Department of Science and Information Technology

Maturity Model for Configuration Management

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Abstract

The Configuration Management process is a support process that helps organizations have a better management of their infrastructure. This process is being implemented in a haphazard way, not producing the benefits that it should produce. In an environment where the success depends on the client's wills, have allowed a significant advance in IT domain, granting a substantial evolution in IT services.

However, with all the frameworks provided, many of the organizations have challenges to implement several processes and to design an improvement plan. Maturity Models can be seen as support tools for this kind of task. The main objective of maturity models is to evaluate and improve the organization's practices by creating an improvement roadmap. Nevertheless, the importance of the conjunction of both concepts, Configuration Management and Maturity Models, has not been justified and developed.

The practices overlap, recommended by the Information Technology frameworks, has been a problem for the organizations due to the fact of several enterprises require to have to implement diverse frameworks, bringing an increase of cost and unnecessary redundancy.

In this research, with the need of the organizations evaluate their Configuration Management process, was developed an overlapless Maturity Model for the Configuration Management by combining several frameworks, with the support of the Systematic Literature Review method and the Design Science research methodology.

Keywords: Configuration Management, Maturity Models, IT Frameworks Overlap, Design Science Research, Systematic Literature Review.

Resumo

O processo de Gestão de Configurações é um processo de suporte que ajuda as organizações a terem uma melhor gestão da sua infraestrutura. É um processo que está a ser implementado de forma aleatória, não produzindo os benefícios que deveria produzir. Num ambiente onde o sucesso depende das vontades dos clientes, permitiu um avanço significativo no domínio das TI, garantindo uma substantiva evolução nos serviços das TI.

Contudo, com todas as frameworks fornecidas, muitas das organizações da área das TI têm dificuldades em implementar vários processos e em desenhar um plano de melhoramento. Os Modelos de Maturidade permitem o suporte para este tipo de tarefa. O objetivo principal desta ferramenta é avaliar e melhorar as práticas das organizações, criando um plano de melhoramento e avaliando o estado *as-is* do processo. Mesmo assim, a importância da conjunção entre estes dois conceitos, Gestão de Configurações e Modelos de Maturidade, nunca foi justificado nem desenvolvido.

A sobreposição das práticas, recomendadas pelas frameworks das TI, tem vindo a ser um problema para as organizações. Esta sobreposição traz um acréscimo de despesa e redundância desnecessária, uma vez que as organizações necessitam de implementar diversas frameworks.

Nesta investigação, com a necessidade de as organizações das TI avaliarem o seu processo de Gestão de Configurações, foi desenvolvido um Modelo de Maturidade sem sobreposição para Gestão de Configurações combinando diversas frameworks, com o suporte do método Revisão Sistemática da Literatura e da metodologia de investigação *Design Science Research*.

Palavras-Chave: Gestão de Configurações, Modelos de Maturidade, Sobreposição das Frameworks de Tecnologias de Informação, Design Science Research, Revisão Sistemática da Literatura.

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List of abbreviations and acronyms

AR	Action Research
CC	Concept Centric
CI	Configuration Item
CM	Configuration Management
CMDB	Configuration Management Database
CMM	Capability Maturity Model
CMMI	Capability Maturity Model Integration
CMMI-SVC	Capability Maturity Model Integration for Services
CMMM	Configuration Management Maturity Model
COBIT	Control Objectives for Information and Related Technologies
DSR	Design Science Research
IM	Incident Management
ISACA	Information Systems Audit and Control Association
IT	Information Technology
ITIL	Information Technology Infrastructure Library
ITSCMM	Information Technology Service Capability Maturity Model
ITSM	Information Technology Service Management
LR	Literature Review
MM	Maturity Model
MPS.BR	Melhoria do Processo de Software Brasileiro
OGC	Office for Government Commerce
PCM	Project Configuration Management
PLM	Product Lifecycle Management
SCM	Software Configuration Management
SLR	Systematic Literature Review

Chapter 1 - Introduction

Nowadays, it is imperative that information technology (IT) organizations follow consumer tendencies and wills, with maximum effectively and efficiently (Asif, 2016). In fact, IT infrastructures are becoming more organizational centralized, increasing the importance and essentiality of IT organizations business development and organization strategies (Ertürk & Vurgun, 2015). This dependency, due to the fact of the considerable number of internal dependencies and relations between the systems and services provided by an organization (Vanbrabant & Joosen, 2013), is turning IT infrastructures more complex and wider. Because of that reason and the increase of IT systems heterogeneity, the weight of IT infrastructure management is increasing in our society, causing the rising of administration costs (Giese, Seibel, & Vogel, 2010). This crucial environment, where IT performance impacts organization revenue, if not efficiently managed can "lead to errors and subsequently to failures", determining the difference between profit and loss (Baiôco, Costa, Calvi, & Garcia, 2009; Vanbrabant & Joosen, 2013).

In line with the substantial increase of the IT value in organizations is the evolution that it has provided. In an environment where the success depends on the clients, is critical to address customer demands and explore new business opportunities. These conditions have allowed significant advances in IT, granting an evolution in IT services, and the satisfaction of internal and external organizational customer requirements (Johnson, Hately, Miller, & Orr, 2007). The growing number of services providers has afforded to these providers with a large share of the IT market, subsequently, they naturally became important to the world’s economy (Hashmi, Lane, Karastoyanova, & Richardson, 2010).

The services are developed and implemented on a subjacent IT Infrastructure, which may consist in thousands of components, from software to hardware, that requires to be managed in conformity with organizational objectives (Hashmi et al., 2010; Madduri et al., 2007). In this complex universe, where is indeed a competitive and rigorous market that origins a constant technology evolution (Baiôco et al., 2009), it is not only required the management of infrastructure changes, which occurred as a result of this constant evolution, but as well as be aware of the risk and impact that they can impose on the organization (Ali & Kidd, 2013). These changes influence significantly the organization systems compatibility and configurations, surging a tremendous need to manage these alterations closely and in a robust way, with the purpose of avoiding services interruptions

(Aleksandar Aleksic, Srdjan Atanasijevic, Mladen Radišić, & Milan Eric, 2010; Johnson et al., 2007).

Therefore, emerged a necessity to implement a process that would be essential to manage the whole IT infrastructure information (Madduri et al., 2007). Many solutions to support this kind of task were proposed in order to make a feasible "platform" that allowed organization's collaborators manage the infrastructure information and changes (Yang, 2010), emerging in recent years studies on the process of Configuration Management (CM) and his feasibility.

CM process importance has been growing (Ali & Kidd, 2015), providing clear and fundamental information to all "kinds of performers" in enterprises (Baiôco et al., 2009). This process has grown as an individual discipline, whose main responsibility is to manage the alterations in favor of maintaining the quality and reducing organizations costs (Fowler, 1996). Nonetheless, to become a helpful and efficient process to the organization, it is required technical and organizational support (Tellioglu, 1996).

In spite of CM being essential to organizations, is often misunderstood and is not given the proper importance by strategic management (Ali & Kidd, 2013; Shah, Khalid, Mahmood, Haron, & Javed, 2012). This process if implemented in a careless and inaccurate way, can lead to equipment's failures or even services disruptions, hence to the costs increase and effectiveness decrease in organizations (Choi & Bae, 2001). However, industries are still having many difficulties with CM process implementation (Ali & Kidd, 2015). Nevertheless, it has been proposed by different authors the use of best practices following distinct standards and frameworks so that CM process becomes more effective and efficient on organizations (Johnson et al., 2007; Ward, Aggarwal, Buco, Olsson, & Weinberger, 2007).

Many of these IT frameworks have been proposed and adopted to achieve organizational objectives (Pardo, Pino, Garcia, Teresa, & Piattini, 2013). However, due to the fact that organizations need to implement different frameworks and standards to mitigate "several difficulties, deficiencies, and needs that are not met by using only one methodology" (Gehrmann, 2012), they overlap each other (Nicho, 2016). This overlap problem turns into an organization big issue since they need to implement and use individually several frameworks, increasing organization's costs, time and resources (Ruben Pereira & da Silva, 2012; Vicente, Gama, & Mira, 2013). Yet, the authors Pardo et al. (2013) state that still exists a lack of solutions to overcome this overlap problem.

With the purpose of assessing organizational practices, organizations have been using Maturity Model (MM) (Haes & Grembergen, 2004; Patas, Pöppelbuß, & Goeken, 2013), that in IT industry has grown in an exponential way due to its importance. Organizations have applied these models not exclusively for evaluation, but also to "benchmark and to improve their process capabilities" (Proença, 2016). Despite that, MMs are frequently accused of being too generic (Neff et al., 2014) or too "broad" (Patas et al., 2013) or even, not well characterized (Becker, Knackstedt, & Pöppelbuß, 2009). Most of the MMs do not deal with overlap's issue.

As mentioned earlier, IT infrastructures are becoming more important and increasingly complex, bringing the necessity to have better control of the IT infrastructure. Implementing CM process "following" framework's best practices can bring efficiently, effectiveness and more control to an organization (Johnson et al., 2007; Ward et al., 2007). However, many of the best practices have been criticized for lack explanation and due to the fact of being complex (Ali & Kidd, 2014). Nevertheless, the requirement of the implementation of several frameworks and standards can bring to organizations an increase of costs and time, since they overlap each other (Gehrmann, 2012; Ruben Pereira & da Silva, 2012). Therefore, it is necessary for an organization to have a Configuration Management multiple-model to lead with the framework's overlap issue. With this evidence and with the inexistence of a model that can mitigate these issues, this research pretends to give further information about this research question:

- RQ.: Is it possible to create an overlapless Configuration Management Maturity Model (CMMM)?

Design Science Research (DSR) methodology helps in Information Systems research field solving problems by creating and evaluating valuable IT artefacts (Hevner et al., 2004). According to Becker et al. (2009), the creation of MMs can be understood as artefacts. In order to create the overlapless model, this research adopts the DSR methodology and Becker et al. (2009) guidelines.

This research is structured as follows. The next chapter affords a background of MM and CM using the Systematic Literature Review (SLR) methodology and Concept Centric (CC) method, in order to present the essentiality of the creation of this model. After, in Chapter 3 is presented the related work that has been developed until now, in order to demonstrate that the model created in this research is a feasible solution. Later, the research methodology adopted by this investigation is described in Chapter 4. The

development of the artefact following the methodology is described in Chapter 5. After the creation of the artefact, and in order to evaluate the MM, were conducted four interviews that are explained in Chapter 6. Lastly, in Chapter 7 the conclusions and future work are outlined.

Chapter 2 - Literature Review

In order to properly inform the readers about CM and MM domains, this chapter details how Literature Review (LR) was conducted by using the SLR methodology. With the final articles result, the background of the CM and MM domains and their relation is presented. On the final section, a synthesis of the LR is made.

2.1. Systematic Literature Review method and Concept Centric Approach

SLR is an approach to conduct a rigorous literature review. The authors Okoli and Schabram (2010) define SLR as "a systematic, explicit and reproducible method for identifying, evaluating, and synthesizing the existing body of completed and recorded work produced by researchers, scholars, and practitioner". SLR can improve literature reviews by bringing transparency and rigor in numerous way (Mallett, Hagen-Zanker, Slater, & Duvendack, 2012).

With the purpose of address the research question and with requisite to explain the "context" and main concepts of this research, a SLR was conducted, with the support of the CC method. This review will help new researchers to have a knowledge basis to start new researches in this domain. This research is based on the guidelines for conducting a SLR of the author Kitchenham (2004). The steps taken to conduct this SLR are visible in Figure 1.

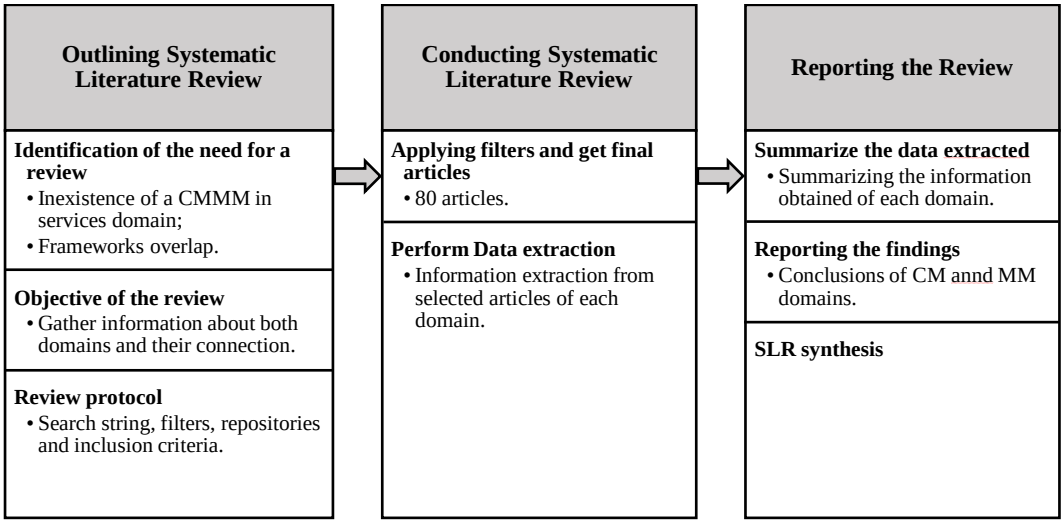


Figure 1 - Systematic Literature Review Stages

In order to present the insights generated of the SLR methodology, this research adopted the CC guidelines of Jane Webster and Richard Watson (2002).

2.2. Outlining Systematic Literature Review

This SLR has not only the objective to explain the concepts of CM and MM, but also justify why the creation of a MM for CM process is a feasible solution, granting many benefits to an organization. In order to achieve these objectives, were conducted individually, two SLR: for the CM process and MM domain. For each domain, the CC approach was adopted to "centralized" the principal concepts intrinsically connected with each domain.

To obtain information about these two domains, five electronical repositories were selected:

- IEEE Online Library (https://ieeexplore.ieee.org/Xplore/home.jsp);
- ResearchGate (https://www.researchgate.net);
- SpringerLink (https://link.springer.com);
- Elsevier (https://www.sciencedirect.com);
- ACM (https://dl.acm.org).

The electronic repositories were the same for both approaches. However, two different keywords were used, which its explanation lies in forwarding sectors. Further, this review included only English and Portuguese articles and were accepted exclusively articles published on Journals or Scientific Magazines and Conferences Proceedings. Additionally, no date filter was used. Were used two search strings, one for each domain. Even though the keywords were established on this stage, with a view of research structuration was decided to introduce them in the next sections.

The search process was exactly the same for both domains (CM and MM). Initially was realized a search with the selected keywords in each repository, without any filter. After that, were created four filters. However, all the electronic libraries use different "search approaches", so a keyword adaptation for each repository was realized. Should be mentioned that in ResearchGate, since it does not have a filtrate option and it is not possible to download all the results at once, each article was added to the support tool manually.

The 1st filter applies the keywords on the article title, or on abstract or on author keywords; On the 2nd one, duplicated articles are removed; On the 3rd filter, articles that are published in lower publications/journals rank are removed. For that reason, were used

two websites Scimago[1] and Conference Ranks[2], which provide journals and conferences ranks, respectively. For conferences were only accepted A, B, A1, A2, B1 and B2 ranks of ERA and Qualis rankings. When an article was assessed by both rankings, Qualis prevailed. For journals were only accepted Q1 and Q2 ranks; Finally, the last stage of filtration was realized by assessing articles introduction and conclusion. The inclusion criteria of this filter of each domain is explained in the next sections.

2.3. Conducting a Systematic Literature Review

As aforementioned, SLR was divided into two domains and the result articles needed to "proceed" through four filters. Both domains filtration process, by each online repository and each filter, is visible in Table 1.

Table 1 - Filtration Process of Both Domains

	No Filter	1st Filter	2nd Filter	3rd Filter	4th Filter
IEEE	5751	318	312	132	10
ACM	2966	172	121	53	9
SpringerLink	5778	204	204	76	13
ScienceDirect	4315	223	223	141	12
ResearchGate	610	610	476	175	36
Total	19420	1527	1336	577	80

The 1st filter had the purpose to separate the articles that are exclusively related with both domains of those who just made a reference of these concepts in the article body, by just selecting the ones that had the keywords in title, abstract and author keywords. These three article sections were chosen for being the main parts that resume the article's matter. With this filter was possible to discard a substantial number of articles.

The 2nd filter had the intention to eliminate the duplicated articles. Can be observed that most of the eliminated articles are from ResearchGate repository, due to the facts mentioned in earlier sections.

On the 3rd filter, were ranked by their rank publication 1336 articles, what was in total nearly of 890 publications since various articles had the same publication (conference/journal). Consequently, were read and "evaluated" by each domain inclusion criteria 577 article's introduction and conclusion, which resulted in 80 final articles. The final articles divided by each publication rank can be shown in Table 2. Articles of

[1] Scimago website: https://www.scimagojr.com
[2] Conference Ranks website: http://www.conferenceranks.com/#data

conference proceedings were the main contributor, being 60% of the result articles from conferences. Important to mention that approximately 28% of the final articles are from journals Q1 rank.

Table 2 - Final Articles by Publication Rank of Both Domains

	Conference rank	Total
ERA	A	5
	B	2
Qualis	A1	8
	A2	10
	B1	13
	B2	10
		48

Journal rank	Total
Q1	22
Q2	10
	32

2.3.1. Systematic Literature Review of Configuration Management

The CM domain search had the purpose on finding its main concepts in "generic" areas, but with focus on the IT services field. Keywords (listed below) were used in all repositories with operators AND and OR, being "Configuration Management" the main keyword.

"Configuration Management"

AND

("Maturity Model" OR "Frameworks" OR "Good Management Practices" OR "International

Standards" OR "Main Concepts" OR "Barriers" OR "IT Service Management"

As mentioned before, the articles of ResearchGate repository were added manually. The stopping criteria of this case was, when the below articles started to be about other "themes". For this reason, 1st filter was not applied in this repository. The flow of all filtration process can be seen in Figure 2.

Since ResearchGate is a social network for professionals where is possible to publish their own articles, accessible for all the community, there may be articles from another online libraries. In fact, on ResearchGate search were found four articles from IEEE repository, two from ACM and two from SpringerLink that were not found in their own repository with the same keywords, which shows the differences between each repository search approach.

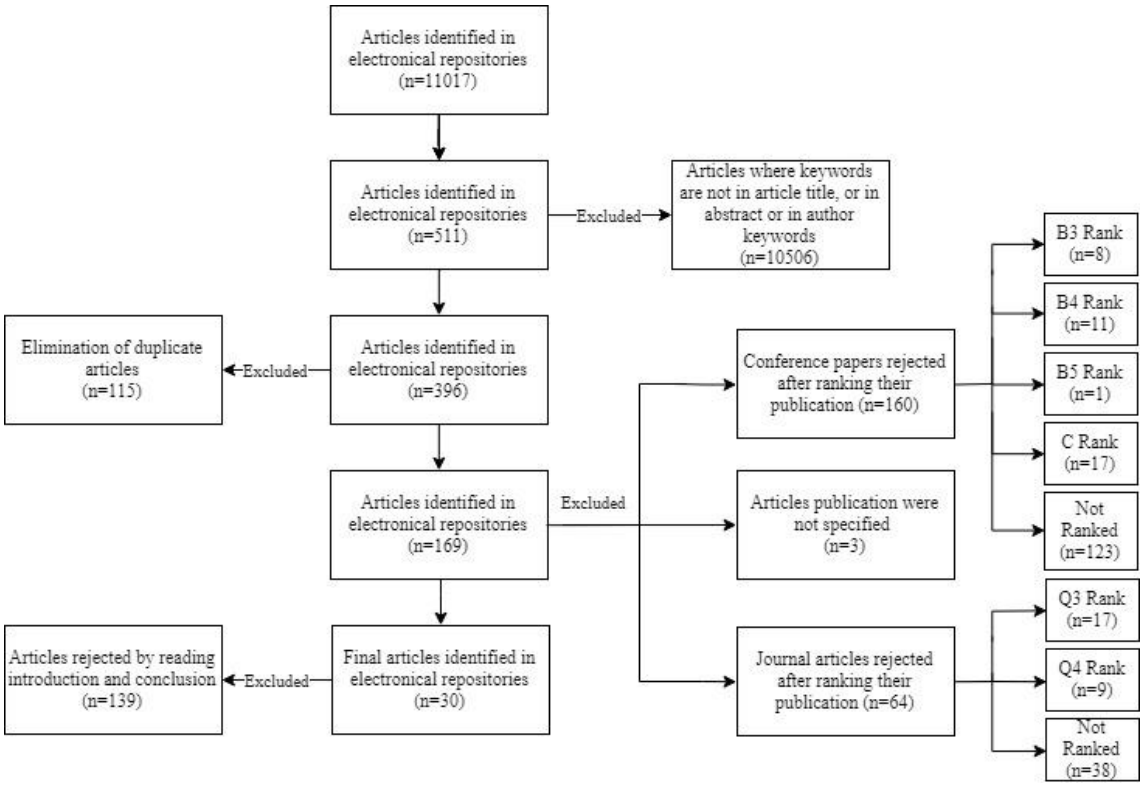


Figure 2 - Flow of all Filtration Process of Configuration Management Domain

On the last filter, where is realized an evaluation of the article's introduction and conclusion as mentioned previously, were followed the following criteria inclusion:

- Were accepted articles, exclusively about CM theme, in any area;
- Were accepted articles about CM benefits and the problems/risks of a bad process implementation;
- Were accepted articles about CM process characteristics.

Articles that did not meet at least one of these "requirements" were rejected. The comparison number between conference papers and journal articles that fulfil all requisites, is visible in Table 3.

