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AN OVERLAPLESS MATURITY MODEL FOR CONFIGURATION MANAGEMENT

IT departments often encounter challenges due to overlapping practices from various frameworks, leading to unnecessary costs and inefficiencies. Additionally, Configuration Management (CM) processes are frequently implemented poorly, missing out on potential benefits. To address these issues, our research employs a Systematic Literature Review and Design Science Research methodology to develop a comprehensive and non-redundant CM Maturity Model. By integrating frameworks such as COBIT, ITIL, and CMMI-SVC, our model is designed to assist organizations lacking clear improvement strategies, those with inadequately implemented CM processes, or those seeking self-assessment. The model is also beneficial for companies managing multiple standards simultaneously. Managers can utilize this model to evaluate CM maturity before implementing various frameworks. Furthermore, we introduce the concept of "Quick Wins" to accelerate improvement initiatives. This research provides a practical tool for IT professionals to streamline CM processes and navigate the complex landscape of IT frameworks, ultimately leading to more efficient and effective CM practices.

Key words: Configuration Management Process, Maturity Models, IT Services Providers, Design Science Research.

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Конфигурация менеджментіне арналған қабаттасусыз жетілу моделі

IT бөлімдері көбінесе әртүрлі негіздемелік стандарттардың тәжірибелерінің қиылысуымен байланысты қиындықтарға тап болады, бұл артық шығындарға, тиімсіздікке және процестердің қайталануына әкеледі. Сонымен қатар, конфигурациялармен менеджмент процестері (КМ) көбінесе тиімсіз жүзеге асырылады, бұл мүмкіндіктерді жіберіп алуға және ықтимал пайданың төмендеуіне әкеледі. Осы маңызды мәселелерді шешу үшін біздің зерттеуіміз МК жетілуінің кешенді және қайталанбайтын моделін жасау үшін әдебиет пен дизайн ғылымына жүйелі шолу әдістемесін қолданады. COBIT, ITIL және CMMI-SVC сияқты дәлелденген негіздемелік стандарттарды біріктіру арқылы біздің модель нақты жақсарту стратегиялары жоқ, нашар іске асырылған МК процестері бар немесе Мұқият өзін-өзі бағалауды жүзеге асыруға ұмтылатын ұйымдарға көмектесуге арналған. Сонымен қатар, бұл модель бір уақытта бірнеше стандарттармен және жақтаулармен жұмыс істейтін компаниялар үшін өте пайдалы. Менеджерлер бұл модельді әртүрлі негіздемелік стандарттарды енгізбес бұрын МК процестерінің жетілуін бағалау үшін тиімді пайдалана алады, бұл құрылымдық және дәйекті тәсілді қамтамасыз етеді. Сонымен қатар, біз «Жылдам жеңістер» тұжырымдамасын енгіздік, ол жақсарту процесін тез бастауға және МК процестерін жетілдірудің алғашқы кезеңдерінде нақты нәтижелерге қол жеткізуге мүмкіндік береді. Бұл зерттеу АТ мамандарына ат стандарттарының күрделі ортасында бағдарлауды жеңілдететін және конфигурацияны басқарудың тиімдірек және жетілген тәжірибелеріне нақты жол беретін МК процестерін оңтайландырудың практикалық және құрылымдық құралын ұсынады.

Түйін сөздер: конфигурацияны басқару процесі, жетілу үлгілері, АТ-қызмет провайдерлері, дизайн ғылымын зерттеу.

