proposed to study if it was possible to help to solve the frameworks' overlap while developing an artefact to help multi-framework implementation by testing the validity of the formulated research question. To do it, the authors developed a maturity model for the IM process containing the knowledge from three of the most used IT frameworks in the market.

The most used IT frameworks in the business world were analyzed and the overlap exists in the most diverse process (25%). This research not only strengthens such peers' statements as well as helps to solve it with the proposed artefact by prior identification of the IT frameworks overlap regarding IM process to support future multi-framework implementation.

All the interviewees found the artefact useful, complete, and came up with new ideas to improve their IM process. Implementing an IT framework is not easy and multi-framework implementation is a real challenge (De Haes et al., 2013). Several organizations fail to do it and something that could help them is still missing.

That said, the authors argue that the research question this research aimed to investigate was positively answered.

This research proves that such artefact can be developed and remain useful and complete as pointed by the interviewees. It provides important insights regarding IT frameworks' overlap thus helping organizations to optimize resources in case of multi-framework implementation. In this case, the authors chose one of the most important processes (argued as being a quick-win of ITIL framework) of any IT framework in order to test the research question validity.

Interesting findings drawn from this research deserve to be discussed.

First, the more obvious conclusion is that on average, the level four of maturity is the lowest (Figure 1 and Figure 2). Even the level five organizations in IM process are at the limit in level four, what obviously lowers their maturity. Which means that, even implementing policies, documenting and planning procedures, and measuring metrics, organizations don't fully use them to improve their performance.

Second, this research corroborates what has been stated in previous researches regarding ITIL being the most adopted IT framework. From seven interviewed organizations, four pointed ITIL as the official IT framework (Figure 3). However, after data analysis the CMMI-SVC framework is actually the most adopted IT framework (Table 13). Even though ITIL is being pointed as the official IT framework by most of the organizations, it turns out that they are adopting more CMMI-SVC activities after all. Reasons behind such results may vary, and the authors believe that is an interesting topic to be further explored.

Third, it is interesting to notice that the activities covered by all the analyzed IT frameworks about the IM process are the most implemented by organizations (Table 13). It seems that IT frameworks are quite aligned about the IM process activities that organizations value more.

Fourth, this research also confirms the overlap problem pointed in the literature. Almost 25% of all the IM process activities identified by the authors are present at least in two of the three IT frameworks considered in this research (Table 13).

Fifth, few organizations are aware of the IM maturity level they actually achieve. Most of them believe to be at level four (Figure 6) which is interesting since is the least achieved mature level among all the interviewed organizations. These misalignment expectations of the state of this particular process can be risky. This can also be further explored in the future.

This research has some limitations as well. The authors proposed an overlapless maturity model for IM process to help organizations in multi-framework implementation. However, the authors cannot argue that the same conclusions above presented can be automatically generalized to the remaining IT processes. Therefore, the development of overlapless maturity models for the remaining IT processes could be an interesting future research. It is crucial that organizations assess the entire process spectrum before any IT framework implementation or even for a process evolution and even more for multi-framework implementation.

Plus, the authors are aware that more interviews could have been performed. The authors applied all their effort on the invitation process but only seven organizations accepted to be interviewed until the submission of this article.

## Contributions

This research reinforces that the overlap among IT frameworks exists, thus proving that some organization may be wasting resources in case of multi-framework implementation. The proposed IT maturity model was used in practice to assess real organizations who, in general, expect to be in different maturity levels when compared with the output of our assessment.

The main contribution of this research is the proposed IT maturity model which has taken into consideration three of the most used and adopted IT frameworks. By using this model, organizations are able to assess not only their maturity level regarding IM in general but also be informed of the specific activities they need to implement as well as the IT frameworks to which they correspond. Therefore, when using our maturity model organizations can identify overlapped activities and achieve resource optimization.

The proposed IM maturity model can be used as a foundation for future research. In fact, to give a widespread and realistic support to the proposed maturity model, it is fundamental to complement it with knowledge from others' research. In this research, the authors performed a set of interviews; however, more interviews must be performed, not only to leverage conclusions about other organizations contexts, but also to reinforce the ones presented in this research.

A unique maturity model covering the entire process spectrum of the most known IT frameworks can represent a huge challenge, but would be extremely interesting to study its advantages. Thus, the authors believe this research was a step forward.

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