Table 3 - Conference Papers vs Journal Articles of Configuration Management Domain

	Total
Conference Papers	18
Scientific Magazines/Journals	12
	30

2.3.2. Systematic Literature Review of Maturity Model

Following the generic search approach discussed initially in this chapter, on MM domain the focus was not just in the IT area but as also in other areas, with a view to find general benefits and difficulties in this domain. Specific keywords (listed below) for this search were used in all repositories with operators AND and OR, with the "Maturity Model" concept being the main keyword.

"Maturity Model"

AND

("IT Frameworks" OR "Best practices" OR "Main Concepts" OR "Benefits" OR "IT Management" OR "Risks")

In the same way as on CM domain research, the articles found in ResearchGate repository were added manually and the 1st filter was not applied in this case. In ResearchGate were found four articles from SpringerLink and one from IEEE that were not found in their own repositories with the same keywords. Figure 3 shows all the filtration process in MM domain research.

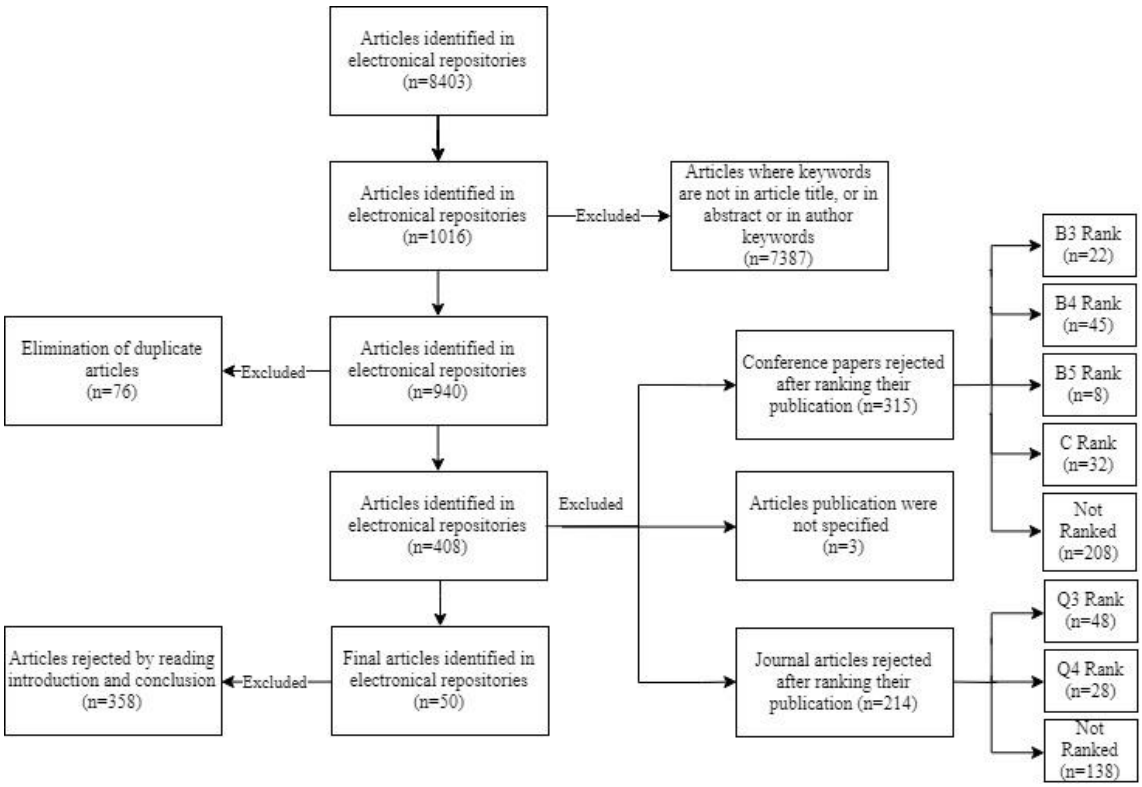


Figure 3 - Flow of all Filtration Process of Maturity Model Domain

On the last filter, the inclusion criteria were:

- Were accepted articles about MM in any area;
- Were accepted articles about MM general characteristics;
- Were accepted articles about MM benefits of any area and MM general problems.

Articles that did not meet at least one of these "requirements" were rejected.

Table 4 shows a comparison between the number of journal articles and conference papers of the result filtration.

Table 4 - Conference Papers vs Journal Articles of Maturity Model Domain

	Total
Conference Papers	30
Scientific articles (Scientific Magazines/Journals)	20
	50

2.4. Configuration Management

Making important decisions is a critical and decisive point in organizations. In these days, ITs are becoming fundamental tools on this type of tasks, allowing organizations to achieve their structural and strategic objectives (Na-Lampang & Vatanawood, 2016), enhancing their indispensability in organizations. Modifications on IT services and IT infrastructure configurations must be managed with extreme caution in order to prevent services interruptions (Johnson et al., 2007). CM is an important support process in the management of any infrastructure that permits an efficient and effective control, promoting critical and important information in any organization division (Baiôco & Garcia, 2010), attending to this configurations changes in a secure way.

Despite CM importance being just increasing in recent years, this process is not technological new. In the 1950s, during the period of "arms race", in order to enhance the production pipeline to reduce the missiles manufacture time, US Department of Defence established CM to control products specifications and deal with alterations during the product life cycle, and to create an accessible and conformed documentation. Therefore, with the purpose of having better control and to regulate how projects should be managed, CM standards were developed. CM expanded beyond its industries roots, since "society" started to become aware of that the majority of businesses are composed by systems with

high complexity that suffers constant changes due to its dynamic environment (Ali & Kidd, 2014; Burgess, McKee, & Kidd, 2005).

CM's recognition has been growing (Ali & Kidd, 2015), despite not being a new concept (Ali & Kidd, 2014). It is a set of actions that its major aim is the management of services and products configurations (Aleksandar Aleksic et al., 2010), to enhance the service provision quality (Hashmi et al., 2010). This process, has a big responsibility not just in managing IT assets and its configurations (Lahtela & Jantti, 2010), but also in providing crucial and accurate information about this "components" to organization operators, such as organization collaborators or even to other service management processes (Baiôco et al., 2009). This conceded information permits an image of the IT infrastructure constitution, allowing them to identify any change that might affect the systems or the infrastructure, assuring to collaborators a fundamental information in decisions that may be taken (Yang, 2010). In Table 5, is visible the main concepts associated with CM: Configuration, Configuration Item (CI) and Configuration Management Database (CMDB).

As aforementioned, CM provides an infrastructure or service model through "identification, controlling, maintaining and verification of existing CI's versions" (Baiôco et al., 2009). CM is defined as having several sub-processes: CI's identification, CI's control, CI's verification, and audit, and finally CI's status accounting and reporting (Madduri et al., 2007). CM sub-processes definitions can be seen in Table 6.

Despite the fact that CM's influence is expanding in IT Services context (Na-Lampang & Vatanawood, 2016), in this state-of-the-art research, this process was found too in other IT scenarios, being very related with Engineering Software, having the CM concept been identified in various contexts**,** like project management, defined as Project Configuration Management (PCM), and in software development, designated as Software Configuration Management (SCM), which their brief explanation is visible in Table 7.

2.5. Maturity Models

As aforementioned, the technology evolution made organizations more IT dependent's, motivating them to improve IT's control and security (Rao & Jamieson, 2003). IT Organizations are growing in a complex form, having the requirement to evaluate their present situation, in order to, in a profitable manner, achieve their strategic objectives and project their future (T. L. Reis, Mathias, & de Oliveira, 2017).

Table 5 - Main Configuration Management Concepts Found in Bibliography Review

Concepts	**Description**	**References**
Configuration	A configuration is frequently referred as the all of the connection of all computer system parts, or a set of items that form a product.	(Aleksandar Aleksic et al., 2010; Calhau & de Almeida Falbo, 2012; Choi & Bae, 2001; Whyte, Stasis, & Lindkvist, 2016)
CI	When a configuration product item is under management is called CI. CI is defined as "an infrastructure component or an item" that have value to the organization, and are vulnerable to change, with the necessity to be tracked throughout its lifecycle. These items may have different sizes and might be services, incidents, hardware components or even software packages. In several cases, it may well be persons.	(Aleksandar Aleksic et al., 2010; Baiôco et al., 2009; Calhau & de Almeida Falbo, 2012; Giese et al., 2010; Johnson et al., 2007; Lahtela & Jantti, 2010; Na-Lampang & Vatanawood, 2016; Pantoni, Mossin, Donaires, & Brandão, 2007; Ward et al., 2007; Whyte et al., 2016)
CMDB	CIs and their relations are saved in a database known as CMDB. CMDB is an IT conceptual model with a predominant role to an efficient IT service management. This database is an auxiliary valuable tool to perform decisions providing CI's dependencies and links in the business, showing promptly the IT infrastructure details, enhancing the quality and efficiency of IT systems.	(Baiôco et al., 2009; Giese et al., 2010; Johnson et al., 2007; Lahtela & Jantti, 2010; Madduri et al., 2007; Na-Lampang & Vatanawood, 2016; Ward et al., 2007; Yang, 2010)

Table 6 - Configuration Management Sub-Processes

Sub-processes	**Description**	**References**
CI's identification	CI's identification is considered as an essential process to the system efficiency, where the identification of the items that will be under tracking will be realized.	(Aleksandar Aleksic et al., 2010; Ali & Kidd, 2013, 2015; Baiôco et al., 2009; Calhau & de Almeida Falbo, 2012; Fowler, 1996; Madduri et al., 2007; Na-Lampang & Vatanawood, 2016; Ward et al., 2007; Whyte et al., 2016)
CI's control	CI's control sub-process permits only authorized changes realized to CIs.	
CI's verification and audit	This sub-process proceeds to the verification of CI's status and integrity, checking if they are in conformity with organization policies and standards.	
CI's status accounting and reporting	CI's status accounting sub-process, realizes information and historic report of the CIs, guaranteeing the availability of this data to the organization executors.	

Table 7 - Configuration Management IT Contexts Found

Contexts	Description	References
SCM	SCM gained particular recognition when Capability Maturity Model was developed, being this process established as a discipline of software development support in teams, which its main function is the accompaniment of the software products development. SCM is a set of principles and practices that are crucial to the software development support, directing the product changes, like programming code (source code), following the software design documentation. SCM comes to support the software development in a manner that can increase the quality and decrease the development time.	(Buchmann, Dotor, & Westfechtel, 2013; Choi & Bae, 2001; Conradi & Westfechtel, 1998; Fahmy, Deraman, & Yahaya, 2018; Pala Er & Erbaş, 2010; Pantoni et al., 2007; Park, Kim, & Lee, 2007; Tellioglu, 1996; Wandel, Jokic, & Kist, 2013; Whyte et al., 2016)
PCM	Since information asset in a project has become a project deliverable, PCM importance has gained some relevance. It is referred as PCM when is necessary bigger control documentation and deliverable, resulting in better monitoring for project managers in the product lifecycle, that praise the PCM as a significant factor in project management.	(Fowler, 1996; Pantoni et al., 2007; Whyte et al., 2016)

Managing IT practices are crucial to conducting the growing IT business value (Curley et al., 2008). Certifying the effectiveness and efficiency of these practices, is an IT strategic management role (Hamel, Herz, Uebernickel, & Brenner, 2013), where their main goal is to “continually improve IT performance with regard to its economic efficiency” (Becker et al., 2009). Hence, enterprises need to evaluate their actual position to in a strategic way, plan their proper investments (SchÃ, 2018). However, traditional measures were inadequate and consequently, emerged a new “assessing methodology” known as MM (Karni, Kaner, Shimomura, & Kimita, 2013).

MMs are becoming gradually more important to organizations and any domain (Hammers et al., 2017). MM concept has begun to be recognized 40 years ago (J. V. Carvalho et al., 2017). These models started to emerge when quality management practices were successfully implemented in manufacturing processes (Kwak, Sadatsafavi, Walewski, & Williams, 2015).

Crosby was one of the pioneers, when in 1979 created the structure that is subjacent to the maturity framework (Rao & Jamieson, 2003), conceiving a Quality Management Maturity Grid (Nord, Dorbecker, & Bohmann, 2016). His creation contributed significantly for the development of quality maturity concept (Wang, Xue, Wy, & Candidate, 2016). In the end of ’80s, US Department with the intention to evaluate the capabilities of software companies, proposed to Watts Humphrey, to the Software Engineering Institute and to Miter Corporation to solve this task. The result of this task was the well-known Capability Maturity Model (CMM) (Proença, Borbinha, Abramowicz, & Paschke, 2018). The MM notoriety grew with the creation of this model (Mettler & Rohner, 2009), which provoke a strong adherence by organizations of all domains and the attention of the research community (Achi et al., 2016), where were created diverse models in different domains, like in construction (Jia et al., 2013), or in project management (Brookes, Butler, Dey, Clark, & Beverly, 2014), or even in agriculture sector (L. Reis et al., 2018). MM is intrinsically associated with three concepts. Their description can be visualized in Table 8.

The author M. Fairchild (2004) defines the MM as "a method for judging whether processes used, and the way they are used, are characteristic of a mature organization”. MMs can be seen as a tool (Curry et al., 2013), used to evaluate the as-is state of an organization (Antunes, Carreira, & Silva, 2014) and to enhance organization’s

capabilities (Proença et al., 2013). The main idea of MM concept is, in a succinct manner, to assess the activities behavior of an organization at a certain number of maturity levels (Hüner, Ofner, & Otto, 2009). This assessment is "constructed" by a comparison between a set of criteria and characteristics, provided by a MM, and the organization activities behaviour, shown in a gradual scale (Lã, 2011), assigning a state or a maturity level to an organization capability or a capability combination (Desharnais & April, 2010).

MM defines an improvement path for the development of these organizational capabilities (J. Carvalho, Rocha, Vasconcelos, & Abreu, 2018), displaying the best procedures to obtain a higher level of maturity (Proença & Borbinha, 2018). Although, it is not an indispensable requisite to obtain the MM maximum level (Hamel et al., 2013), since each organization has its optimum level, that is defined as "the level that delivers the organization's strategic objectives most effectively and efficiently", which not corresponds to the scale highest level (Introna, Cesarotti, Benedetti, Biagiotti, & Rotunno, 2014). The improvement/implementation path can distinguish the type of MM. The two types of paths are characterized in Table 9.

One of the MM main roles is to identify organization's weaknesses and strengths (Lahrmann et al., 2010) for subsequently, being able to create a capability improvement path and create a strategic plan for the future (Frick, Küttner, & Schubert, 2013). In literature were found three specific purposes for the use of MMs. The description of these three purposes is present in Table 10.

2.6. Configuration Management and Maturity Model

As previously mentioned, CM is considered a process with the focus on quality. This process has great benefits, in terms of changes identification and the responsibility identification of those who performed them, maintaining the service's quality and integrity (Aleksandar Aleksic et al., 2010). Organizations in service's industry suffers changes frequently, and it is required to have a process that, not merely control that changes but also maintain the IT infrastructure control and integrity, to enhance the service's development and provision.

CM process, at a development level, can be an essential tool in project delivery strategy, by reducing development time, and minimizing risk or errors. (Ali & Kidd, 2014), allowing the substantial increase of the final product quality (Fowler, 1996).

Table 8 - Maturity Model Concepts

Concepts	Description	References
Maturity	Maturity concept has been described as a "state in which an organization is perfectly able to achieve the goals it sets itself". This concept is recognized as a measure to assess how-well are the organization capabilities. The maturity "component" it may be an object, a system or a person.	(Antunes et al., 2014; Brooks, El-Gayar, & Sarnikar, 2015; Cleven, Winter, Wortmann, & Mettler, 2014; Hammers et al., 2017; Introna et al., 2014; Karni et al., 2013; Mayer & Fagundes, 2009; Mettler & Rohner, 2009; Proença & Borbinha, 2018; Proença et al., 2017, 2018; T. L. Reis et al., 2017; Vezzetti, Violante, & Marcolin, 2014)
Capability	A Capability is characterized as an ability of an organization to produce value. Organizations use their capabilities strategically to improve their "abilities" to another level of efficient and effectively.	(Bezerra, Moura, & Lima, 2014; Curley et al., 2008; Hauck & Wangenheim, 2011; Karni et al., 2013; Picard et al., 2015; T. L. Reis et al., 2017; Wendler, 2012)
Maturity Levels	Maturity Levels or stages are a sequential path, not just to give an improvement path to organization, but as well as "situate" organization capabilities in a hierarchal level. Maturity Levels are often five, and each one has their procedures to implement in order to achieve that level.	(Antunes et al., 2014; Brooks et al., 2015; J. Carvalho et al., 2018; Cleven et al., 2014; Frick et al., 2013; Introna et al., 2014; Lahrmann et al., 2010; Mettler & Rohner, 2009; Nord et al., 2016; Proença & Borbinha, 2018; Serenko, Bontis, & Hull, 2016; Vezzetti et al., 2014)

Table 9 - Types of Improvement/Implementation Path

Paths	**Description**	**References**
Staged	Staged model helps an organization to improve their capabilities "as a whole". To achieve a certain maturity level, is required that the organization capabilities are compliance with the characteristics of that level. This model help organizations to characterize the "overall state of organization's capabilities".	(Antunes et al., 2014; Cleven et al., 2014; Finnerty, Sterling, Coakley, & Keane, 2017; Karni et al., 2013; Kayaga, Mugabi, & Kingdom, 2013; Lahrmann et al., 2010; Mayer & Fagundes, 2009; Picard et al., 2015)
Continuous	In continuous path are the description the procedures to improve/evaluate individually each capability of an area to improve. Each capability can be in different maturity level. This helps the organization to develop and characterize the state of their individually capabilities and abilities.	

Table 10 - Maturity Model Specific Purposes

Purposes	**Description**	**References**
Descriptive	MM can be used for an as-is situation of an organization, easing a basic assessment of the organization's capabilities. In descriptive purpose, MM is used like a "diagnostic tool".	(Cleven et al., 2014; Finnerty et al., 2017; Kayaga et al., 2013; Pã, 2011; T. L. Reis et al., 2017; Röglinger, Pöppelbuß, & Becker, 2012; Röglinger et al., 2018; Serenko et al., 2016)
Prescriptive	MM has a prescriptive purpose when gives an improvement path to higher maturity level, providing guidelines and measures to an organization.	
Comparative	Comparative purpose permits an organization to benchmark its capabilities in externally and internally way, using a large number of historical data from another organization's assessments.	

This process can be a core support tool of organization operationality, by diminishing the delays in development and operations (Ali & Kidd, 2013), not only that, but many of the enterprises implement this process to help in ensuring that the infrastructure is in conformity with the legislation and policies of its environment (Baiôco et al., 2009).

With all the literature review, can be affirmed that the CM process can "produce" several benefits to an organization. This process intends to reduce the number of quality and conformity problems by providing important information, also seeks to increase the capabilities and resources of the organization and reduce the risks. CM process, being properly implemented and monitored, can "deliver" transparency, integrity and a bigger control to enterprises, increasing the quality of provision service's and client's satisfaction. However, it seems, by observing the number of papers in higher quality journals/conference's proceedings in the CM domain, that has not been given proper importance to this discipline. Moreover, it is defended that this process has not been taking into account by strategic management (Ali & Kidd, 2013).

A bad or inexistent implementation of this process might bring problems like service failures and deficiencies in performance (Hashmi et al., 2010), leading to operational cost increase and to effectiveness decrease, hence leads to the reduction of quality (Choi & Bae, 2001).

It is clear to note that, by comparing the benefits and the losses of a "bad or inexistent implementation" of the CM process, and observing the researches realized in this domain, that is important to an organization have a proper implementation of the CM process and an improvement path plan.

In immature organizations, their processes are improvised and implemented in an ad-hoc manner, being difficult to take benefits from these processes. In this sort of organizations, where does not exist a process's improvement plan, it may be a problem to achieve quality products. At the same time, in mature organizations where their processes are constantly updated, these enterprises can obtain quality products and a have more control of their projects and infrastructures (T. L. Reis et al., 2017).

MMs can help immature organizations become more robust and sustainable. These tools support organizations, by assessing their process's current state and by defining an improvement path (Achi et al., 2016). MMs assists to an organization adapt to their environment and being more agile (Mettler & Rohner, 2009), helps to find weak and

strong “spots” , and improve organization’s processes quality (Achi et al., 2016). They will ensure low costs and processes execution in lower time (Hamel et al., 2013).

According to the literature review, MMs are being developed in a wide scope of domains. In the IT domain, these tools contributed to the creation of best practices (Proença et al., 2013), helping the management in IT organizations (Curry et al., 2013). IT management practices are critical to IT business (Curley et al., 2008), so it is turning to be necessary to have these practices in their maximum maturity level, depending on the organization's objectives.

It is defended that the use of best-practices following standards and frameworks in IT service domain, can bring many benefits to the organization performance (Knahl, Bayro-Corrochano, & Hancock, 2013). Some studies, with the realization of questionnaires to organizations that use best practices of frameworks like Capability Maturity Model Integration (CMMI) and Information Technology Infrastructure Library (ITIL), conclude that as processes maturity levels grows, more benefits and lower issues organizations will have, like positive impact in business performance, an increase of organization profitability and competitive leverage (Marrone & Kolbe, 2010, 2011; Salman, Daim, Raffo, & Dabic, 2018).

Even though MMs can bring many benefits, the improvement process is slow, can take years to achieve a superior maturity level and to realize the benefits (Jiang, Klein, Hwang, Huang, & Hung, 2004).

Considering the losses that an organization can have by not giving importance to the CM process and the requirement to enhance this process by creating a strategic improvement plan, MM is a viable solution. Observing the benefits and objectives of both domains (CM and MM) can be concluded that MM domain complements CM process by assessing their current state and supporting it through an improvement path, turning him in a robust and mature process. On that premise, the creation of a Configuration Management Maturity Model (CMMM) based on frameworks can be an essential tool for an organization, generating many benefits, and mitigating the problems of an immature CM process.