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Модель зрелости для менеджмента конфигурациями без перекрытий

IT-отделы часто сталкиваются с проблемами, связанными с пересечением практик различных рамочных стандартов, что приводит к избыточным затратам, неэффективности и дублированию процессов. Одновременно с этим процессы менеджмента конфигурациями (МК) зачастую внедряются неэффективно, что приводит к упущенным возможностям и снижению потенциальных выгод. Для решения этих критически важных проблем наше исследование использует методологию систематического обзора литературы и дизайн-науки для разработки комплексной и недублирующей модели зрелости МК. Путём интеграции таких проверенных рамочных стандартов, как COBIT, ITIL и CMMI-SVC, наша модель призвана помочь организациям, которые сталкиваются с отсутствием чётких стратегий улучшения, имеют плохо реализованные процессы МК или стремятся провести тщательную самооценку. Более того, эта модель особенно полезна для компаний, работающих с несколькими стандартами и рамками одновременно. Менеджеры могут эффективно использовать эту модель для оценки зрелости процессов МК перед внедрением различных рамочных стандартов, что обеспечивает более структурированный и последовательный подход. Кроме того, мы внедрили концепцию «Быстрые победы», которая позволяет быстро запустить процесс улучшений и получить ощутимые результаты уже на ранних этапах совершенствования процессов МК. Данное исследование предлагает ИТ-специалистам практичный и структурированный инструмент для оптимизации процессов МК, упрощая ориентацию в сложной среде ИТ-стандартов и предоставляя чёткий путь к более эффективным и зрелым практикам менеджмента конфигурациями.

Ключевые слова: процесс менеджмента конфигурациями, модели зрелости, поставщики ИТ-услуг, исследования методами дизайн-науки.

Introduction

In today's rapidly evolving environment, it is imperative for Information Technology (IT) organizations to align efficiently with consumer trends and preferences (Bianchi, 2023). The increasing centralization of IT infrastructures has amplified the role of IT organizations in business development and strategic decision-making (Amorim, 2020; Ertürk, 2015; Henriques, 2020). The presence of numerous internal dependencies and interrelations among systems and services provided by organizations (Bianchi, 2013) has resulted in more complex and extensive IT infrastructures. This complexity, coupled with growing IT system heterogeneity, exacerbates the burden of IT infrastructure management, leading to increased administration costs (Giese, 2010). In this critical landscape, efficient IT performance is essential, as mismanagement can lead to errors and subsequent failures, significantly affecting organizational profitability (Baiôco, 2009; Vanbrabant, 2013; Bianchi, 2019).

The rising value of IT within organizations has spurred significant advancements in the field. In an era where success depends heavily on client satisfaction, addressing client demands and exploring new business opportunities have become crucial. These dynamics have driven substantial progress in IT services, meeting both internal and external organizational client requirements (Ferreira, 2021; Johnson, 2007). The proliferation of service providers has allowed them to capture a significant share of the IT market, becoming increasingly integral to the global economy (Hashmi, 2010). This is further corroborated by the growing importance of digital transformation initiatives across industries (Vial, 2019).

IT services are developed and implemented on an infrastructure composed of thousands of components, ranging from software to hardware, which must be managed in alignment with organizational goals (Hashmi et al., 2010; Madduri et al., 2007). In this competitive and evolving technological landscape (Baiôco et al., 2009), it is crucial not only to manage infrastructure changes due to constant innovation but also to be aware of the risks and impacts these changes can have on the organization (Ali, 2013). Such changes significantly affect system compatibility and configurations, necessitating robust management to prevent service interruptions (Aleksic, 2010; Johnson et al., 2007). Recent studies also highlight the role of IT governance in mitigating these risks by establishing a clear framework for

decision-making and accountability (Weill, 2004; De Haes,2009).

Consequently, there is a need to implement processes that effectively manage the entire IT infrastructure's information (Madduri et al., 2007). Various solutions have been proposed to support this task, creating platforms that enable organizational collaboration in managing infrastructure information and changes (Yang, 2010). Recent studies have focused on the Configuration Management (CM) process and its feasibility as a critical component of IT service management frameworks like ITIL (Information Technology Infrastructure Library) (Axelos, 2019; Jäntti 2019).