2.7. Systematic Literature Review Synthesis

Due to the constant pressures of the market and the environment, like the reduction costs of operations, but with the requirement of maintaining the same or better quality,

organizations need to constantly upgrade themselves by having mature processes, and MM can turn as an excellent tool to improve organizations processes. With SLR methodology and CC method, was possible to explain CM and MM concepts and their main characteristics and benefits, such as their problems and difficulties. It was also possible to demonstrate that a MM specific for CM, can be an essential quality tool for an organization, by comparing the benefits and objectives of both domains.

On CM domain research, the number of result articles was just 30, and some of them are from the ’90s. This demonstrates that, although is proved that CM process could be essential for an organization, researches by the scientific community in higher-ranked journals/conferences in this domain and CM’s recognition, is far below than should be. Different from CM, on MM research, were found many articles about the creation of new MMs and their importance in a broad domain variety, which reveals the substantial MM importance for an organization.

Concluding SLR synthesis, both SLR approaches can contribute with the literature review of CM and MM areas, helping the scientific community to initiate new researches on both domains.

Chapter 3 - Related Work

As mentioned before, this research has the purpose to create an overlapless CMMM grounded on the most known IT frameworks. Despite the lack number of MMs that follow this approach, this chapter lists the similar MMs that were created by the scientific research community so far.

3.1. Articles Selection

Many developed MMs were found in the Literature Review, however, none of them addressed the CM process or the overlapping activities issue. Since many of these MMs were rejected by the filters of the SLR imposed by this investigation, was necessary to realize an ad-hoc search in the electronic repositories, in order to find the MMs related with this research.

In this ad-hoc search were used the keywords : “Configuration Management”, “Maturity Models development”, “IT Service Management” and “Overlapping activities”, although, these keywords were not adopted in this order or all at the same time. Were found many MMs, but only seven were selected. The inclusion criteria for the selected articles were:

- Were selected MMs that were about CM process;
- Were selected MMs that addressed the overlapping activities issue;
- Were selected MMs developed for the IT Service domain.

The list of the related MMs can be seen in Table 11.

3.2. Related Work Found

To fulfil the gap of roadmaps inexistence that elucidates an organization about their CM process maturity level, the authors Niknam, Bonnal and Ovtcharova (2013) have created a CMMM in Product Lifecycle Management (PLM) domain. Their CMMM intends to evaluate maturity CM process in scientific facilities to help them find their own gaps and improve this process. The authors of this model, with state-of-the-art analysis and a study of the current maturity models and standards, extracted the critical activities and dimensions of CM. Subsequently, the authors developed four maturity levels.

Table 11 - Related Maturity Models Proposed in the Literature

Articles	Scope	Area	Directed to	Methodology adopted	Guidelines Adopted	Frameworks overlap	Based on	Maturity Levels
(Niessink & Vliet, 1998)	Services	IT organizations	Management practices overall	Ad-Hoc	Ad-Hoc	Not applied	CMM	5
(Caffery & Coleman, 2007)	Software	Medical devices industry	CM process	Ad-Hoc	Ad-Hoc	Not applied	CMMI	5
(Rúben Pereira & Mira, 2010)	Services	IT organizations	ITIL practices	Action Research (AR)	Ad-Hoc	Not treated	ITSCMM; CMMI-SVC	5
(Lã, 2011)	Services	IT organizations	Management practices overall	Ad-Hoc	(Becker et al., 2009)	Not treated	COBIT, ITIL, CMMI	5
(Machado, Reinehr, & Malucelli, 2012)	Services	IT organizations	Management practices overall	Ad-Hoc	Ad-Hoc	Treated	ISO/IEC 200, CMMI-SVC, MPS.BR, ITIL	7
(Niknam et al., 2013)	PLM	Scientific facilities	CM process	Ad-Hoc	(Bruin, Freeze, & Rosemann, 2005)	Treated	CMMI, International Atomic Energy Agency (standards), SPICE-BOOTSTRAP, Project Management Maturity Model, Systems Engineering Capability Model, ISO 9000-3, ISO/IEC 12207, ISO 9001, ISO 10007: 2003, EIA-649-B, MIL-STD-3046	4
(Aguiar, Pereira, & Vasconcelos, 2018)	Services	IT organizations	IM process	DSR	(Becker et al., 2009)	Treated	ITIL, COBIT, CMMI	5

In other research, with the requirement to have medical devices conformed with some directives and with the necessity the companies of medical devices produce files of histories with the software components used in the development of these devices, Caffery and Coleman (2007) have developed a MM for the medical device industry. The authors compared the regulations of medical device regulations and the best practices of the CM process area of the CMMI model. The MM is composed of five maturity levels.

The two MMs developed for the CM process described earlier were the only MMs found for this process, therefore as referred initially in this chapter, was determined to search diverse MMs that had a similar approach that this research intends to make.

With the problems that many organizations face with the implementation of ITIL in mind, the authors Filipe Pereira and Mira (2010) created a MM to help organizations assess their ITIL implementation and to create an improvement roadmap of this framework. Their MM is based on two models: IT Service Capability Maturity Model (ITSCMM) and Capability Maturity Model Integration for Services (CMMI-SVC). The authors developed a continuous and staged model to support organizations that are at different levels of maturity. Both models are composed of five maturity levels.

Within the same idea, the author Lã (2011) developed a MM to help IT service providers analyze their IT service strategy, by relating their IT management practices with the IT service management (ITSM) practices from a service perspective. The author model has the frameworks Control Objectives for Information and Related Technologies (COBIT), ITIL and CMMI subjacent. This model is composed of five maturity levels.

The authors Machado, Reinehr and Malucelli (2012) had the same focus by creating a MM. This MM is compliant with the ISO / IEC 20000, CMMI-SVC, with the Brazilian program *Melhoria do Processo de Software Brasileiro* (MPS.BR)[3] and has ITIL practices. Its main objective is to support IT service providers by improving the management of IT services. This model has seven maturity levels.

On the same basis is the MM created by Niessink and Vliet (1998) with focus on services providers. This MM has the objectives of helping organizations to assess their capabilities and providing a service capability improvement path. This MM was developed under CMM basis and is composed of five maturity levels.

[3] In English: Brazilian Program for software process improvement

On the other hand, the authors Aguiar, Pereira and Vasconcelos (2018) created an overlapless MM, focused on IT service management, more precisely on the Incident Management (IM) process. This MM was created by eliminating all the overlapped incident management process activities of the frameworks ITIL, COBIT, and CMMI and has the objective of helping organizations to assess their IM process. This model consists of five maturity levels.

These are the MMs created by the scientific research community that are most related to this research scope. The summary of the MMs characteristics is visible in Table 11. Despite the fact that already exists two MMs for CM, they do not have the scope on IT Services and do not concern with the framework's overlap problem. Until the recent date, were not found any article of any MM creation, that take aim of these concerns. Nevertheless, were found models that have the focus on improving and assessing the practices of IT service providers, which demonstrates that IT services starts to be an area of concern, especially the consideration that process's improvement is an important strategy that IT service providers should implement.

Considering that was not found any MM for CM process that solves the problems previously mentioned, the creation of this model can be a contribution to the scientific community, by helping to "add value" to CM process of the IT providers. This model can support IT organizations by evaluating the CM process and planning an improvement path, which can converge to profit and better control of their IT infrastructure. Since the development of this model addresses the overlap problem of several frameworks, this MM can help to decrease the costs of the necessity to implement various frameworks, due to the requirement of being conform with the legislation and politics of the environment.

This research intends to follow the same approach of Aguiar et al. (2018), with the difference that the development of this MM focuses on the CM process.

Chapter 4 - Research Methodology

This research decided to address the problem found by adopting the DSR methodology complemented with Becker (2009) guidelines. This chapter reveals the methods and the methodology adopted to develop the artefact.

4.1. Approach

It is important that researchers in scientific research area, where the purpose is to create an innovation, define and specify the path made to develop the solution, not just to help other researchers improve their capabilities by observing errors that other researchers committed, but also to help new investigation in various areas, by assisting the scientific community replicating their results or even use their results to improve or create new solutions. From this perspective and through the analysis of the related MMs found in the literature (Table 11), was extracted the methodology and the guidelines used to create the MM. In order to normalize the development structure of a MM, this investigation defined the guidelines as the practical steps to develop the innovation, which can be viewed as a pragmatic steps inside of the methodology.

By observing Table 11 is possible to affirm that most of the authors adopted their own approach to construct the MM (Ad-Hoc). However, were found two guidelines established by the scientific community: from Becker et al. (2009) and from Bruin et al. (2005). Becker guidelines were utilized two times and the guidelines of Bruin were used once. In terms of methodologies, were only found two: DSR and AR, once each.

Although being a small sample to draw conclusions, it appears to be a good possibility the adoption of DSR with the endorsement of Becker guidelines for this investigation, since the DSR is a non-specific domain and the guidelines of Becker are specific for the creation of MMs in IT Management domain, being these evidences supported with the fact that both “practices” were found in the MMs related with this research.

In order to supplement these decisions, was decided to investigate the adoption of the DSR and Becker in other scientific articles. This brief search was realized in Ad-Hoc form through electronical repositories. Were found three scientific articles which used this same approach in other sub-domains of IT (Hamel et al., 2013; Proença et al., 2018, 2017). Despite that, were discovered two more articles that only adopted the Becker guidelines as the methodology (Batenburg, Neppelenbroek, & Shahim, 2014; Cuylen, Kosch, & Breitner, 2016).

Based on these articles, this research determined that would be more sustained and completed if adopted DSR methodology and, for the practical development, used the Becker guidelines.

4.2. Design Science Research

Design is a fundamental process to Information Systems (IS) domain, by helping IS professionals create artefacts, with a view of improving the performance of the organization's business (March & Storey, 2008). The DSR methodology is becoming one of the most adopted methodologies in the IS domain, due to his flexibility in any area. In fact, this methodology is constantly evolving (Peffers, Tuunanen, Rothenberger, & Chatterjee, 2008), and is specialized for specific areas.

Hevner (2004) defined the DSR as the creation and evaluation of artefacts, with the intention of solving the identified organization's problems. The author Marian Carcary (2011) established this methodology as "a problem-solving paradigm that involves building and evaluating innovative artefacts in a rigorous manner". The IT artefacts can be characterized as constructs, models, methods, and instantiations (Herselman, Botha, & Meraka, 2015). Shortly, the DSR is a methodology that aims to create an artefact in order to solve an identified problem.

This research decided to adopt the DSR Process Model created by Peffers et al. (2008), as the research methodology . This methodology is composed of six activities, and they are visible in Figure 4.

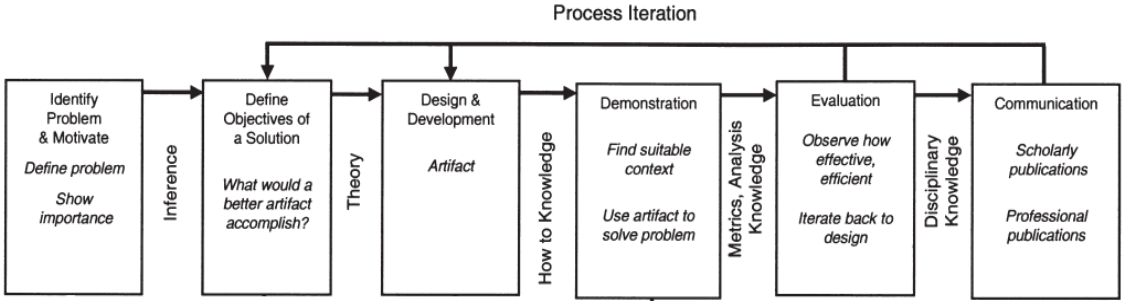


Figure 4 - Design Science Research Process Model from Ken Peffers (Peffers et al., 2008)

4.3. Becker Guidelines

Becker guidelines are based on Hevner guidelines (2004). These "instructions" are very flexible in terms of domain application since they were adopted in diverse areas, despite being created for IT management domain. As DSR is an iterative cycle of development, these guidelines determine that the development of a MM is made

consequently by improvement iterations. Becker instructions are composed of eight phases, that can be seen in Figure 5.

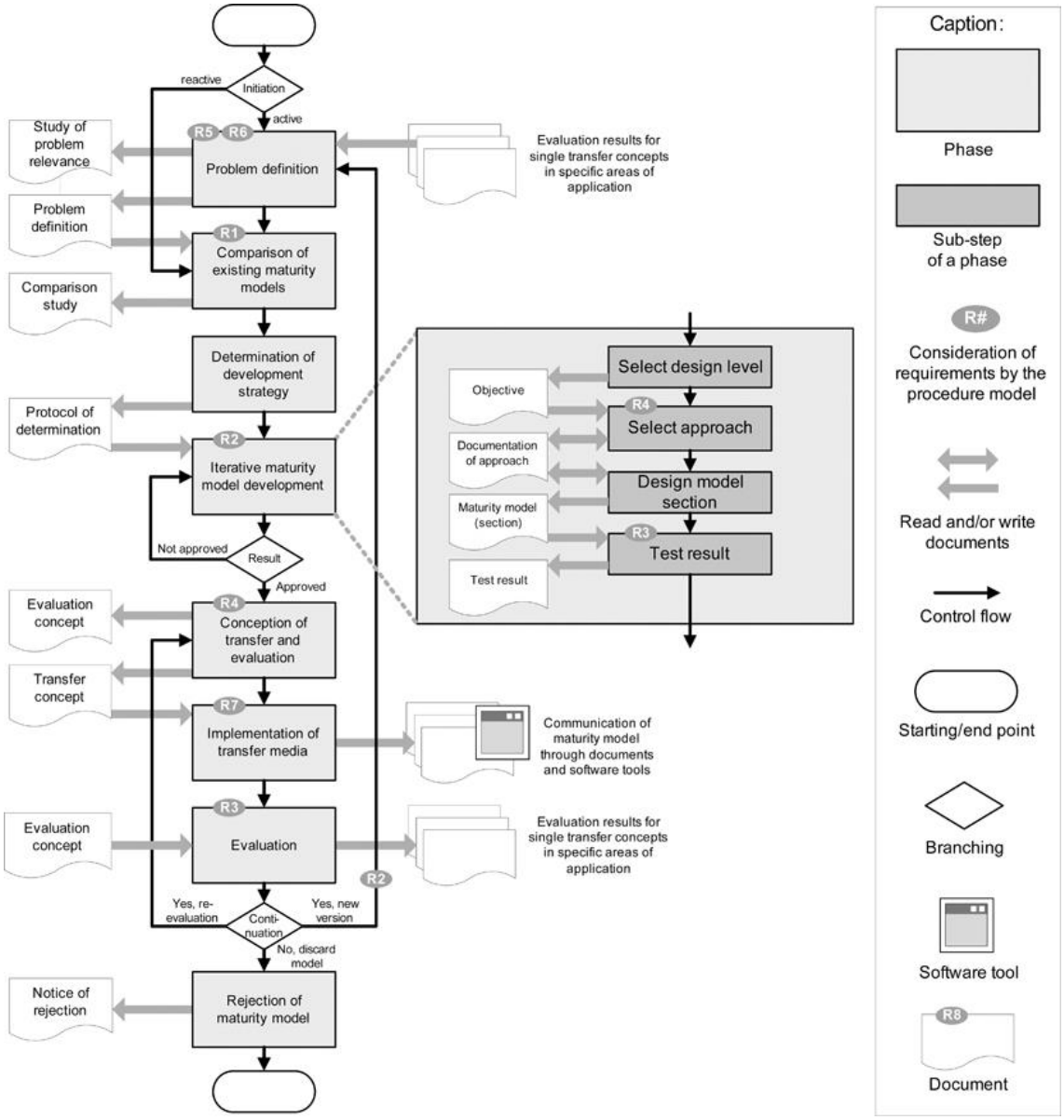


Figure 5 - Procedure Model of Becker (Becker et al., 2009)

4.4. Design Science Research and Becker Guidelines

As mentioned before, DSR has the objective to create an artefact. In the manner that this methodology is designed, *a priori*, the artefact design or the type of artefact to create is not known. On the other hand, Becker methodology is exclusively to develop MMs, knowing at the beginning which artefact to develop. Several steps of both methodologies are the same since Becker instructions are descendant of DSR methodology. However, with the facts referred and in the point of view and interpretation of this research, it makes perfect sense the conjunction of both methodologies: the Peffers methodology as the main

methodology, and Becker guidelines as the “practical steps” of the artefact development. This approach can be compared with layers, where the DSR methodology is the first layer (main) and the guidelines are the second layer (subordinate). For a better understanding of the approach, Figure 6 shows the relation between both.

By observing Figure 6, is visible that both methodologies can be integrated into each other, being the Becker guidelines more practical than the DSR methodology of Peffers. However, some adaptations of the methodologies for this investigation needed to be made:

- Peffers methodology defines two “types of assessment”: Demonstration and Evaluation. In the phase Demonstration phase, the MM should be tested in one or more instances of the problem. The second one, Ken Peffers defined that MM should be tested in a more complex environment by observing and measuring how the artefact can mitigate or solve the problem. Since this research opted to realize semi-structured interviews and the evaluation of the MM was realized in middle-term of both phases, these steps were joined;
- The same occurred with the “Implementation of Transfer Media” and “Evaluation” Becker guidelines phases. In this section will be the evaluation of the MM and the results discussion;
- The process iteration just happened from the phase Demonstration & Evaluation to the Design and Development, that is, the improvement process of the MM, just occurred in this direction.

With both methodologies integrated, the “final methodology”, followed by this research, had eight phases where each phase is described in the respective chapter, that are indicated in Figure 6.

The last step will be realized with the publish of scientific articles and with the publication of this thesis in an online library of the institution where this research took place.

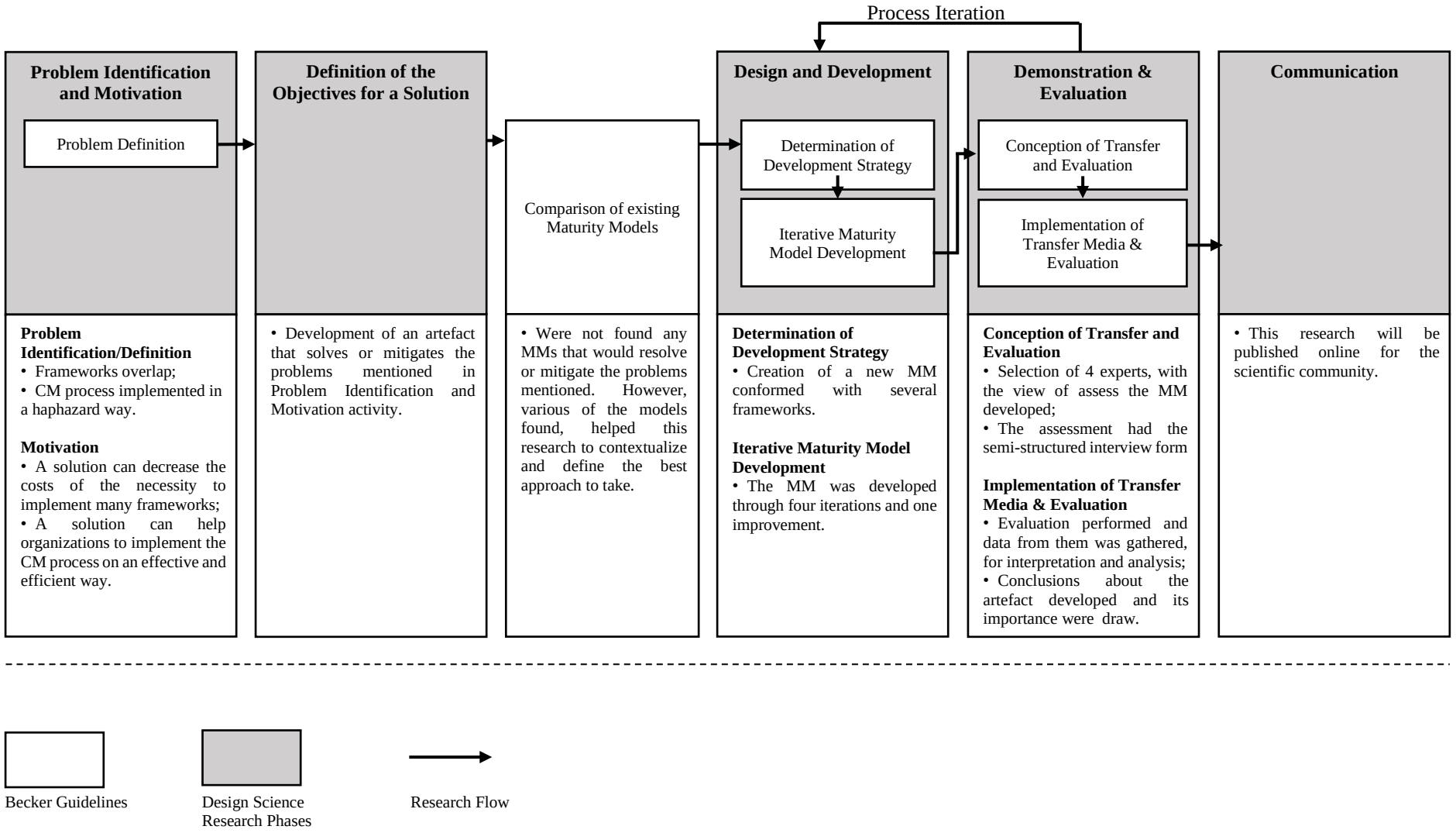


Figure 6 - Design Science Research Activities Integrated with Becker Guidelines Followed in this Research (Adapted from (Becker et al., 2009) and (Peffers et al., 2008))

Chapter 5 - Design and Development

The Design and Development activity involves the definition of the artefact architecture and functionality such as its implementation. As mentioned before, this research adopted the Becker guidelines to create the artefact.

In this chapter is described the practical process that this research took to develop the MM. Each section represents each phase of the Becker guidelines.

5.1. Determination of Development Strategy

After the comparison between the MMs, it is imperative to establish a well-documented strategy for the development of the MM. Becker (Becker et al., 2009) defends that exists three types of strategies: the development of a new MM design or the improvement of an existing one; the blending of several MMs into a new one; or the reallocation of the structures of contents into a new area.

This research decided that for the development of the MM would adopt one of the strategies mentioned by Becker. As described in Chapter 3, this investigation did not find any MM that would resolve the problems defined, so this investigation addressed the problem by developing a new MM.

As noted above, the use of best-practices following the standards and frameworks in IT service domain can increase organizations performance. To develop the MM, this research followed three frameworks: COBIT 5, CMMI-SVC 1.2 and ITIL v3. These frameworks were choose since they address the service domain and are the most known in the market (Baiôco & Garcia, 2010; Na-Lampang & Vatanawood, 2016). Therefore, the strategy established was the creation of a new model that would be conformed with the three frameworks COBIT, CMMI-SVC, ITIL and that would address the overlap problem.

5.2. Iterative Maturity Model Development

As previously stated, Becker guidelines have focus on an iterative process for the development of MMs, that is, for the creation of a MM is necessary to improve this artefact multiple times, and the development of the MM is performed by iterations. This activity is the central phase, where the model is produced.

The MM creation was divided into fourth iterations: the first step was the process of understanding how the frameworks described the CM process, and realize the extraction of the process activities of each framework (Appendix A, Appendix B and Appendix C); at this point and along with all the activities extracted, the elimination of the overlapped activities was performed (Appendix D); after the elimination of the overlapped activities, the development of the MM proceeded with the activities classification; lastly, the final step was the definition of the classification criteria for the organizations assessment using the final MM. The flow of this process is perceivable in Figure 7.

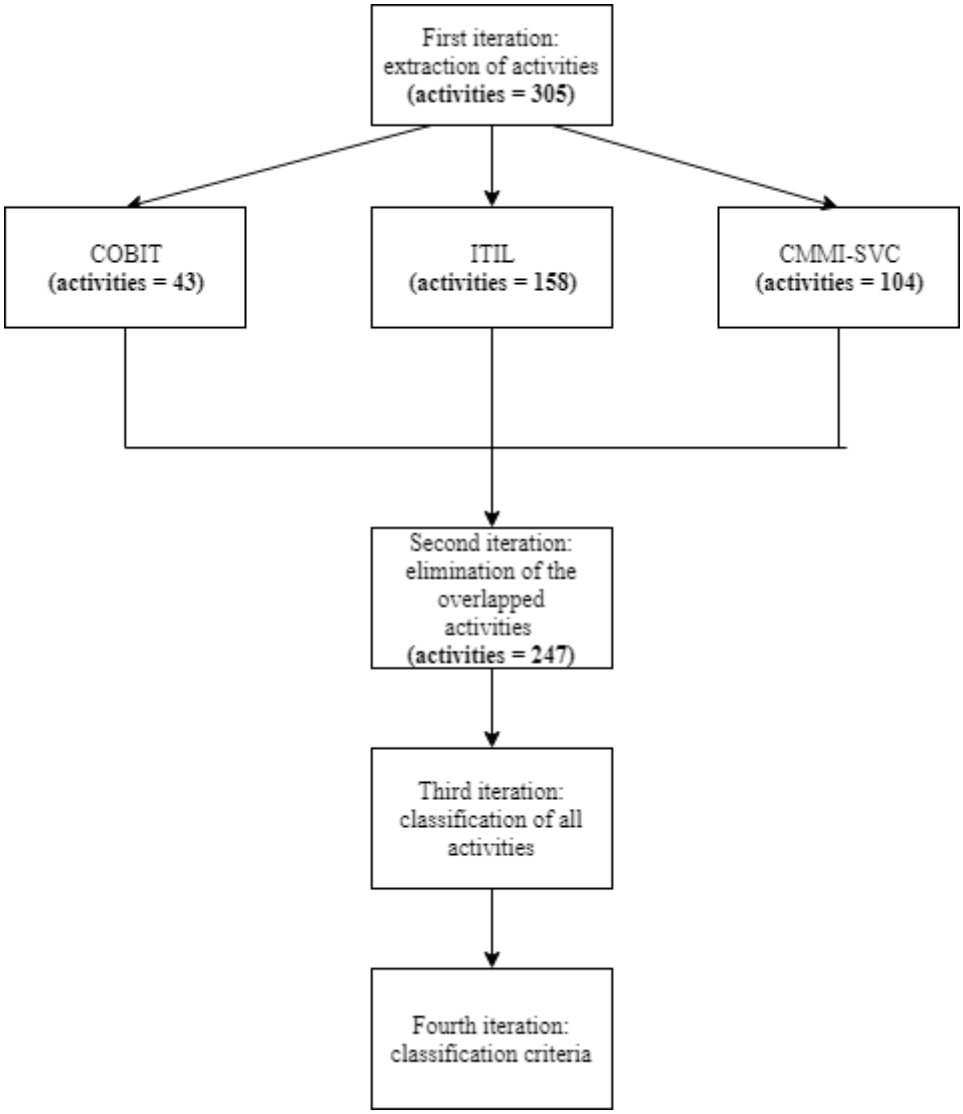


Figure 7 - Flow of the Maturity Model Development

5.2.1. First Iteration: Activities Extraction

This investigation decided that the final MM would be constituted by practices in the form of a question that was called as “activity”. An activity is a practice that represents

what the final result of a CM process characteristic should have. The COBIT and CMMI frameworks have these activities explicit as a practice, structured in a perceptive and simple way. However, in ITIL is different, the practices described are blended in the CM description, which difficulted the research work.

For all the considered frameworks, in order to structure all the activities, were defined two "types" of activities: the first type is defined as a single question, the second type is defined as multiple questions, where the main question is composed of several sub-questions. Each of those sub-questions is considered as an activity. These two types can be observable in Table 12.

Table 12 - The Two Types of Question

Question	**Type**	**Number of Activities**
Are the reporting requirements from all stakeholders identified?	Single question	1
Are the quantitative objectives based on: • the customer needs? • the business objectives?	Multiple questions	2

The extraction of activities from the frameworks was the first step taken. COBIT framework has 17 activities described, however, this research divided into sub-activities, which generated 43 activities in total. The same process occurred with CMMI-SVC, composed of 79 activities was sub-divided into 104 activities in total. With the ITIL framework, as above mentioned, the first step was different. Became an interpretative task since the description of the CM process is not explicitly divided by activities. From ITIL, were extracted 158 activities. In total, 305 activities were elicited from the frameworks.

5.2.2. Second Iteration: Overlapped Activities Elimination

With all the activities extracted it was necessary to eliminate those that were overlapped. In order to remove all the duplication activities, an exhaustive comparison between all the activities of each framework was made. Those activities which were similar were merged into one activity. An example of the elimination process can be seen

in Table 13. On balance, after the elimination, remained 247 activities which correspond to the elimination of 19% of the total activities (58 activities were merged).

Table 13 - Elimination of the Overlapped Activities

COBIT	ITIL	CMMI-SVC	Final Activity
-	Are the CIs uniquely identified?	Do configuration items have a unique identifier?	Are the CIs uniquely identified?
Is a logical model for configuration management established and maintained?	Is a logical configuration model, representing the relationships between configuration items, established?	Are the relationships among configuration items specified?	Is a logical configuration model, representing the relationships between configuration items, established and maintained?
Are the CIs populated in the repository?	-	Are the configuration items stored and retrieved in a configuration management system?	Are the CIs populated and retrieved in the repository?

5.2.3. Third Iteration: Activities Classification

Thereafter, this investigation proceeded with activities classification stage. By classifying the final activities, the MM was completed. This step followed the CMM described by the CMMI-SVC framework, which is composed of six maturity levels. This generic MM is visible in Table 14. The final MM is composed of six maturity levels in an ordinal order (from 0 to 5). With all the activities classified, the final distribution is as follows:

- Maturity Level 1: 137 activities;
- Maturity Level 2: 57 activities;
- Maturity Level 3: 43 activities;
- Maturity Level 4: 5 activities;
- Maturity Level 5: 5 activities.

Table 14 - Capability Maturity Model of CMMI-SVC (SEI, 2009)

Maturity Level	**Description**
Capability Level 0: Incomplete	An incomplete process is a process that either is not performed or partially performed. One or more of the specific goals of the process are not satisfied and no generic goals exist for this level since there is no reason to institutionalize a partially performed process.
Capability Level 1: Performed	A capability level 1 process is characterized as a performed process. A performed process is a process that satisfies the specific goals of the process area. It supports and enables the work needed to provide services. Although capability level 1 results in important improvements, those improvements can be lost over time if they are not institutionalized.
Capability Level 2: Managed	A capability level 2 process is characterized as a managed process. A managed process is a performed (capability level 1) process that has the basic infrastructure in place to support the process. It is planned and executed in accordance with policy; employs skilled people who have adequate resources to produce controlled outputs; involves relevant stakeholders; is monitored, controlled, and reviewed; and is evaluated for adherence to its process description.
Capability Level 3: Defined	A capability level 3 process is characterized as a defined process. A defined process is a managed (capability level 2) process that is tailored from the organization's set of standard processes according to the organization's tailoring guidelines and contributes work products, measures, and other process improvement information to the organizational process assets. At capability level 3, the standards, process descriptions, and procedures for a project are tailored from the organization's set of standard processes to suit a particular project or organizational unit and therefore are more consistent, except for the differences allowed by the tailoring guidelines.
Capability Level 4: Quantitatively Managed	A capability level 4 process is characterized as a quantitatively managed process. A quantitatively managed process is a defined (capability level 3) process that is controlled using statistical and other quantitative techniques. Quantitative objectives for quality and process performance are established and used as criteria in managing the process. Quality and process performance is understood in statistical terms and is managed throughout the life of the process.
Capability Level 5: Optimizing	A capability level 5 process is characterized as an optimizing process. An optimizing process is a quantitatively managed (capability level 4) process that is improved based on an understanding of the common causes of variation inherent in the process. The focus of an optimizing process is on continually improving the range of process performance through both incremental and innovative improvements.

5.2.4. Fourth Iteration: Classification Criteria

With the purpose of adapting this MM to the "practical environment" that ITSM is, was necessary to have some considerations:

- All the organizations have different necessities, different environments and different objectives and plans;
- The MM is mostly composed of multiple question type, that is, the majority of the questions have sub-questions. This can bring a big dependency of several questions with the main question, which sometimes for different organizations this main question is not required and not useful to implement.

As previously explained, for a process to achieve a specific maturity level, it is necessary to implement all the activities of that specific level. However, considering all the circumstances mentioned above, this research decided that to achieve a particular maturity level, it was only necessary to implement 70% of the activities of that level. In terms of example, for a process to accomplish the level 1 is required only to implement 96 activities of the maturity level 1, if not implemented, the process will stay at level 0.

The chosen classification criteria (percentage of activities to implement) has not an empirical validation or a scientific criterion, however, seems to this research that this number is a suitable percentage since that is not too hard or too easy to achieve. With the results of the evaluation step, this investigation had the purpose to adjust this value.

5.3. Maturity Model Improvement Iteration

Due to structural reasons of the methodology adopted, the modifications of the MM, that were provided by the interviews, are described in this sub-section. The improvements provided by the expert of the first interview were not just of the MM structure but also of the activities.

For better understanding, the improvements related to the activities' reformulation made to the MM are visible in Table 15. In total, 16 questions were changed. The support tool remained with 238 activities, which makes a total of 4% of activities reduction.

The expert also supplied an improvement of the answer options. Initially, the questionnaire had three options, however, with the feedback provided was included two more options:

Table 15 - Actions Realized to Questions According to Feedback Provided

Action	Reason	Number of Questions Found
Elimination	The elimination questions occurred, due to the facts of: • Questions that are indirectly answered by other questions; • Ambiguous and redundant questions; • Questions that do not make sense; • Questions that are too generic	9
Question Reformulation	The reformulation of questions was made to questions that were ambiguous but possible to improve. Except for one question that was joined with other.	7

- Not applicable: The activity for the organization is not worth to be implemented due to the size and strategic objectives of the enterprise. In this instance, for the final classification, this question will not count as an activity to be implemented;
- No answer: The interview does not have the knowledge of whether the activity is implemented.

The elimination of activities ranged from level 1 and level 2 , being eight of the level of maturity 1 and the other of maturity level 2. The final MM is visible in the Appendix E.

Chapter 6 - Demonstration & Evaluation

After the development of the artefact it was necessary to demonstrate and evaluate its usefulness and applicability. This chapter describes the performed demonstration and evaluation.

6.1. Conception of Transfer and Evaluation

In several occasions, in the development of MMs area, the researchers try to implement the MMs developed in the organizations, with a view of evaluating their artefact in practical circumstances and assessing the maturity of the organizations under study. However, in the context and environment where this investigation took place, was difficult to find organizations that have adopted the CM process and make themselves available to perform this kind of evaluations.

With the purpose of assessing the artefact created, was decided to use the MM in a questionnaire format, where the questions were the activities that MM is composed, as described in the previous chapter (Appendix F). In the first version of the questionnaire, each question had three options:

- Yes: the activity is totally implemented;
- Partial: the activity is partially implemented, or the activity is merely applied few times. In this case, by following the classification criteria explained earlier, for the final count of the activities implemented this activity will count as 0,5;
- No: the activity is not implemented.

In order to set this in practice, was decided to adopt the semi-structured interviews for data collection and feedback.

Semi-structured interviews can be very flexible and appropriate for small scale researches. This kind of technique is used to gather beneficial information in bi-directional communication with the interviewed (Pathak & Intratat, 2012), despite that the interviewer has structured key questions prepared before the interview, to help guide and define main areas to be explored (Gill, Stewart, Treasure, & Chadwick, 2008).

For this research, the semi-structured interviews were the most suitable method to provide a qualitative assessment of the MM, either of the structure or the activities quality.

From this perspective, since the objective was not to implement the MM in the organizations, as a main part of the researchers did, it was asked to the interviewees as they answered the questionnaire to supply an assessment of the questions, with the viewpoint of their organization or an organization they had worked with a CM process implemented, semi-implemented or with a plan for the implementation of this process.

In the end, was developed a sub-questionnaire to evaluate the MM overall that is visible in Appendix F.

6.2. Implementation of Transfer Media & Evaluation - Organization A

In the first organization were realized three semi-structured interviews, with three experts in the ITSM area. The information of the interviewed is visible in Table 16.

Table 16 - Experts Personal Information from Organization A

	Years of Experience in IT Area	Years of Experience in ITSM Area	Organization Position	Industry Area	Experts in
E1	28	15	IT Management	Banking	ITIL and CMMI
E2	25	4	Systems Analyst	Banking	ITIL
E3	30	7	Service Management	Banking	ITIL

The organization of these experts is from the banking area, which have already several processes implemented, providing with a stable structure, services to their internal and external clients. The details of this organization are visible in Table 17.

Table 17 - Information of the Organization A

Industry Area	Multinational Organization	Number of Organization Employees	Number of Organization IT Department Employees
Banking	No	5000	150

The interviews had on average 58 minutes period of time. The longest interview took 92 minutes (1:32h) and the briefest took 40 minutes.

As already stated, until the artefact reaches a good maturity and a stable "version", it needs to be improved by iterations. In this research, each interview was considered as an improvement iteration.

6.2.1. Organization A - Demonstration

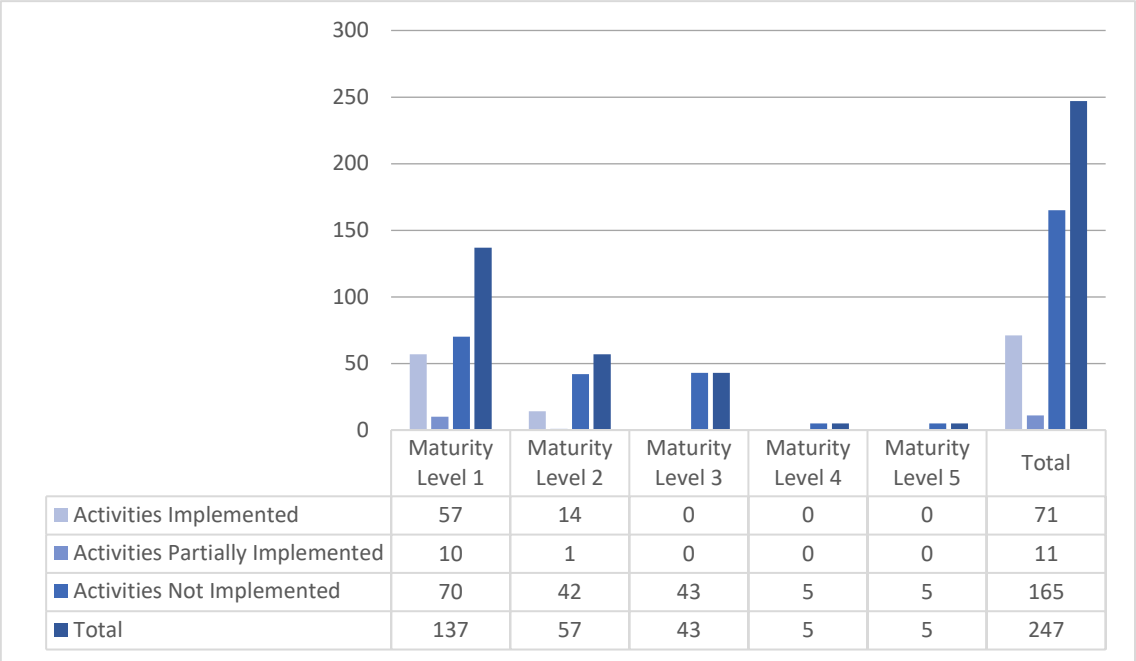
The organization A has not the CM process formalized however, this enterprise gave internally priority to other processes, having a variety of activities related with the activities proposed by the process in study, implemented The experts of this organization have extensive knowledge of frameworks like ITIL and CMMI.

Since the interviewed E1, E2 and E3 were from the same organization, in order to evaluate the enterprise maturity level, although not being the main objective, was settled that the assessment process would follow the questionnaire of the interviewed E1, given that has more years in the ITSM area and has knowledge of more frameworks than the others.

The first interview was the one that took more time, for the simple reason that the questionnaire was in a "raw" state since no improvements had been made. Even so, the expert provided wide improvements to the MM, that are visible in Section 5.3. The E2 and E3 just provided feedback on the overall MM, where the conclusions are in the Sub-Section 6.2.2.

Considering that this enterprise does not have already the process formalized and, is fragmentized, the maturity of the CM is at level 0. However, the organization has a plan defined and documented for performing the CM process. Due to the fact that the CM process is connected with other processes, following the MM proposed in this research, this enterprise has already implemented 71 activities completely applied. The distribution between the activities and the maturity levels are visible in Figure 8.

By visualizing the Figure 8, is feasible to conclude that the organization A is at its beginnings of the implementation of CM practices. In accordance with the classification criteria, the organization has 62 activities implemented (partial activities count as 0,5), which makes a total of 45% practices adopted of maturity level 1. Consequently, this enterprise, as mentioned before, is at level 0. The organization has, in total, 71 activities already implemented, and 11 practices partially implemented, which symbolizes nearly 30% of all activities. With all these practices already applied in the organization, seems



	Maturity Level 1	Maturity Level 2	Maturity Level 3	Maturity Level 4	Maturity Level 5	Total
Activities Implemented	57	14	0	0	0	71
Activities Partially Implemented	10	1	0	0	0	11
Activities Not Implemented	70	42	43	5	5	165
Total	137	57	43	5	5	247

Figure 8 - Activities Already Implemented by Organization A

to be a good start and a robust "foundation" to start the formalization and adoption of the CM process good practices.

6.2.2. Organization A - Evaluation

As previously stated, was important to evaluate the MM, reflecting it in the questionnaire, since was not found a range of companies to implement the artefact created, and examine the medium- and long-term benefits. In order to achieve this, the three experts answered the sub-questionnaire composed of three questions. All the answers given to this sub-questionnaire are presented in Table 18.

The banking industry is evolving, beginning to have a wide budget to invest in IT infrastructures and services. For these experts, the utilization of this MM would be a great mechanism for companies that are initiating the implementation of the process, by creating a roadmap. The experts of the organization A found the questionnaire useful and complete, allowing the management to have a tool for decision support.

Despite that, the expert E1 considered the artefact as very time-consuming and hard to identify the benefits that a set of practices would provide to the organization, which this investigation considers this as the main feature to be developed in the future.

The expert E2 finds this MM very complete and very detailed in the management of the CMDB. However, considers that if the organizations fully applied this MM, could bring risks and monetary costs. With the same opinion was the expert E4, which evaluates

Table 18 - Answers of E1, E2, E3 experts given to the sub-questionnaire

Experts	Question 1	Question 2	Question 3	
			Pros	Cons
E1	Very Complete	9	• Being very complete; • Improvements identification; • Decision support; • Awareness of the process maturity.	• Time-Consuming; • Hard to identify the "Quick-Wins".
E2	Very Complete	8	• Full management of CMDB; • Contribution to the relations between other processes.	Can have higher cost if taken to the "extreme";
E3	Very Complete	7	Very detailed.	

this MM as very detailed as pros and cons, since the organizations would spend many resources to have this tool completely implemented, but also this tool is very detailed, helping to guide easily through the process implementation and evaluation.

Although, was explained that the organizations should view this MM as a tool to support their CM implementations to a certain level of maturity, considering their strategic objectives and the organization culture, and not to implement entirely if not necessary.

6.3. Implementation of Transfer Media & Evaluation - Organization B

After the assessments did by the experts from the organization A, was realized a fourth interview in a distinct enterprise. The chosen expert has a substantial understanding of the CM process and many years of experience. His information is visible in Table 19.

Table 19 - Expert Personal Information from Organization B

	Years of Experience in IT Area	Years of Experience in ITSM Area	Organization Position	Industry Area	Experts in
E4	-	17	Director	IT	ITIL

The organization of this expert is from the IT area and has already the CM process implemented and consistent. The information of the organization B can be seen in Table 20.

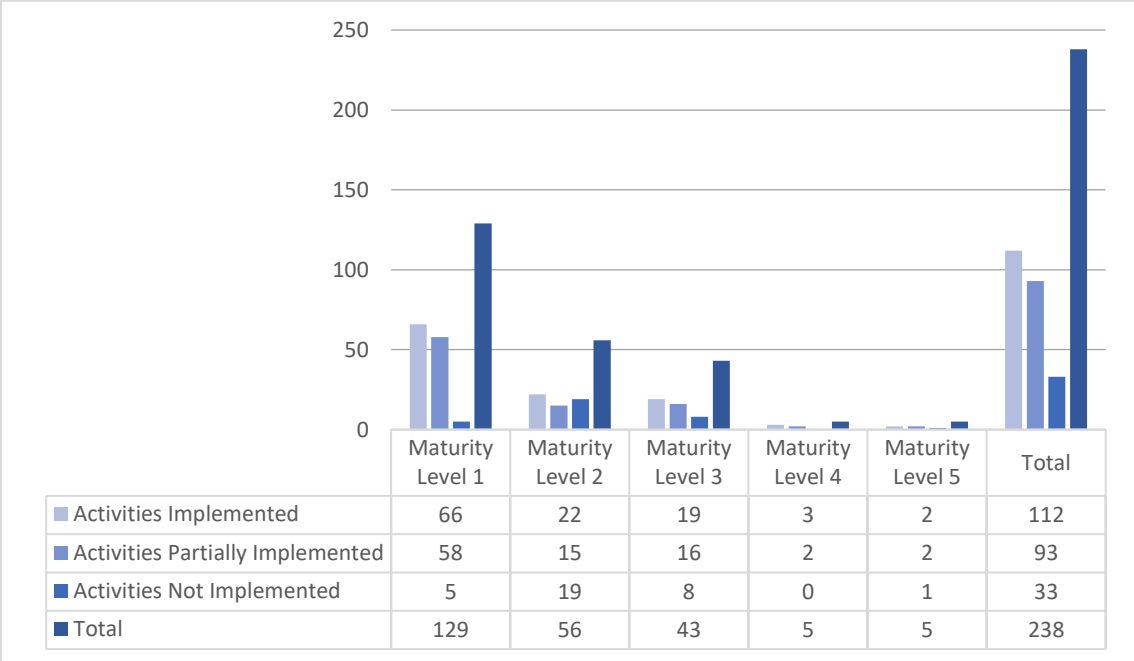
Table 20 - Information of the Organization B

Industry Area	Multinational Organization	Number of Organization Employees	Number of Organization IT Department Employees
IT	Yes	100	800

The interview took 88 minutes (1:29h), where beyond of the objectives established for the semi-structured interview, was also discuss the state-of-art and the evolution of the CM process.

6.3.1. Organization B - Demonstration

In contrast to organization A was organization B, which has practices of all levels of maturity implemented. At this organization, the utilization of tools that somehow automate the activities of this process is a "priority". With the expert was discussed the evolution that the CM took, and the benefits of transferring the "control" to third-party tools. All the activities that are implemented, are visible in Figure 9. The other two options of answer are not presented in Figure 9 since they were not chosen in any question.



	Maturity Level 1	Maturity Level 2	Maturity Level 3	Maturity Level 4	Maturity Level 5	Total
Activities Implemented	66	22	19	3	2	112
Activities Partially Implemented	58	15	16	2	2	93
Activities Not Implemented	5	19	8	0	1	33
Total	129	56	43	5	5	238

Figure 9 - Activities Already Implemented by Organization B

By observing Figure 9, can be declared that the organization B has activities implemented through all the maturity levels. However, this organization is at level 1 of maturity with 74% of level 1 activities applied. It is visible that this organization has a process more mature since does not have only 33 activities partially or totally implemented. Additionally, this enterprise has more than half the practices applied of each level maturity, standing out the level 4 and 5 where the organization B has 80% and 60% of activities applied respectively. Which reveals that this company has already a big concern with this process, trying to optimize and measuring it statistically.

Besides having a substantial awareness of the process, the organization does not have all the basic activities (Level 1 and Level 2), that are the base for a well-implemented process, applied. Nevertheless, the company has a considerable number of partial practices implemented, which are in a favourable position to easily improve the process itself.

Furthermore, with the support of the MM developed in this investigation, is possible to visualize that the organization B is applying the practices according to their necessities and objectives, not following necessarily a model, since the practices that are applied are spread through all levels. Eventually, this company has the process implemented in this manner due to the fact of having a significant reliance on automation and management tools.

6.3.2. Organization B – Evaluation

The expert from the organization B was very critical, considering the MM as a tool that would not be useful for an organization that has already a process developed. The expert E4 finds this tool as too bureaucratic and out of date. In the IT environment, since technology is constantly evolving, many practices became outdated very quickly, which is not viable for organizations in this industry.

However, according to the opinion of the same expert, this MM would be a supportive tool for industries where the environment is composed of critical systems that could involve human life given that this artefact is too detailed and bureaucratic. The answers to the sub-questionnaire can be observable in Table 21.

Table 21 - Answers of the expert E4 given to the sub-questionnaire

Experts	Question 1	Question 2	Question 3	
			Pros	Cons
E4	Sufficient	3	Good mode for environments with critic systems that could involve human life.	• Bureaucratic; • Out of date.

6.4. Interviews Conclusions

Taking into account all the feedback provided by the experts, in overall, only one interviewee pointed the MM as uncompleted. Mainly because the expert E4 believes that the information used to build the MM is outdated. The remaining experts find this MM as very complete and useful tool.

With the result of these interviews, the artefact developed can be characterized by three points of view:

- Organizations without a "clear idea" of what needs to be implemented or how to start and does not have a critical dependency of the IT development, this MM could be an excellent support tool to create an implementation and improvement roadmap;
- Being this artefact very detailed and descriptive, for companies with critical systems with very bureaucratic protocols to follow, this MM should be a good option to help have a better control;
- For organizations where already have a process implemented and have an enormous dependency on their IT technology and operate only in IT industry, this MM maybe be out of date and inadequate to their necessities considering that the technology is evolving at a breakneck pace.

Although the MM, in overall, received good feedback in the interviews, the evaluation had a lack of scientific criterion, since the suggested improvements of the first interviewed were not assessed by the others in a bi-directional discussion. In an attempt to mitigate as much as possible this lack of scientific rigour, several times in the interviews were asked to the experts if they agreed with the improvements suggested of the other experts, in an informal way. In all interventions like that, all the experts agreed with the recommended optimizations.

Attending to the issues found and described in Chapter 1, apparently, to this research, the MM created may be useful in several environments, where the implementation of the process is in its beginnings, helping the organizations that have the process implemented in a haphazard way evolve the process until a “stable version”. In terms of frameworks overlap issue, this MM can help mitigate this problem in variable situations, by extracting the best insights of each framework removing the necessity to implement several standards.

Chapter 7 - Conclusion

One of the main objectives of the organizations is to become self-sustainable by improving their capabilities in an economical manner. Hence, enterprises need to evaluate their current position to plan their proper investments in a strategic way, since the knowledge of the maturity level of an organization is important to its improvement and evolution. The value of maturity concept is increasing in organizations being important to their development, coming to the point of being identified as a contingency factor for the adoption and improvement of governance structures in organizations. This shows that more knowledge in this area is important and more research in this domain is needed.

This investigation aimed to develop an overlapless MM for the CM process following several frameworks. In order to conduct this research, two SLRs approaches were adopted, one for each concept: CM and MM. Both approaches helped this investigation by providing context and describing the benefits and compliance between the two concepts. With the analyzation of the 80 articles found in both SLRs, was possible to compare the benefits and the utility that a CM would have in the management of an IT organization, concluded that a MM specific for CM, would be an essential quality tool for an enterprise, such as the utilization of frameworks for the development of this kind of utensil. With the realization of the LR also was possible to conclude that a overlapless CMMM would help several organizations that needed to implement diverse standards consequently of legislation reasons.

Following this thinking and verifying that no overlapless CMMM was created, this research decided that would address the problems found by adopting the DSR as a research methodology. An analyse of the frameworks COBIT, CMMI-SVC and ITIL was made and in total were extracted 247 activities with the elimination of the activities overlapped already realized. The creation of the MM was finalized with the classification of all activities through five levels of maturity.

With a view of evaluating the artefact created, were realized four semi-structured interviews with four experts in ITSM domain. These interviews were realized with the purpose of assessing the MM by using a questionnaire formed by the MM. However, only in one interview was provided improvements to the questionnaire. The other three interviews contributed with overall questionnaire feedback, characterizing the questions as understandable and well designed.

With the feedback provided by the experts was possible to conclude that:

- In IT organizations where their focus is the IT industry and have already a process implemented, this MM would not be a good fit as a support tool, being characterized as outdated and too bureaucratic;
- In organizations that do not have already a process, and have the necessity of an "implementation guide", this MM would be an excellent tool, not just for the implementation, but also for the creating of an improvement roadmap;
- In organizations that have critical systems and complex protocols, this artefact could be an excellent tool, since is very detailed and complete.

In the point of view of this research, with the analyse of the frameworks, the CM process is becoming into a concept and not a process. By taking into account all the activities described by all the frameworks is possible to state that many of them should be automated in order to diminish the operation costs and the factor of human error. In addition, is also feasible to affirm that most of the practices involve and are around on the CMDB, not having defined process flow, like the other processes. With the discussion with the third expert, was determined that nearly 90% of the CM activities can be managed and automized by tools. However, this research believes that before the automatization of the process, the executors should have the knowledge of the main concepts of this domain, and how this process is "executed" through the support software.

In conclusion, although the investigation perspective about the evolution of the CM process, the artefact created can be useful in several environments, where the complexity of the management of IT infrastructures and assets increases. The MM can also assist organizations that do not have the idea of how to improve the process and companies that have the process applied in a careless way. Furthermore, can be a feasible option for organizations that need to have several standards implemented. Despite this, for future work, should be realized a robust and thorough MM validation where the objective was to measure, medium and long term, the benefits of the utilization and adoption of this artefact. This investigation also suggests the development of the "Quick-Wins" concept for this MM proposed by the first expert. Nevertheless, this research can be used as a reference point for new researchers that intend to develop new MMs.

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Appendix

Appendix A - Activities Extraction of the CMMI-SVC Framework

Configuration Management (CMMI-SVC)				
Goal	**Practice**	**Activity extracted or description extracted**	**Sub-activities**	**ID**
SG 1 - Establish Baselines (Baselines of identified work products are established)	**SP 1.1** - Identify Configuration Items (Identify configuration items, components, and related work products to be placed under configuration management	A1.1.1 - Select configuration items and work products that compose them based on documented criteria.	Is the selection of configuration items and work products that compose them, based on documented criteria ?	1C
		A1.1.2 - Assign unique identifiers to configuration items.	Do configuration items have a unique identifier ?	2C
		A1.1.3 - Specify the important characteristics of each configuration item.	Are the most important characteristics of each configuration item specified ?	3C
		A1.1.4 - Specify when each configuration item is placed under configuration management	Is each configuration item specified when are placed under configuration management ?	4C
		A1.1.5 - Identify the owner responsible for each configuration item.	Is the owner responsible for each configuration item identified ?	5C
		A1.1.6 - Specify relationships among configuration items.	Are the relationships among configuration items specified ?	6C
	SP 1.2 - Establish a Configuration Management System (Establish and maintain a configuration management and change management system for controlling work products.)	A1.2.1 - Establish a mechanism to manage multiple levels of control.	Is a mechanism to manage multiple levels of control established ?	7C
			Are the levels of control based on:	
			project objectives ?	8C
			risks ?	9C
			resources ?	10C
		A1.2.2 - Provide access control to ensure authorized access to the configuration management system.	In order to ensure that is made only authorized accesses to the configuration management system, is access control provided ?	11C
		A1.2.3 - Store and retrieve configuration items in a configuration management system.	Are the configuration items stored and retrieved in a configuration management system ?	12C

		A1.2.4 - Share and transfer configuration items between control levels in the configuration management system.	Are the configuration items shared and transferred between control levels in the configuration management system ?	13C
		A1.2.5 - Store and recover archived versions of configuration items.	Are the archived versions of configuration items stored and recovered ?	14C
		A1.2.6 - Store, update, and retrieve configuration management records.	Are the configuration management records:	
			stored ?	15C
			updated ?	16C
			retrieved ?	17C
		A1.2.7 - Create configuration management reports from the configuration management system.	From the configuration management system, are configuration management reports created ?	18C
		A1.2.8 - Preserve the contents of the configuration management system.	Are the contents of the configuration management system preserved ?	19C
		A1.2.9 - Revise the configuration management structure as necessary.	Are the configuration management structure revised when is necessary ?	20C
	SP 1.3 - Create or Release Baselines (Create or release baselines for internal use and for delivery to the customer.)	A1.3.1 - Obtain authorization from the configuration control board (CCB) before creating or releasing baselines of configuration items.	Is obtained an authorization from the Configuration Control Board before:	
			creating a configuration item baseline?	21C
			releasing a configuration item baseline?	22C
		A1.3.2 - Create or release baselines only from configuration items in the configuration management system.	Is only from the configuration items in the configuration management system that are:	
			created baselines?	23C
			released baselines?	24C
		A1.3.3 - Document the set of configuration items that are contained in a baseline.	Are the set of configuration items contained in a baseline, documented?	25C
		A1.3.4 - Make the current set of baselines readily available.	Is the current set of baselines readily available?	26C
SG 2 - Track and Control Changes (Changes to the	**SP 2.1** - Track Changes Requests (Track	A2.1.1 - Initiate and record change requests in the	Are the change requests initiated and recorded in	27C

work products under configuration management are tracked and controlled.)	change requests for configuration items.)	change request database.	the change request database?	
		A2.1.2 - Analyse the impact of changes and fixes proposed in change requests.	Is the impact of changes and fixes proposed in change requests, analysed?	28C
		A2.1.3 - Categorize and prioritize change requests.	Are change requests:	
			categorized?	29C
			prioritized when necessary?	30C
		A2.1.4 - Review change requests to be addressed in the next baseline with relevant stakeholders and get their agreement.	Are change requests, that are to be addressed in the next baseline, reviewed with relevant stakeholders in order to get their agreement?	31C
		A2.1.5 - Track the status of change requests to closure.	Is the status of change requests tracked to closure?	32C
	SP 2.2 - Control Configuration Items (Control changes to configuration items.)	A2.2.1 - Control changes to configuration items throughout the life of the product or service.	Are the changes to configuration items controlled throughout the life of the product or service?	33C
		A2.2.2 - Obtain appropriate authorization before changed configuration items are entered into the configuration management system.	Before changed configuration items are entered into the configuration management system, is obtained an appropriate authorization?	34C
		A2.2.3 - Check-in and checkout configuration items in the configuration management system for incorporation of changes in a manner that maintains the correctness and integrity of configuration items.	Is the check-in and checkout made to configuration items in the configuration management system for incorporation of changes, in a manner that maintains the correctness and integrity of configuration items?	35C
		A2.2.4 - Perform reviews to ensure that changes have not caused unintended effects on the baselines.	In order to ensure that changes have not caused unintended effects on the baselines, are reviews performed?	36C
		A2.2.5 - Record changes to configuration items and reasons for changes as appropriate.	Are the changes to configuration items recorded appropriately?	37C
			Are the reasons for changes recorded appropriately?	38C

SG 3 - Establish Integrity (Integrity of baselines is established and maintained.)	**SP 3.1** - Establish Configuration Management Records (Establish and maintain records describing configuration items.)	A3.1.1 - Record configuration management actions in sufficient detail so the content and status of each configuration item are known and previous versions can be recovered.	In order for the content and status of each configuration item is known and previous versions can be recovered, are the configuration management actions recorded in sufficient detail?	39C
		A3.1.2 - Ensure that relevant stakeholders have access to and knowledge of the configuration status of configuration items.	Do the relevant stakeholders have access to and knowledge of the configuration status of configuration items?	40C
		A3.1.3 - Specify the latest version of baselines.	Is the latest version of baselines specified?	41C
		A3.1.4 - Identify the version of configuration items that constitute a particular baseline.	Is the version of configuration items, that constitute a particular baseline, identified?	42C
		A3.1.5 - Describe differences between successive baselines.	Are the differences between successive baselines described?	43C
		A3.1.6 - Revise the status and history (i.e., changes and other actions) of each configuration item as necessary.	Are the status and history of each configuration item, revised when necessary?	44C
	SP 3.2 - Perform Configuration Audits (Perform configuration audits to maintain the integrity of configuration baselines.)	A3.2.1 - Assess the integrity of baselines.	Is the integrity of baselines assessed?	45C
		A3.2.2 - Confirm that configuration management records correctly identify configuration items.	Is made a confirmation if the configuration management record, correctly identifies the configuration items?	46C
		A3.2.3 - Review the structure and integrity of items in the configuration management system.	Are the structure and integrity of items in the configuration management system, reviewed?	47C
		A3.2.4 - Confirm the completeness and correctness of items in the configuration management system.	Are the completeness and correctness of items in the configuration management system, confirmed?	48C
		A3.2.5 - Confirm compliance with applicable configuration management standards and procedures.	Is confirmed the compliance with applicable configuration management standards and procedures?	49C

		A3.2.6 - Track action items from the audit to closure.	Are the action items from the audit tracked to closure?	50C
GG 2 - Institutionalize a Managed Process (The process is institutionalized as a managed process.)	**GP 2.1** - Establish an Organizational Policy (Establish and maintain an organizational policy for planning and performing the process.)	-	Is an organizational policy for planning and performing the configuration management process, established and maintained?	51C
	GP 2.2 - Plan the Process (Establish and maintain the plan for performing the process.)	A2.2.1 - Define and document the plan for performing the process.	Is the plan for performing the configuration management process defined and documented?	52C
		A2.2.2 - Define and document the process description.	Is the configuration management process description defined and documented?	53C
		A2.2.3 - Review the plan with relevant stakeholders and get their agreement.	Is the plan reviewed with the relevant stakeholders?	54C
		A2.2.4 - Revise the plan as necessary.	Is the plan revised when necessary?	55C
	GP 2.3 - Provide Resources (Provide adequate resources for performing the process, developing the work products, and providing the services of the process.)	-	Are the resources provided, adequate for performing the configuration management process?	56C
	GP 2.4 - Assign Responsibility (Assign responsibility and authority for performing the process, developing the work products, and providing the services of the process.)	A2.4.1 - Assign overall responsibility and authority for performing the process.	Are the responsibility and authority overall assigned for performing the configuration management process?	57C
		A2.4.2 - Assign responsibility and authority for performing the specific tasks of the process.	Are the responsibility and authority assigned for performing the specific tasks of the configuration management process?	58C
		A2.4.3 - Confirm that the people assigned to the responsibilities and authorities	The people that are assigned to the responsibilities and authorities understand and accept them ?	59C

		understand and accept them.		
	GP 2.5 - Train People (Train the people performing or supporting the process as needed.)	-	Are the people that are performing and supporting the process, trained when needed ?	60C
	GP 2.7 - Identify and Involve Relevant Stakeholders (Identify and involve the relevant stakeholders of the process as planned.)	A2.7.1 - Identify stakeholders relevant to this process and their appropriate involvement.	Are the relevant stakeholders identified in the configuration management process ?	61C
		A2.7.3 - Involve relevant stakeholders as planned.	Are the relevant stakeholders involved as planned ?	62C
		-	Are the stakeholders involved in the activity of:	
			establishing baselines ?	63C
			reviewing configuration management systems reports and resolving issues ?	64C
			assessing the impact of changes for configuration items ?	65C
			performing configuration audits ?	66C
			reviewing the results of configuration management audits ?	67C
	GP 2.8 - Monitor and Control the Process (Monitor and control the process against the plan for performing the process and take appropriate corrective action.)	A2.8.1 - Measure actual performance against the plan for performing the process.	Is the actual performance measured against the plan for performing the configuration management process ?	68C
		A2.8.2 - Review the accomplishments and results of the process against the plan for performing the process.	Are the accomplishments and results of the configuration management process reviewed against the plan for performing the process ?	69C
		A2.8.3 - Review activities, status, and results of the process with the immediate level of management responsible for the process and identify issues.	In order to identify issues, are the activities, the status and the results of the process reviewed with the immediate level of management responsible for the configuration management process ?	70C

		A2.8.4 - Identify and evaluate the effects of significant deviations from the plan for performing the process.	Are the effects of significant deviations from the plan for performing the process, identified and evaluated ?	71C
		A2.8.5 - Identify problems in the plan for performing the process and in the execution of the process.	Are the problems, in the plan for performing the process and in the execution of the process, identified ?	72C
		A2.8.6 - Take corrective action when requirements and objectives are not being satisfied, when issues are identified, or when progress differs significantly from the plan for performing the process.	Are corrective actions taken when the process is not being executed comparing with the plan for performing the process ?	73C
		A2.8.7 - Track corrective action to closure.	Are the corrective action tracked to closure ?	74C
		-	Does the measures and work products used in monitoring and controlling include the:	
			number of changes to configuration items ?	75C
			the number of configuration audits conducted ?	76C
			schedule of configuration control board or audit activities ?	77C
	GP 2.9 - Objectively Evaluate Adherence (Objectively evaluate adherence of the process against its process description, standards, and procedures, and address noncompliance.)	-	Is objectively evaluated the adherence of the configuration management process against its process description, standards, procedures ?	78C
		-	Does the activities reviewed include the activity:	
			establishing baselines ?	79C
			tracking and controlling changes ?	80C
			establishing and maintaining the integrity of baselines ?	81C
		-	Does the work products reviewed include the:	

			archives of baselines ?	82C
			change request database ?	83C
	GP 2.10 - Review Status with Higher Level Management (Review the activities, status, and results of the process with higher-level management and resolve issues.)	-	With the higher level of management, are reviewed:	
			the activities of the process ?	84C
			the status of the process ?	85C
			the results of the process ?	86C
GG 3 - Institutionalize a Defined Process (The process is institutionalized as a defined process.)	**GP 3.1** - Establish a Defined Process (Establish and maintain the description of a defined process.)	A3.1.3 - Ensure that the organization's process objectives are appropriately addressed in the defined process.	Are the organization's configuration management process objectives, appropriately addressed in the defined process ?	87C
	GP 3.2 - Collect Improvement Information (Collect work products, measures, measurement results, and improvement information derived from planning and performing the process to support the future use and improvement of the organization's processes and process assets.)	A3.2.1 - Store process and product measures in the organization's measurement repository.	Are the process measures stored in the organization's measurement repository ?	88C
		A3.2.2 - Submit documentation for inclusion in the organization's process asset library.	Is the documentation submitted in the organization's process asset library ?	89C
		A3.2.3 - Document lessons learned from the process for inclusion in the organization's process asset library.	Are the lessons learned from the configuration management process, documented and stored in the organization's configuration management process asset library ?	90C
		-	In order to support the future use and improvement of the organization's processes and process assets, by collecting the improvement information derived from planning and performing the process, does the work products, measures, measurement results, and improvement information include the:	
			trends in the status of configuration items ?	91C
			configuration audit results ?	92C
			change request aging reports ?	93C

GG 4 - Institutionalize a Quantitatively Managed Process (The process is institutionalized as a quantitatively managed process.)	**GP 4.1** - Establish Quantitative Objectives for the Process (Establish and maintain quantitative objectives for the process, which address quality and process performance, based on customer needs and business objectives.)	A4.1.1 - Establish the quantitative objectives that pertain to the process.	Are the quantitative objectives that pertain to the configuration management process, established ?	94C
		-	Are the quantitative objectives based on:	
			the customer needs ?	95C
			the business objectives ?	96C
		A4.1.2 - Allocate the quantitative objectives to the process or its subprocesses.	Are the quantitative objectives allocated to the process or its subprocesses ?	97C
	GP 4.2 - Stabilize Subprocess Performance (Stabilize the performance of one or more subprocesses to determine the ability of the process to achieve the established quantitative quality and process-performance objectives.)	A4.2.1 - Statistically manage the performance of one or more subprocesses that are critical contributors to the overall performance of the process.	Is the performance of the subprocesses that are critical contributors to the overall performance of the configuration management process, statistically managed ?	98C
		A4.2.2 - Predict the ability of the process to achieve its established quantitative objectives considering the performance of the statistically managed subprocesses.	Is the ability of the process to achieve its established quantitative objectives, considering the performance of the subprocesses, predicted ?	99C

GG 5 - Institutionalize an Optimizing Process (The process is institutionalized as an optimizing process.)	**GP 5.1** - Ensure Continuous Process Improvement (Ensure continuous improvement of the process in fulfilling the relevant business objectives of the organization.)	A5.1.2 - Identify process improvements that would result in measurable improvements to process performance.	Are the configuration management improvements, that would result in measurable improvements to process performance, identified ?	100C
		A5.1.3 - Define strategies and manage the deployment of selected process improvements based on the quantified expected benefits, the estimated costs and impacts, and the measured change to process performance.	Are the strategies and the deployment management of the selected process improvements, defined based on:	
			the quantified expected benefits ?	101C
			the estimated costs and impacts ?	102C
			the measured change to process performance ?	103C
	GP 5.2 - Correct Root Causes of Problems (Identify and correct the root causes of defects and other problems in the process)	-	Are the root causes of defects and other problems in the configuration management process, identified and corrected ?	104C

Appendix B - Activities Extraction of the COBIT Framework

Managed Configuration (COBIT 5)			
Management Practice	**Activity extracted or description extracted**	**Sub-Activities**	**ID**
BAI10.01 Establish and maintain a configuration model (Establish and maintain a logical model of the services, assets, infrastructure and recording of configuration items (CIs), including the relationships among them. Include the CIs considered necessary to manage services effectively and to provide a single, reliable description of the assets in a service).	**1.1.** Define and agree on the scope and level of detail for configuration management (i.e., which services, assets and infrastructure configurable items to include).	Is the scope for configuration management defined?	1B
		Is the level of detail for configuration management defined?	2B
	1.2. Establish and maintain a logical model for configuration management, including information on CI types, attributes, relationship types, relationship attributes and status codes.	Is a logical model for configuration management established and maintained?	3B
		Does this logical model include information of:	
		CI types?	4B
		CI attributes?	5B
		CI relationship types?	6B
		CI relationship attributes?	7B
		CI status codes?	8B
BAI10.02 Establish and maintain a configuration repository and baseline (Establish and maintain a configuration management repository and create controlled configuration baselines).	**2.1.** Identify and classify the CIs and populate the repository.	Are the CIs:	
		identified?	9B
		classified?	10B
		populated in the repository?	11B
	2.2. Create, review and formally agree on configuration baselines of a service, application or infrastructure.	Are the configuration baselines of a service, application or infrastructure:	
		created?	12B
		reviewed?	13B
		formally agreed?	14B
	2.2. Create, review and formally agree on configuration baselines of a service, application or infrastructure. (Outro)	When a configuration baseline is created:	
		are the release records included (current, past and planned) ?	15B
		are the other change records included (current, past and planned)?	16B

		are the status of the CI and is documentation when a change is approved and implemented, included?	17B
		are the status of the CI and its documentation when a package release is applied, included?	18B
		are the standards specifications on the hardware and software involved, included?	19B
		are the affected business processes and process owners, included?	20B
BAI10.03 Maintain and control configuration items (Maintain an up-to-date repository of configuration items (CIs) by populating any configuration changes).	**3.1.** Regularly identify all changes to CIs.	Are the changes to CIs identified?	21B
	3.2. To ensure completeness and accuracy, review proposed changes to CIs against the baseline.	In order to ensure the completeness and accuracy, are the proposed changes to CIs reviewed against the baseline?	22B
	3.3. Update configuration details for approved changes to CIs.	Are the configuration details for approved changes to CIs updated?	23B
	3.4. Create, review and formally agree on changes to configuration baselines whenever needed.	Whenever needed, are the changes to configuration baselines:	
		created?	24B
		reviewed?	25B
		formally agreed?	26B
	(Outro)	Are the changes made to the Configuration Management System communicated to CI owners and other stakeholders?	27B
BAI10.04 Produce status and configuration reports (Define and produce configuration reports on status changes of configuration items).	**4.1.** Identify status changes of CIs and report against the baseline.	Are the status changes of CIs:	
		identified?	28B
		reported against the baseline?	29B
	4.2. Match all configuration changes with approved requests for change to identify any unauthorized changes. Report unauthorized changes to change management.	In order to identify any unauthorized changes and therefore report these unauthorized changes to change management, are all the configuration changes verified by matching with approved requests for change?	30B

	4.3. Identify reporting requirements from all stakeholders, including content, frequency and media. Produce reports according to the identified requirements.	Are the reporting requirements from all stakeholders identified?	31B
		The reporting requirements identified include:	
		the content?	32B
		the frequency?	33B
		the media?	34B
		According to the identified requirements, are reports produced?	35B
BAI10.05 Verify and review integrity of the configuration repository (Periodically review the configuration repository and verify completeness and correctness against the desired target).	**5.1.** Periodically verify live configuration items against the configuration repository by comparing physical and logical configurations and using appropriate discovery tools, as required.	By comparing physical and logical configurations and by using appropriate discovery tools, are periodically the live configuration items verified against the configuration repository?	36B
	5.2. Report and review all deviations for approved corrections or action to remove any unauthorized assets.	Are all the deviations that were noted, for approved corrections or actions to remove any unauthorized assets:	
		reported?	37B
		reviewed?	38B
	5.3. Periodically verify that all physical configuration items, as defined in the repository, physically exist. Report any deviations to management.	Are all the physical configuration items verified, as defined in the repository, if physically exist?	39B
		Are the deviations identified in this verification reported to management?	40B
	5.4. Set and periodically review the target for completeness of the configuration repository based on business need.	Is the target for completeness of the configuration repository based on business need, set and periodically reviewed?	41B
	5.5. Periodically compare the degree of completeness and accuracy against targets and take remedial action, as necessary, to improve the quality of the repository data.	Is the degree of completeness and accuracy of the repository data, periodically compared against targets?	42B
		Are taken remedial actions to improve the quality of the repository data, as necessary?	43B

Appendix C - Activities Extraction of the ITIL v3 Framework

Service Asset and Configuration Management (ITIL v3)		
Area	**Activity**	**ID**
Service Asset and Configuration Management policies	Are the policies of the configuration management process established?	1A
	In the policies established for the process:	
	Are the objectives established ?	2A
	Are the scope established ?	3A
	Are the principles established ?	4A
	Are the Critical Success Factors (CSFs) established ?	5A
	Those policies are based on:	
	organization's business drivers ?	6A
	contractual and Service Management requirements ?	7A
	compliance with applicable laws, regulations and standards ?	8A
Basic concepts - The configuration model	Is a logical configuration model, representing the relationships between configuration items, established ?	9A
Configuration Management System	Are automated processes to load and update the Configuration Management database developed and established ?	10A
Configuration Management System - The Definitive Media Library	Do the DML include the definitive copies of purchased software ?	11A
	Do the DML include the software developed on-site ?	12A
	Is only authorized media accepted into DML ?	13A
	Do the definition of the DML configuration includes:	
	The physical location ?	14A
	Hardware and software to be used ?	15A
	The naming conventions for filestore areas and physical media ?	16A
	Environments supported ?	17A
	Security arrangements for submitting changes ?	18A
	The scope of the DML ?	19A
	Archive and retention periods ?	20A
	Capacity plans for the DML and procedures for monitoring growth in size ?	21A
	Audit procedures ?	22A
	Procedures to ensure that the DML is protected form erroneous or unauthorized change ?	23A
Configuration Management System - Configuration Baseline	Are the configuration baselines formally reviewed ?	24A

Management and Planning	Do the management team and configuration management decide what level of Configuration Management is required for a certain service or project ?	25A
	Does the Configuration Management Plan include:	
	the context and purpose ?	26A
	the requirements ?	27A
	the applicable policies and standards ?	28A
	the Organization for Configuration Management (responsibilities and owners, etc) ?	29A
	the selection and application of processes and procedures to implement Configuration Management activities ?	30A
	the relationship management and interface controls ?	31A
Configuration Identification	When planning the configuration identification, is defined how the classes and types of configuration items are to be:	
	selected ?	32A
	grouped ?	33A
	classified ?	34A
	defined by appropriate characteristics ?	35A
	Are the roles and responsibilities of the owner defined for configuration item type, at each stage of its lifecycle ?	36A
	Is the selection of the configuration items and the components that compose them based on these documented criteria ?	37A
	Is specified when each configuration item is placed under Configuration Management ?	38A
	Is the owner responsible for each configuration item identified ?	39A
Configuration Identification - Configuration Structures and the selection of Configuration Items	Does the configuration model describe the relationship and the position of CIs in each structure ?	40A
	Are the CIs selected by applying a top-down approach ?	41A
	Does the organization plan a review of the CI level regularly ?	42A
	Are the CIs uniquely identified ?	43A
	Does this identification differentiate between successive versions?	44A
	Does this identification enable the items under control to be unambiguously traceable to their specifications or equivalent documented descriptions ?	45A
	Are the configuration descriptions and data, conformed with service, product or technology standards ?	46A
	Do the configuration data permit the forward and backward traceability to other baseline configuration states ?	47A
	Are naming conventions established ?	48A

Configuration Identification - Naming configuration items	Are the naming conventions applied to :	
	the identification of CIs ?	49A
	the configuration documents ?	50A
	to the changes ?	51A
	to the baselines?	52A
	Are the naming conventions unique ?	53A
	Does the naming conventions include the management of:	
	Hierarchical relationships between CIs within a configuration structure ?	54A
	Hierarchical or subordinate relationships in each CI ?	55A
	Relationships between CIs and their associated documents ?	56A
	Relationships between CIs and changes ?	57A
	Relationships between CIs, incidents, problems and known errors?	58A
Configuration Identification - Attributes for configuration items	The attributes to be recorded for each CI, include:	
	the unique identifier ?	59A
	the CI type ?	60A
	the Name/Description ?	61A
	the version ?	62A
	the Location ?	63A
	the Supply date ?	64A
	the licence details ?	65A
	the owner ?	66A
	the status ?	67A
	the supplier/source ?	68A
	the related document masters ?	69A
	the related software masters ?	70A
	the historical data ?	71A
	the relationship type ?	72A
	the applicable SLA ?	73A
Configuration Identification - Relationships	Are the relationships between CIs maintained ?	74A
	Are the relationships between CIs and incident records, problem records, known errors and release records, included in CMS ?	75A
Configuration Identification - Identification of configuration baselines	Are the configuration baselines established by the formal agreement at specific points in time ?	76A
	Are the baselines referred by a unique version number ?	77A
	As the baselines are developed, are they added to CMS ?	78A
	Are the changes to baselines systematically controlled and monitored ?	79A
	In configuration identification, is defined and recorded the rationale for each baseline ?	80A

	Are the associated authorizations required to approve the configuration baseline data, defined and recorded ?	81A
Configuration Control	Is ensured that are adequate control mechanisms over CIs ?	82A
	Do CIs have appropriate controlling documentation or a procedure being followed, when are being:	
	added ?	83A
	modified ?	84A
	replaced ?	85A
	removed ?	86A
	Are established policies and procedures that cover:	
	the licence control ?	87A
	Change Management ?	88A
	the version control ?	89A
	Access control ?	90A
	Build control ?	91A
	the promotion, migration of electronic data and information ?	92A
	taking a configuration baseline of CIs before performing a release in a manner that can be used for subsequent checking against actual deployment ?	93A
	the deployment control ?	94A
	the installation ?	95A
	Maintaining the integrity of the DML ?	96A
	During the planning stage, is designed an effective configuration control model ?	97A
	Is this model implemented in a way that staff can easily locate and use the associated training products and procedures ?	98A
	Are methods, to ensure that the configuration data is complete and consistent, established and maintained ?	99A
Status accounting and reporting	Is the significance of each state defined in terms of what use can be made of the CI in that state ?	100A
	Is the way of when CI move from one state to another, defined ?	101A
	At each lifecycle status change of a CI, is the CMS updated ?	102A
	When updated, is included:	
	the reason ?	103A
	the date-time stamp ?	104A
	the person that did the status change ?	105A
	Do those activities include:	
	Maintaining configuration record through the service lifecycle and archiving them according to agreements, relevant legislation or best industry practice or standards ?	106A

	Managing the recording, retrieval and consolidation of the current configuration status and the status of all preceding configurations to confirm information correctness, timeliness, integrity and security ?	107A
	Making the status of items under Configuration Management available throughout the lifecycle ?	108A
	Recording changes to CIs from receipt to disposal ?	109A
	Ensuring that changes to configuration baselines are properly documented ?	110A
Status accounting and reporting - Records	Do the configuration status record, when created, include details of:	
	service configuration information ?	111A
	the service or product configuration ?	112A
	the status of release of new configuration information ?	113A
	changes implemented and in progress ?	114A
	capturing the results from quality assurance tests to update the configuration records ?	115A
Status accounting and reporting - Service asset and configuration reports	Do the configuration reports include:	
	a list of product configuration information included in a specific configuration baseline ?	116A
	a list of configuration items and their configuration baselines ?	117A
	details of the current revision status and change history ?	118A
	status and reports on changes, waivers and deviations ?	119A
	details of the status of delivered and maintained products concerning part and traceability numbers ?	120A
	revision status ?	121A
	report on unauthorized usage of hardware and software ?	122A
	unauthorized CIs detected ?	123A
	variations from CMS to physical audit reports ?	124A
Verification and audit	Is ensured that there is conformity between the documented baselines and the actual business environment to which they refer ?	125A
	Is the physical existence of CIs in the organization or in the DML and spares stores, the functional and operational characteristics of CIs, verified ?	126A
	Is it checked that the release and configuration documentation is present before making a release ?	127A
	Are made regularly configuration audits to check that the CMDB and related configuration information is consistent with the physical state of all CIs and vice versa ?	128A
	Are physical configuration audits carried out ?	129A

	Do the audits verify if the correct and authorized versions of CIs exist ?	130A
	Are taken corrective actions when are found unregistered and unauthorized items?	131A
	Do configuration audits check if a change and release records have been properly authorized by Change Management ?	132A
Information Management	Are backup copies of the CMS taken regularly and securely stored ?	133A
	Is the retention policy on historical CI records regularly reviewed and changed if necessary ?	134A
	In order to ensure that redundant CI records are systematically archived, is regular housekeeping carried out ?	135A
Key performance indicators and metrics	In order to optimize the cost and performance of the service assets and configurations, do the measures include:	
	the percentage improvement in maintenance schedule over the life of an asset ?	136A
	the degree of alignment between provided maintenance and business support ?	137A
	the assets identified as the cause of service failures ?	138A
	the improved speed for incident management to identify faulty CIs and restore service?	139A
	the impact of incidents and errors affecting particular CI types ?	140A
	the percentage re-use and redistribution of under-utilized resources and assets ?	141A
	degree of alignment of insurance premiums with business needs ?	142A
	the ratio of used licences against paid-for licences?	143A
	the average cost per user for licences ?	144A
	the achieved accuracy in budgets and charges for the assets utilized by each customer or business unit ?	145A
	the percentage reduction in the business impact of outages and incidents caused by poor Asset and Configuration Management ?	146A
	the improved audit compliance ?	147A
	the increased quality and accuracy of asset and configuration information ?	148A
	the fewer errors caused by people working with out-of-date information ?	149A
	shorter audits as quality asset and configuration information are easily accessible ?	150A
	the reduction in the use of unauthorized hardware and software ?	151A

	the reduction in the average time and cost of diagnosing and resolving incidents and problems (by type) ?	152A
	the improvement in time to identify poor-performing and poor-quality assets ?	153A
	the occasions when the 'configuration' is not as authorized ?	154A
	the changes that were not completed successfully or caused errors because of poor impact assessment, incorrect data in the CMS, or poor version control ?	155A
	the exceptions reported during configuration audits ?	156A
	the value of IT components detected in use ?	157A
	the reduction in risks due to early identification of unauthorized change ?	158A

Appendix D - Elimination Process of the Overlapping Activities

Activities overlapped				
Activities overlapped	**COBIT 5**	**ITIL v3**	**CMMI-SVC**	**Frameworks overlapped**
COBIT				
Is an organizational policy for planning and performing the configuration management process, established and maintained?	-	1A	51C	ITIL/CMMI
In the policies established for the process:	-	-	-	-
are the objectives that pertain to the configuration management process, established ?	-	2A	94C	ITIL/CMMI
is the scope for configuration management established ?	1B	3A		COBIT/ITIL
are the principles established ?	-	4A	-	-
are the Critical Success Factors (CSFs), established ?	-	5A	-	-
Do the management team and configuration management decide what level of Configuration Management is required for a certain service or product ?	2B	25A	39C	COBIT/ITIL/CMMI
Is a logical configuration model, representing the relationships between configuration items, established and maintained ?	3B	9A	6C	COBIT/ITIL/CMMI
Does this logical model include information of:	-	-	-	-
CI types ?	4B	-	-	-
CI attributes ?	5B	-	-	-
CI relationship types ?	6B	40A	-	COBIT/ITIL
CI relationship attributes ?	7B	-	-	-
CI status codes ?	8B	-	-	-
Is the selection of the configuration items and the components that compose them based on these documented criteria ?	9B 10B	37A	1C	ITIL/COBIT/CMMI
Are the CIs populated and retrieved in the repository ?	11B	-	12C	COBIT/CMMI
From the configuration items in the configuration management system, are the configuration baselines of a service, application or infrastructure:	-	-	-	-
created ?	12B	78A	23C	COBIT/CMMI/ITIL
released ?	-		24C	ITIL/CMMI
reviewed ?	13B	24A		COBIT/ITIL

formally agreed with Configuration Control Board ?	14B	76A	21C	COBIT/ITIL/CMMI
When a configuration baseline is created:	-	-	-	-
are the release records included (current, past and planned) ?	15B	80A	-	COBIT/ITIL
are the other change records included (current, past and planned) ?	16B		-	
are the status of the CI and is documentation when a change is approved and implemented, included ?	17B		-	
are the status of the CI and its documentation when a package release is applied, included ?	18B		42C	COBIT/ITIL/CMMI
are the standards specifications on the hardware and software involved, included ?	19B		-	COBIT/ITIL
are the affected business processes and process owners, included ?	20B		-	
Are the changes to CIs identified ?	21B	114A	27C	COBIT/ITIL/CMMI
Are the change requests reviewed with the relevant stakeholders ?	22B	-	31C	COBIT/CMMI
Are the changes to CIs updated appropriately ?	23B	-	37C	COBIT/CMMI
Are the reasons for these changes recorded ?		-	38C	COBIT/CMMI
Whenever needed, are the changes to configuration baselines:	-	-	-	-
created ?	24B	-	-	-
reviewed ?	25B	79A	36C	COBIT/CMMI/ITIL
formally agreed ?	26B		-	COBIT/ITIL
Are the changes made to the Configuration Management System communicated to CI owners and other stakeholders ?	27B	-	-	-
Are the status changes of CIs:	-	-	-	-
identified ?	28B	101A	-	COBIT/ITIL
reported against the baseline ?	29B	102A	-	COBIT/ITIL
Do configuration audits check if a change and release records have been properly authorized by Change Management ?	30B	132A	-	COBIT/ITIL
Are the reporting requirements from all stakeholders identified ?	31B	-	64C	COBIT/CMMI
The reporting requirements identified include:		-	-	-
the content ?	32B	-	-	-
the frequency ?	33B	-	-	-
the media ?	34B	-	-	-
Are reports from the configuration management system and according with the stakeholder's requirements produced ?	35B	-	18C	COBIT/CMMI

By comparing physical and logical configurations and by using appropriate discovery tools, are periodically the live configuration items verified against the configuration repository ?	36B	128A	47C	COBIT/CMMI/ITIL
Are all the deviations that were noted, for approved corrections or actions to remove any unauthorized assets, reviewed ?	38B	-	-	-
Are all the physical configuration items verified, as defined in the repository, if physically exist ?	39B	126A	-	COBIT/ITIL
Are the deviations identified in this verification, reported to management ?	40B	123A	-	COBIT/ITIL
Are the completeness and correctness of items in the configuration management system, confirmed and periodically reviewed ?	41B	130A	48C	COBIT/CMMI/ITIL
CMMI				
Are the CIs uniquely identified ?	-	43A	2C	CMMI/ITIL
Is specified when each configuration item is placed under Configuration Management ?	-	38A	4C	CMMI/ITIL
Is the owner responsible for each CI identified ?	-	39A	5C	CMMI/ITIL
Is ensured that are adequate control mechanisms over CIs ?	-	82A	7C	CMMI/ITIL
Are the levels of control based on:	-	-	-	-
project objectives ?	-	-	8C	-
risks ?	-	-	9C	-
resources ?	-	-	10C	-
Are established policies and procedures that cover the access control ?	-	90A	11C	ITIL/CMMI
Are the configuration items shared and transferred between control levels in the configuration management system ?	-	-	13C	-
Are the archived versions of configuration items stored and recovered ?	-	-	14C	-
Are the configuration management records:	-	-	-	-
stored ?	-	106A	15C	ITIL/CMMI
updated ?	-		16C	
retrieved ?	-		17C	
Are the contents of the configuration management system preserved by:	-	-	-	-
taking and securely stored, backup copies of the CMS regularly ?	-	133A	19C	ITIL/CMMI
reviewing regularly and change if necessary the retention policy of historical CI records ?	-	134A		
archiving systematically CI records ?	-	135A		
Is the configuration management structure revised when is necessary ?	-	-	20C	-

Is obtained an authorization from the Configuration Control Board before releasing a configuration item baseline ?	-	-	22C	-
Is the current set of baselines readily available ?	-	-	26C	-
Is the impact of changes and fixes proposed in change requests, analyzed ?	-	-	28C	-
Are change requests:	-	-	-	-
categorized ?	-	-	29C	-
prioritized when necessary ?	-	-	30C	-
Do these activities include recording changes to CIs to closure ?	-	109A	32C	ITIL/CMMI
Are the changes to configuration items controlled throughout the life of the product or service ?	-	-	33C	-
Before changed configuration items are entered into the configuration management system, is obtained an appropriate authorization ?	-	81A	34C	CMMI/ITIL
Are methods, to ensure that the configuration data is complete and consistent, established and maintained ?	-	99A	35C	ITIL/CMMI
Do the relevant stakeholders have access to and knowledge of the configuration status of configuration items ?	-	-	40C	-
Is the latest version of baselines specified ?	-	-	41C	-
Are the differences between successive baselines described ?	-	-	43C	-
Are configuration reports made of:	-	-	-	-
a list of product configuration information included in a specific configuration baseline ?	-	116A	25C	ITIL/CMMI
a list of configuration items and their configuration baselines ?	-	117A	-	-
the details of the current revision status and change history ?	-	118A	44C	ITIL/CMMI
status and reports on changes, waivers and deviations ?	37B	119A	-	COBIT/ITIL
the details of the status of delivered and maintained products concerning part and traceability numbers ?	-	120A	-	-
the revision status ?	-	121A	-	-
the report on unauthorized usage of hardware and software ?	-	122A	-	-
the variations from CMS to physical audit reports ?	42B	124A	-	COBIT/ITIL
Is the integrity of baselines assessed ?	-	125A	45C	ITIL/CMMI
Is confirmed the compliance with applicable configuration management standards and procedures ?	-	46A	49C	ITIL/CMMI
Are the action items from the audit tracked to closure ?	-	-	50C	-

Is the plan for performing the configuration management process defined and documented ?	-	-	52C	-
Does the Configuration Management Plan include the applicable policies and standards ?	-	28A	53C	ITIL/CMMI
Is the plan reviewed with the relevant stakeholders ?	-	-	54C	-
Is the plan revised when necessary ?	-	-	55C	-
Are the resources provided, adequate for performing the configuration management process ?	-	-	56C	-
Are the responsibility and authority overall assigned for performing the configuration management process ?	-	-	57C	-
Are the roles and responsibilities of the owner defined for configuration item type, at each stage of its lifecycle ?	-	36A	58C	CMMI/ITIL
The people that are assigned to the responsibilities and authorities understand and accept them ?	-	-	59C	-
Are the people that are performing and supporting the process, trained when needed ?	-	-	60C	-
Are the relevant stakeholders identified in the configuration management process ?	-	-	61C	-
Are the relevant stakeholders involved as planned ?	-	-	62C	
Are the stakeholders involved in the activity of:	-	-		-
establishing baselines ?	-	-	63C	-
assessing the impact of changes for configuration items ?	-	-	65C	-
performing configuration audits ?	-	-	66C	-
reviewing the results of configuration management audits ?	-	-	67C	-
Is the actual performance measured against the plan for performing the configuration management process ?	-	-	68C	-
Are the accomplishments and results of the configuration management process reviewed against the plan for performing the process ?	-	-	69C	-
In order to identify issues, are the activities, the status and the results of the process reviewed with the immediate level of management responsible for the configuration management process ?	-	-	70C	-
Are the effects of significant deviations from the plan for performing the process, identified and evaluated ?	-	-	71C	-
Are the problems, in the plan for performing the process and in the execution of the process, identified ?	-	-	72C	-
Are corrective actions taken when the process is not being executed comparing with the plan for performing the process ?	43B	131A	73C	ITIL/CMMI/COBIT

Are the corrective action tracked to closure ?	-	-	74C	-
Does the measures and work products used in monitoring and controlling include the:	-	-	-	-
the number of changes to configuration items ?	-	-	75C	-
number of configuration audits conducted ?	-	-	76C	-
schedule of configuration control board or audit activities ?	-	-	77C	-
Is objectively evaluated the adherence of the configuration management process against its process description, standards, procedures ?	-	-	78C	-
Do the activities reviewed include the activity:	-	-	-	-
establishing baselines ?	-	-	79C	-
tracking and controlling changes ?	-	-	80C	-
establishing and maintaining the integrity of baselines ?	-	-	81C	-
Does the work products reviewed include the:	-	-	-	-
archives of baselines ?	-	-	82C	-
change request database ?	-	-	83C	-
With the higher level of management, are reviewed:	-	-	-	-
the activities of the process ?	-	-	84C	-
the status of the process ?	-	-	85C	-
the results of the process ?	-	-	86C	-
Are the organization's configuration management process objectives, appropriately addressed in the defined process ?	-	-	87C	-
Are the process measures stored in the organization's measurement repository ?	-	-	88C	-
Is the documentation submitted in the organization's process asset library ?	-	-	89C	-
Are the lessons learned from the configuration management process documented and stored in the organization's configuration management process asset library ?	-	-	90C	-
Are the quantitative objectives based on:	-	-	-	-
the customer needs ?	-	-	95C	-
the business objectives ?	-	-	96C	-
Are the quantitative objectives allocated to the process or its subprocesses ?	-	-	97C	-
Is the performance of the subprocesses that are critical contributors to the overall performance of the configuration management process, statistically managed ?	-	-	98C	-

Is the ability of the process to achieve its established quantitative objectives, considering the performance of the subprocesses, predicted ?	-	-	99C	-
Are the configuration management improvements, that would result in measurable improvements to process performance, identified ?	-	-	100C	-
Are the strategies and the deployment management of the selected process improvements, defined based on:	-	-	-	-
the quantified expected benefits ?	-	-	101C	-
the estimated costs and impacts ?	-	-	102C	-
the measured change to process performance ?	-	-	103C	-
Are the root causes of defects and other problems in the configuration management process, identified ?	-	-	104C	-
ITIL				
Those policies are based on:	-	-	-	-
organization's business drivers ?	-	6A	-	-
contractual and Service Management requirements ?	-	7A	-	-
compliance with applicable laws, regulations and standards ?	-	8A	-	-
Are automated processes to load and update the Configuration Management database developed and established ?	-	10A	-	-
Do the DML include the definitive copies of purchased software ?	-	11A	-	-
Do the DML include the software developed on-site ?	-	12A	-	-
Is only authorized media accepted into DML ?	-	13A	-	-
Do the definition of the DML configuration includes:	-	-	-	-
the physical location ?	-	14A	-	-
hardware and software to be used ?	-	15A	-	-
the naming conventions for filestore areas and physical media ?	-	16A	-	-
environments supported ?	-	17A	-	-
security arrangements for submitting changes ?	-	18A	-	-
the scope of the DML ?	-	19A	-	-
archive and retention periods ?	-	20A	-	-
capacity plans for the DML and procedures for monitoring growth in size ?	-	21A	-	-
audit procedures ?	-	22A	-	-
procedures to ensure that the DML is protected form erroneous or unauthorized change ?	-	23A	-	-

Does the Configuration Management Plan include:	-	-	-	-
the context and purpose ?	-	26A	-	-
the requirements ?	-	27A	-	-
the Organization for Configuration Management (responsibilities and owners, etc) ?	-	29A	-	-
the selection and application of processes and procedures to implement Configuration Management activities ?	-	30A	-	-
the relationship management and interface controls ?	-	31A	-	-
When planning the configuration identification, is defined how the classes and types of configuration items are to be:	-	-	-	-
selected ?	-	32A	-	-
grouped ?	-	33A	-	-
classified ?	-	34A	-	-
defined by appropriate characteristics ?	-	35A	-	-
Are the CIs selected by applying a top-down approach ?	-	41A	-	-
Does the organization plan a review of the CI level regularly ?	-	42A	-	-
Does the identification of CIs differentiate between successive versions?	-	44A	-	-
Does this identification enable the items under control to be unambiguously traceable to their specifications or equivalent, documented descriptions ?		45A	-	-
Do the configuration data permit the forward and backward traceability to other baseline configuration states ?	-	47A	-	-
Are naming conventions established ?	-	48A	-	-
Are the naming conventions applied to :	-	-	-	-
the identification of CIs ?	-	49A	-	-
the configuration documents ?	-	50A	-	-
to the changes ?	-	51A	-	-
to the baselines?	-	52A	-	-
Are the naming conventions unique ?	-	53A	-	-
Does the naming conventions include the management of:	-	-	-	-
Hierarchical relationships between CIs within a configuration structure ?	-	54A	-	-
Hierarchical or subordinate relationships in each CI ?	-	55A	-	-
Relationships between CIs and their associated documents ?	-	56A	-	-
Relationships between CIs and changes ?	-	57A	-	-
Relationships between CIs, incidents, problems and known errors?	-	58A	-	-

The attributes to be recorded for each CI, include:	-	-	-	-
the unique identifier ?	-	59A	3C	ITIL/CMMI
the CI type ?	-	60A		
the Name/Description ?	-	61A		
the version ?	-	62A		
the Location ?	-	63A		
the Supply date ?	-	64A		
the licence details ?	-	65A		
the owner ?	-	66A		
the status ?	-	67A		
the supplier/source ?	-	68A		
the related document masters ?	-	69A		
the related software masters ?	-	70A		
the historical data ?	-	71A		
the relationship type ?	-	72A		
the applicable SLA ?	-	73A		
Are the relationships between CIs maintained ?	-	74A	-	-
Are the relationships between CIs and incident records, problem records, known errors and release records, included in CMS ?	-	75A	-	-
Are the baselines referred by a unique version number ?	-	77A	-	-
Do CIs have appropriate controlling documentation or a procedure being followed, when are being:	-	-	-	-
added ?	-	83A	-	-
modified ?	-	84A	-	-
replaced ?	-	85A	-	-
removed ?	-	86A	-	-
Are established policies and procedures that cover:	-	-	-	-
the licence control ?	-	87A	-	-
the Change Management ?	-	88A	-	-
the version control ?	-	89A	-	-
the build control ?	-	91A	-	-
the promotion, migration of electronic data and information ?	-	92A	-	-
taking a configuration baseline of CIs before performing a release in a manner that can be used for subsequent checking against actual deployment ?	-	93A	-	-
the deployment control ?	-	94A	-	-
the installation ?	-	95A	-	-
maintaining the integrity of the DML ?	-	96A	-	-
During the planning stage, is designed an effective configuration control model ?	-	97A	-	-

Is this model implemented in a way that staff can easily locate and use the associated training products and procedures ?	-	98A	-	-
Is the significance of each state defined in terms of what use can be made of the CI in that state ?	-	100A	-	-
When updated, is included:	-	-	-	-
the reason ?	-	103A	-	-
the date-time stamp ?	-	104A	-	-
the person that did the status change ?	-	105A	-	-
Do the activities of status accounting and reporting, include:	-	-	-	-
managing the recording, retrieval and consolidation of the current configuration status and the status of all preceding configurations to confirm information correctness, timeliness, integrity and security ?	-	107A	-	-
making the status of items under Configuration Management available throughout the lifecycle ?	-	108A	-	-
ensuring that changes to configuration baselines are properly documented ?	-	110A	-	-
Do the configuration status record, when created, include details of:	-	-	-	-
service configuration information ?	-	111A	46C	CMMI/ITIL
the service or product configuration ?	-	112A	-	-
the status of release of new configuration information ?	-	113A	-	-
capturing the results from quality assurance tests to update the configuration records ?	-	115A	-	-
Is it checked that the release and configuration documentation is present before making a release ?	-	127A	-	-
Are physical configuration audits carried out ?	-	129A	-	-
In order to optimize the cost and performance of the service assets and configurations, do the measures include:	-	-	-	-
trends in the status of configuration items ?	-	-	91C	-
configuration audit results ?	-	-	92C	-
change request aging reports ?	-	-	93C	-
the percentage improvement in maintenance schedule over the life of an asset ?	-	136A	-	-
the degree of alignment between provided maintenance and business support ?	-	137A	-	-
the assets identified as the cause of service failures ?	-	138A	-	-
the improved speed for incident management to identify faulty CIs and restore service?	-	139A	-	-

the impact of incidents and errors affecting particular CI types ?	-	140A	-	-
the percentage re-use and redistribution of under-utilized resources and assets ?	-	141A	-	-
degree of alignment of insurance premiums with business needs ?	-	142A	-	-
the ratio of used licences against paid-for licences?	-	143A	-	-
the average cost per user for licences ?	-	144A	-	-
the achieved accuracy in budgets and charges for the assets utilized by each customer or business unit ?	-	145A	-	-
the percentage reduction in the business impact of outages and incidents caused by poor Asset and Configuration Management ?	-	146A	-	-
the improved audit compliance ?	-	147A	-	-
the increased quality and accuracy of asset and configuration information ?	-	148A	-	-
the fewer errors caused by people working with out-of-date information ?	-	149A	-	-
shorter audits as quality asset and configuration information are easily accessible ?	-	150A	-	-
the reduction in the use of unauthorized hardware and software ?	-	151A	-	-
the reduction in the average time and cost of diagnosing and resolving incidents and problems (by type) ?	-	152A	-	-
the improvement in time to identify poor-performing and poor-quality assets ?	-	153A	-	-
the occasions when the 'configuration' is not as authorized ?	-	154A	-	-
the changes that were not completed successfully or caused errors because of poor impact assessment, incorrect data in the CMS, or poor version control ?	-	155A	-	-
the exceptions reported during configuration audits ?	-	156A	-	-
the value of IT components detected in use ?	-	157A	-	-
the reduction in risks due to early identification of unauthorized change ?	-	158A	-	-

Appendix E - Final Maturity Model

Maturity Level 1
Do the management team and configuration management decide what level of Configuration Management is required for a certain service or product ?
Is a logical configuration model, representing the relationships between configuration items, established and maintained ?
Does this logical model include information of:
• CI types ?
• CI attributes ?
• CI relationship types ?
• CI relationship attributes ?
• CI status codes ?
Is the selection of the configuration items and the components that compose them based on this documented criterion?
From the configuration items in the configuration management system, are the configuration baselines of a service, application or infrastructure:
• created ?
• released ?
• reviewed ?
formally agreed with Configuration Control Board ?
When a configuration baseline is created:
• are the release records included (current, past and planned) ?
• are the other change records included (current, past and planned) ?
• are the status of the CI and is documentation when a change is approved and implemented, included ?
• are the status of the CI and its documentation when a package release is applied, included ?
• are the standards specifications on the hardware and software involved, included ?
• are the affected business processes and process owners, included ?
Are the changes to CIs identified ?
Are the change requests reviewed with the relevant stakeholders ?
Are the changes to CIs updated appropriately ?
Are the reasons for these changes recorded ?
Whenever needed, are the changes to configuration baselines:
• created ?
• reviewed ?
• formally agreed ?
Are the changes made to the Configuration Management System communicated to CI owners and other stakeholders ?
Are the status changes of CIs:
identified ?
reported against the baseline ?
Do configuration audits check if a change and release records have been properly authorized by Change Management ?
Are reports from configuration management system and according with the stakeholders requirements produced ?
By comparing physical and logical configurations and by using appropriate discovery tools, are periodically the live configuration items verified against the configuration repository ?
Are all the physical configuration items verified, as defined in the repository, if physically exist ?
Are the deviations identified in this verification, reported to management ?
Are the completeness and correctness of items in configuration management system, confirmed and periodically reviewed ?
Are the CIs uniquely identified ?
Is specified when each configuration item is placed under Configuration Management ?
Is the owner responsible for each CI identified ?
Is ensured that are adequate control mechanisms over CIs ?

Are the levels of control based on:
• project objectives ?
• risks ?
• resources ?
Are the configuration items shared and transferred between control levels in the configuration management system ?
Are the archived versions of configuration items stored and recovered ?
Are the configuration management records:
• stored ?
• updated ?
• retrieved ?
Are the contents of the configuration management system preserved by:
• taking and securely stored, backup copies of the CMS regularly ?
• reviewing regularly and change if necessary the retention policy of historical CI records ?
• archiving systematically CI records ?
Is the configuration management structure revised when is necessary ?
Is obtained an authorization from the Configuration Control Board before releasing a configuration item baseline ?
Is the current set of baselines readily available ?
Is the impact of changes and fixes proposed in change requests, analysed ?
Are change requests:
• categorized ?
• prioritized when necessary ?
Are the changes to configuration items controlled throughout the life of the product or service ?
Are methods, to ensure that the configuration data is complete and consistent, established and maintained ?
Do the relevant stakeholders have access to and knowledge of the configuration status of configuration items ?
Is the latest version of baselines specified ?
Are the differences between successive baselines described ?
Are configuration reports made of:
• a list of product configuration information included in a specific configuration baseline ?
• a list of configuration items and their configuration baselines ?
• the details of the current revision status and change history ?
• status and reports on changes, waivers and deviations ?
• the revision status ?
• the report on unauthorized usage of hardware and software ?
• the variations from CMS to physical audit reports ?
Is the integrity of baselines assessed ?
Is confirmed the compliance with applicable configuration management standards and procedures ?
Are the action items from the audit tracked to closure ?
The attributes to be recorded for each CI, include:
• the unique identifier ?
• the CI type ?
• the Name/Description ?
• the version ?
• the Location ?
• the Supply date ?
• the licence details ?
• the owner ?
• the status ?
• the supplier/source ?
• the related document masters ?
• the related software masters ?
• the historical data ?
• the relationship type ?

• the applicable SLA ?
Do the DML include the definitive copies of purchased software ?
Do the DML include the software developed on site ?
Is only authorized media accepted into DML ?
Do the definition of the DML configuration includes:
• the physical location ?
• hardware and software to be used ?
• the naming conventions for file store areas and physical media ?
• environments supported ?
• security arrangements for submitting changes ?
• the scope of the DML ?
• archive and retention periods ?
• capacity plans for the DML and procedures for monitoring growth in size ?
• audit procedures ?
• procedures to ensure that the DML is protected form erroneous or unauthorized change ?
When planning the configuration identification, is defined how the classes and types of configuration items are to be:
• selected ?
• grouped ?
• classified ?
• defined by appropriate characteristics ?
Are the CIs selected by applying a top down approach ?
Does the identification of CIs differentiate between successive versions?
Does this identification enable the items under control to be unambiguously traceable to their specifications or equivalent, documented descriptions ?
Do the configuration data permit the forward and backward traceability to other baseline configuration states ?
Are naming conventions established ?
Are the naming conventions applied to:
• the identification of CIs ?
• to the changes ?
• to the baselines?
Does the naming conventions include the management of:
• Hierarchical relationships between CIs within a configuration structure ?
• Hierarchical or subordinate relationships in each CI ?
• Relationships between CIs and their associated documents ?
• Relationships between CIs and changes ?
• Relationships between CIs, incidents, problems and known errors?
Are the relationships between CIs maintained ?
Are the relationships between CIs and incident records, problem records, known errors and release records, included in CMS ?
Are the baselines referred by a unique version number ?
Is the significance of each state defined in terms of what use can be made of the CI in that state ?
When updated, is included:
• the reason ?
• the date-time stamp ?
• the person that did the status change ?
Does the activities of status accounting and reporting, include:
Managing the recording, retrieval and consolidation of the current configuration status and the status of all preceding configurations to confirm information correctness, timeliness, integrity and security ?
Making the status of items under Configuration Management available throughout the lifecycle ?
Ensuring that changes to configuration baselines are properly documented ?
Does those activities include recording changes to CIs from receipt to disposal ?
Is it checked that the release and configuration documentation is present before making a release ?
Are physical configuration audits carried out ?

Maturity Level 2
Are the reporting requirements from all stakeholders identified ?
The reporting requirements identified include:
• the content ?
• the frequency ?
• the media ?
Are all the deviations that were noted, for approved corrections or actions to remove any unauthorized assets, reviewed ?
Are established policies and procedures that cover:
• the licence control ?
• the Change Management ?
• the version control ?
• cover the access control ?
• the build control ?
• the promotion, migration of electronic data and information ?
• taking a configuration baseline of CIs before performing a release in a manner that can be used for subsequent checking against actual deployment ?
• the deployment control/installation ?
• the maintaining the integrity of the DML ?
Is the plan for performing the configuration management process defined and documented ?
Does the Configuration Management Plan include:
• the applicable policies and standards ?
• the context and purpose ?
• the requirements ?
• the Organization for Configuration Management (responsibilities and owners, etc) ?
• the selection and application of processes and procedures to implement Configuration Management activities ?
• the relationship management and interface controls ?
Is the plan reviewed with the relevant stakeholders ?
Is the plan revised when necessary ?
Are the resources provided, adequate for performing the configuration management process ?
Are the responsibility and authority overall assigned for performing the configuration management process ?
Are the roles and responsibilities of the owner defined for configuration item type, at each stage of its lifecycle ?
The people that are assigned to the responsibilities and authorities understand and accept them ?
Are the people that are performing and supporting the process, trained when needed ?
Are the relevant stakeholders identified to the configuration management process ?
Are the relevant stakeholders involved as planned ?
Are the stakeholders involved in the activity of:
• establishing baselines ?
• assessing the impact of changes for configuration items ?
• performing configuration audits ?
• reviewing results of configuration management audits ?
Is the actual performance measured against the plan for performing the configuration management process ?
Are the accomplishments and results of the configuration management process reviewed against the plan for performing the process ?
In order to identify issues, are the activities, the status and the results of the process reviewed with the immediate level of management responsible for the configuration management process ?
Are the effects of significant deviations from the plan for performing the process, identified and evaluated ?
Are the problems, in the plan for performing the process and in the execution of the process, identified ?
Are corrective actions taken when the process is not being executed comparing with the plan for performing the process ?
Are the corrective action tracked to closure ?

Is objectively evaluated the adherence of the configuration management process against its process description, standards, procedures ?
Does the activities reviewed include the activity:
• establishing baselines ?
• tracking and controlling changes ?
• establishing and maintaining the integrity of baselines ?
With the higher level of management, are reviewed:
• the activities of the process ?
• the status of the process ?
• the results of the process ?
Are automated processes to load and update the Configuration Management database developed and established ?
Does the organization plan the review of the CI level regularly ?
Do CIs have an appropriate controlling documentation or a procedure being followed, when are being:
• added ?
• modified ?
• replaced ?
• removed ?
During the planning stage, is designed an effective configuration control model ?
Is this model implemented in a way that staff can easily locate and use the associated training products and procedures ?

Maturity Level 3
Is an organizational policy for planning and performing the configuration management process, established and maintained?
In the policies established for the process:
• are the objectives that pertain to the configuration management process, established ?
• is the scope for configuration management established ?
• are the principles established ?
• are the Critical Success Factors (CSFs), established ?
Those policies are based on:
• organization's business drivers ?
• contractual and Service Management requirements ?
• compliance to applicable laws, regulations and standards ?
Does the measures and work products used in monitoring and controlling include the:
• number of changes to configuration items ?
• number of configuration audits conducted ?
• schedule of configuration control board or audit activities ?
Does the work products reviewed include the:
• archives of baselines ?
• change request database ?
Are the organization's configuration management process objectives, appropriately addressed in the defined process ?
Are the process measures stored in the organization's measurement repository ?
Is the documentation submitted in the organization's process asset library ?
Are the lessons learned from the configuration management process documented and stored in the organization's configuration management process asset library ?
In order to optimize the cost and performance of the service assets and configurations, does the measures include:
• trends in the status of configuration items ?
• configuration audit results ?
• change request aging reports ?
• the percentage improvement in maintenance scheduling over the life of an asset ?
• the degree of alignment between provided maintenance and business support ?
• the assets identified as the cause of service failures ?
• the improved speed for incident management to identify faulty CIs and restore service?

• the impact of incidents and errors affecting particular CI types ?
• the percentage re-use and redistribution of under-utilized resources and assets ?
• degree of alignment of insurance premiums with business needs ?
• the ratio of used licences against paid for licences?
• the average cost per user for licences ?
• the achieved accuracy in budgets and charges for the assets utilized by each costumer or business unit ?
• the percentage reduction in business impact of outages and incidents caused by poor Asset and Configuration Management ?
• the improved audit compliance ?
• the increased quality and accuracy of asset and configuration information ?
• the fewer errors caused by people working with out-of-date information ?
• shorter audits as quality asset and configuration information is easily acessible ?
• the reduction in the use of unauthorized hardware and software ?
• the reduction in the average time and cost of diagnosing and resolving incidents and problems (by type) ?
• the improvement in time to identify poor-performing and poor-quality assets ?
• the occasions when the 'configuration' is not as authorized ?
• the changes that were not completed successfully or caused errors because of poor impact assessment, incorrect data in the CMS, or poor version control ?
• the exceptions reported during configuration audits ?
• the value of IT components detected in use ?
• the reduction in risks due to early identification of unauthorized change ?

Maturity Level 4
Are the quantitative objectives based on:
• the customer needs ?
• the business objectives ?
Are the quantitative objectives allocated to the process or its subprocesses ?
Is the performance of the subprocesses that are critical contributors to the overall performance of the configuration management process, statistically managed ?
Is the ability of the process to achieve its established quantitative objectives, considering the performance of the subprocesses, predicted ?

Maturity Level 5
Are the configuration management improvements, that would result in measurable improvements to process performance, identified ?
Are the strategies and the deployment management of the selected process improvements, defined based on:
• the quantified expected benefits ?
• the estimated costs and impacts ?
• the measured change to process performance ?
Are the root causes of defects and other problems in the configuration management process, identified?

Appendix F - Questionnaire and Sub-Questionnaire Used in the Interviews

Questionnaire

Assessing the Maturity Level of Configuration Management Process

This questionnaire was developed under an academic investigation. The objective of the questionnaire is to assess the Configuration Management process of several organizations in order to, validate the Maturity Model that this investigation has elaborated and to raise awareness of the interviewed organizations maturity level.

Any personal information treated in this questionnaire, is totally confidential and will not be revealed to anyone.

After the analysis of the questionnaire, will be provided a report of the process maturity.

Thank you in advance for your cooperation.

João Serrano

Information of the Interviewee and the Interviewee Organization

Personal Information

First Name	
Last Name	
Years of Experience	
Organization Position	

Organization Information

Name	
Industry Area	
Multinational Organization	
Employees Number of Organization/ IT Department	

Questionnaire

Activity	Yes	Partial	No	Not Applicable	No Answer	ID
Management Policies and Logical Model						
Policies						
Is an organizational policy for planning and performing the configuration management process, established and maintained?						1P
In the policies established for the process:	-	-	-			-
• are the objectives that pertain to the configuration management process, established?						2P
• is the scope for configuration management established?						3P
• are the principles established?						4P
• are the Critical Success Factors (CSFs), established?						5P
Those policies are based on:	-	-	-			-
• organization's business drivers?						6P
• contractual and Service Management requirements?						7P
• compliance with applicable laws, regulations and standards?						8P
Logical Model						
Is a logical configuration model, representing the relationships between configuration items, established and maintained?						9P
Does this logical model include information of:	-	-	-			-
• Configuration Items (CI) types?						10P
• CI attributes?						11P
• CI relationship types?						12P
• CI relationship attributes?						13P
• CI status codes?						14P

Configuration Management System (CMS)						
General						
Are the archived versions of configuration items stored and recovered?						15P
Is the configuration management structure revised when is necessary?						16P
Are automated processes to load and update the Configuration Management Database developed and established?						17P
Definitive Media Library (DML)						

Does the DML include the definitive copies of purchased software?						18P
Does the DML include the software developed on site?						19P
Is only authorized media accepted into DML?						20P
The definition of DML configuration includes:	-	-	-			-
• the physical location?						21P
• hardware and software to be used?						22P
• the naming conventions for file store areas and physical media?						23P
• environments supported?						24P
• security arrangements for submitting changes?						25P
• the scope of the DML?						26P
• archive and retention periods?						27P
• capacity plans for the DML and procedures for monitoring growth in size?						28P
• audit procedures?						29P
• procedures to ensure that the DML is protected from erroneous or unauthorized change?						30P
Preservation						
Are the contents of the configuration management system preserved by:	-	-	-			-
• taking and securely stored backup copies of the CMS regularly?						31P
• reviewing regularly and change if necessary, the retention policy of historical CI records?						32P
• archiving systematically CI records?						33P

Stakeholders						
Involvement of Stakeholders in the Process						
Are the relevant stakeholders identified to the configuration management process?						34P
Are the relevant stakeholders involved as planned?						35P
Are the stakeholders involved in the activity of:	-	-	-			-
• establishing baselines?						36P
• assessing the impact of changes for configuration items?						37P
• performing configuration audits?						38P
• reviewing results of configuration management audits?						39P

Sub-Process Management and Planning						
Plan of the Configuration Management Process						
Is the plan for performing the configuration management process defined and documented?						40P
Does the Configuration Management Plan include:	-	-	-			-
• the applicable policies and standards?						41P
• the context and purpose?						42P
• the requirements?						43P
• the Organization for Configuration Management (responsibilities and owners, etc)?						44P
• the selection and application of processes and procedures to implement Configuration Management activities?						45P
• the relationship management and interface controls?						46P
Is the plan reviewed with the relevant stakeholders?						47P
Is the plan revised when necessary?						48P
Does the management team and configuration management decide what level of Configuration Management is required for a certain service or product?						49P
Does the organization plan the review of the CI level regularly?						50P
Performing the Process						
Are the resources provided, adequate for performing the configuration management process?						51P
Are the responsibility and authority overall assigned for performing the configuration management process?						52P
The people that are assigned to the responsibilities and authorities understand and accept them?						53P
Process Objectives						
Are the quantitative objectives based on:	-	-	-			-
• the customer needs?						54P
• the business objectives?						55P

Sub-Process Configuration Identification						
CI's Identification						
Is the selection of the configuration items and the components that compose them based on a documented criterion?						56P
When planning the configuration identification, is defined how the classes and types of configuration items are to be:	-	-	-			-
• selected?						57P

• grouped?						58P
• classified?						59P
• defined by appropriate characteristics?						60P
Are the CIs selected by applying a top down approach?						61P
Are the CIs uniquely identified?						62P
Does the identification of CIs differentiate between successive versions?						63P
Does this identification enable the items under control to be unambiguously traceable to their specifications or equivalent, documented descriptions?						64P
Is the owner responsible for each CI identified?						65P
The attributes to be recorded for each CI, include:	-	-	-			-
• the unique identifier?						66P
• the CI type?						67P
• the Name/Description?						68P
• the version?						69P
• the Location?						70P
• the Supply date?						71P
• the licence details?						72P
• the owner?						73P
• the status?						74P
• the supplier/source?						75P
• the related document masters?						76P
• the related software masters?						77P
• the historical data?						78P
• the relationship type?						79P
• the applicable SLA?						80P
Is specified when each configuration item is placed under Configuration Management?						81P
Are the roles and responsibilities of the owner defined for configuration item type, at each stage of its lifecycle?						82P
Are the relationships between CIs maintained?						83P
Are the relationships between CIs and incident records, problem records, known errors and release records, included in CMS?						84P
Baselines						
From the configuration items in the configuration management system, are the configuration baselines of a service, application or infrastructure:	-	-	-			-
• created?						85P
• released?						86P
• reviewed?						87P
• formally agreed with Configuration Control Board?						88P
When a configuration baseline is created:	-	-	-			-

• are the release records included (current, past and planned)?						89P
• are the other change records included (current, past and planned)?						90P
• are the status of the CI and its documentation when a change is approved and implemented, included?						91P
• are the status of the CI and its documentation when a package release is applied, included?						92P
• are the standards specifications on the hardware and software involved, included?						93P
• are the affected business processes and process owners, included?						94P
Are the baselines referred by a unique version number?						95P
Is the current set of baselines readily available?						96P
Is obtained an authorization from the Configuration Control Board before releasing a configuration item baseline?						97P
Does the configuration data permit the forward and backward traceability to other baseline configuration states?						98P
Naming Conventions						
Are naming conventions established?						99P
Are the naming conventions applied to:	-	-	-			-
• the identification of CIs?						100P
• to the changes IDs?						101P
• to the baselines?						102P
Does the naming conventions include the management of:	-	-	-			-
• hierarchical relationships between CIs within a configuration structure?						103P
• hierarchical or subordinate relationships in each CI?						104P
• relationships between CIs and their associated documents?						105P
• relationships between CIs and changes?						106P
• relationships between CIs, incidents, problems and known errors?						107P

Sub-Process Configuration Control						
Changes to CIs						
Are the changes to CIs identified?						108P
Are the change requests reviewed with the relevant stakeholders?						109P
Is the impact of changes and fixes proposed in change requests, analysed?						110P

Are change requests:	-	-	-			-
• categorized?						111P
• prioritized when necessary?						112P
Are the changes to CIs updated appropriately?						113P
Are the reasons for these changes, recorded?						114P
Are the changes made to the CMS communicated to CI owners and other stakeholders?						115P
Are the changes to configuration items controlled throughout the life of the product or service?						116P
Changes to CI Status						
Are the status changes of CIs:	-	-	-			-
• identified?						117P
• reported against the baseline?						118P
Is the significance of each state defined in terms of what use can be made of the CI in that state?						119P
When updated, is included:	-	-	-			-
• the reason?						120P
• the date-time stamp?						121P
• the person that did the status change?						122P
Changes to Baselines						
Whenever needed, are the changes to configuration baselines:	-	-	-			-
• created?						123P
• reviewed?						124P
• formally agreed?						125P
Control Mechanisms						
Is ensured that are adequate control mechanisms over CIs?						126P
Are the levels of control based on:	-	-	-			-
• project objectives?						127P
• risks?						128P
• resources?						129P
Are the configuration items shared and transferred between control levels in the configuration management system?						130P
Policies and Procedures						
During the planning stage, is designed an effective configuration control model?						131P
Is this model implemented in a way that staff can easily locate and use the associated training products and procedures?						132P
Are established policies and procedures that cover:	-	-	-			-
• the licence control?						133P
• the Change Management?						134P
• the version control?						135P
• cover the access control?						136P
• the build control?						137P

• the promotion, migration of electronic data and information?						138P
• taking a configuration baseline of CIs before performing a release in a manner that can be used for subsequent checking against actual deployment?						139P
• the deployment/ installation control?						140P
• the installation?						141P
• the maintenance the integrity of the DML?						142P
Do CIs have an appropriate controlling documentation, or a procedure being followed, when are being:	-	-	-			-
• added?						143P
• modified?						144P
• replaced?						145P
• removed?						146P
Are methods, to ensure that the configuration data is complete and consistent, established and maintained?						147P

Sub-Process Status Accounting and Reporting						
Main Activities of this Sub-Process						
Do the activities of status accounting and reporting, include:	-	-	-			-
• managing the recording, retrieval and consolidation of the current configuration status and the status of all preceding configurations to confirm information correctness, timeliness, integrity and security?						148P
• making the status of items under Configuration Management available throughout the lifecycle?						149P
• ensuring that changes to configuration baselines are properly documented?						150P
• recording changes to CIs to closure?						151P
Reporting Requirements						
Are the reporting requirements from all stakeholders identified?						152P
The reporting requirements identified include:	-	-	-			-
• the content?						153P
• the frequency?						154P
• the media?						155P
Creating Reports						
Are reports from configuration management system and according with the stakeholder's requirements, produced?						156P

Are configuration reports made of:	-	-	-			-
• a list of product configuration information included in a specific configuration baseline?						157P
• a list of configuration items and their configuration baselines?						158P
• the details of the current revision status and change history?						159P
• status and reports on changes, waivers and deviations?						160P
• the revision status?						161P
• the report on unauthorized usage of hardware and software?						162P
• the variations from CMS to physical audit reports?						163P

CI's Records						
Are the CI's records:	-	-	-			-
• stored?						164P
• updated?						165P
• retrieved?						166P
Do the relevant stakeholders have access to and knowledge of the configuration status of configuration items?						167P
Is the latest version of baselines specified?						168P
Are the differences between successive baselines described?						169P

Sub-Process Verification and Audit						
Changes						
Do configuration audits check if a change and release records have been properly authorized by Change Management?						170P
CIs and CMS						
By comparing physical and logical configurations and by using appropriate discovery tools, are periodically the live configuration items verified against the configuration repository?						171P
Are all the physical configuration items verified, as defined in the repository, if physically exist?						172P
Are the deviations identified in this verification reported to management?						173P
Are the completeness and correctness of items in configuration management system, confirmed and periodically reviewed?						174P
Is confirmed the compliance with applicable configuration management standards and procedures?						175P

Is the integrity of baselines assessed?						176P
General						
Are all the deviations that were noted, for approved corrections or actions to remove any unauthorized assets, reviewed?						177P
Is it checked that the release and configuration documentation is present before deploying a release?						178P
Are physical configuration audits carried out?						179P
Are the action items from the audit tracked to closure?						180P
Process Improvement						
Monitoring and Control of the Process						
Is the actual performance measured against the plan for performing the configuration management process?						181P
Are the accomplishments and results of the configuration management process reviewed against the plan for performing the process?						182P
Is objectively evaluated the adherence of the configuration management process against its process description, standards, procedures?						183P
In order to identify issues, are the activities, the status and the results of the process reviewed with the immediate level of management responsible for the configuration management process?						184P
Does the activities reviewed include the activity:	-	-	-			-
• establishing baselines?						185P
• tracking and controlling changes?						186P
• establishing and maintaining the integrity of baselines?						187P
Does the work products reviewed include the:	-	-	-			-
• archives of baselines?						188P
• change request database?						189P
With the higher level of management, are reviewed:	-	-	-			-
• the activities of the process?						190P
• the status of the process?						191P
• the results of the process?						192P
Are the effects of significant deviations from the plan for performing the process, identified and evaluated?						193P
Are the issues, in the plan for performing the process and in the execution of the process, identified?						194P
Are corrective actions taken when the process is not being executed comparing with the plan for performing the process?						195P

Are the corrective action tracked to closure?						196P

Communication and Training						
Are the people that are performing and supporting the process, trained when needed?						197P
Are the lessons learned from the configuration management process documented and stored in the organization's configuration management process library?						198P
Is the documentation submitted in the organization's process library?						199P
Process Objectives and Management of Sub-processes						
Are the organization's configuration management process objectives, appropriately addressed in the defined process?						200P
Are the quantitative objectives allocated to the process or its subprocesses?						201P
Is the performance of the subprocesses that are critical contributors to the overall performance of the configuration management process, statistically managed?						202P
Is the ability of the process to achieve its established quantitative objectives, considering the performance of the subprocesses, predicted?						203P
General Improvement						
Are the configuration management improvements, that would result in measurable improvements to process performance, identified?						204P
Are the strategies and the deployment management of the selected process improvements, defined based on:	-	-	-			-
• the quantified expected benefits?						205P
• the estimated costs and impacts?						206P
• the measured change to process performance?						207P
Are the root causes of defects and other problems in the configuration management process, identified?						208P
Performance Indicators						
Are the Configuration Management process measures stored in the organization's measurement repository?						209P
Does the measures and work products used in monitoring and controlling include the:	-	-	-			-
• number of changes to configuration items?						210P

• number of configuration audits conducted?						211P
• schedule of configuration control board or audit activities?						212P
In order to optimize the cost and performance of the service assets and configurations, does the measures include:	-	-	-			-
• trends in the status of configuration items?						213P
• configuration audit results?						214P
• change request aging reports?						215P
• the percentage improvement in maintenance scheduling over the life of an asset?						216P
• the degree of alignment between provided maintenance and business support?						217P
• the assets identified as the cause of service failures?						218P
• the improved speed for incident management to identify faulty CIs and restore service?						219P
• the impact of incidents and errors affecting particular CI types?						220P
• the percentage re-use and redistribution of under-utilized resources and assets?						221P
• degree of alignment of insurance premiums with business needs?						222P
• the ratio of used licences against paid for licences?						223P
• the average cost per user for licences?						224P
• the achieved accuracy in budgets and charges for the assets utilized by each costumer or business unit?						225P
• the percentage reduction in business impact of outages and incidents caused by poor Asset and Configuration Management?						226P
• the improved audit compliance?						227P
• the increased quality and accuracy of asset and configuration information?						228P
• the fewer errors caused by people working with out-of-date information?						229P
• shorter audits as quality asset and configuration information is easily accessible?						230P

• the reduction in the use of unauthorized hardware and software?						231P
• the reduction in the average time and cost of diagnosing and resolving incidents and problems (by type)?						232P
• the improvement in time to identify poor-performing and poor-quality assets?						233P
• the occasions when the 'configuration' is not as authorized?						234P
• the changes that were not completed successfully or caused errors because of poor impact assessment, incorrect data in the CMS, or poor version control?						235P
• the exceptions reported during configuration audits?						236P
• the value of IT components detected in use?						237P
• the reduction in risks due to early identification of unauthorized change?						238P

Observations

ID	Observation

Questionnaire Assessment

1. What do you think of the questionnaire, in terms of completeness?

Insufficient Sufficient Complete Very Complete

2. If you were to implement a Configuration Management process, from 1 to 10 (1 = nothing; 10 = very useful), how much can the questionnaire help you?

Answer:

_____

_____

_____

_____

3. In your opinion, which are the pros and cons one could face from applying this maturity model in a regular basis?

_____

_____

_____

_____