The importance of the CM process has been growing (Ali, 2015; Tocto-Cano, 2020), providing essential information to various stakeholders within enterprises (Baiôco et al., 2009; Wang et al., 2022). CM has evolved as a distinct discipline, primarily responsible for managing changes to maintain quality and reduce organizational costs (Fowler, 1996; Lee, 2019). However, to be effective, CM requires both technical and organizational support (Tellioglu, 1996). Despite its critical role, CM is often misunderstood and undervalued by strategic management (Ali, 2013; Limpeeticharoenchot, 2022; Shah et al., 2012). Poorly implemented CM processes can lead to equipment failures or service disruptions, increasing costs and decreasing organizational effectiveness (Choi, 2001). Nonetheless, many industries still struggle with CM implementation (Ali, 2015; Gökalp, 2022). Various authors have proposed best practices, following different standards and frameworks, to enhance the effectiveness and efficiency of CM processes within organizations (Johnson et al., 2007; Serrano, 2020; Ward, 2007). However, as OGC (Office of Government Commerce) notes, the full benefits of these frameworks are only realized when properly integrated with the organization's overall IT strategy (OGC, 2009).

Many of these IT frameworks have been proposed and adopted to achieve organizational objectives (Pardo, et al. 2013). However, organizations often face challenges when implementing multiple frameworks and standards, as they must address "various difficulties, deficiencies, and needs that are not met by using only one methodology" (Gehrmann, 2012). The overlap between these frameworks can become a significant issue, requiring organizations to implement and use several frameworks individually, which increases costs, time, and resource demands (Pereira, 2012; Vicente, 2013). Pardo et al. (2013) indicate that there is still a lack of solutions to address this overlap problem effectively.

To assess organizational practices, many organizations have adopted Maturity Models (MMs) (Haes & Grembergen, 2004; Patas et al., 2013; Uhrenholt et al., 2022), which have become increasingly significant in the IT industry. These models are used not only for evaluation but also for benchmarking and enhancing process capabilities (Proença, 2016). MMs assess an organization's capabilities by assigning a maturity level, representing a sequential path that guides improvement and situates the organization's capabilities within a hierarchical framework. Typically, these maturity levels are structured into five stages, each with specific procedures required to achieve that level (Antunes et al., 2014; Brooks et al., 2015; Carvalho et al., 2018).

However, MMs are often criticized for being too generic (Neff et al., 2014), overly broad (Patas et al., 2013), or not well-defined (Becker et al., 2009). Additionally, Pereira and Serrano (2020) compiled methodologies used by the scientific community to develop MMs, revealing a lack of consensus on a specific methodology. Moreover, most MMs do not adequately address the issue of overlaps, leading to challenges in their practical application (Lahrmann et al., 2011).

As mentioned earlier, IT infrastructures are becoming more critical and increasingly complex, necessitating better control of these environments. Implementing the CM process by "following" the best practices of frameworks can bring efficiency, effectiveness, and more control to an organization (Johnson et al., 2007; Ward et al., 2007). However, many best practices have been criticized for lacking clarity and being overly complex (Ali & Kidd, 2014). Nevertheless, the requirement to implement multiple frameworks and standards can increase costs and time for organizations, as they often overlap (Aguiar et al., 2018; Gehrmann, 2012; Pereira, 2012). Therefore, it is necessary for an organization to have a multiple-model CM approach to address the framework overlap issue. Given the current evidence and the lack of a model that can mitigate these issues, this research aims to create an overlapless Configuration Management Maturity Model (CMMM). To develop the overlapless model, this research adopted the Design Science Research (DSR) methodology, following the guidelines proposed by Becker et al. (2009). The structure of this research is as follows: the next section introduces the related work already developed. Section 3 outlines the research methodology adopted for this investigation. Section 4 details the design and development of the artifact. Finally, the concluding section presents a discussion of the findings and the resulting implications.

Literature review

Configuration Management and Maturity Model

Configuration Management (CM) is a quality-focused process that offers significant benefits by identifying changes and assigning responsibility to those who implement them, thereby maintaining the quality and integrity of services (Aleksandar Aleksic et al., 2010). Organizations in the service industry frequently undergo changes, necessitating a process that not only controls these changes but also maintains IT infrastructure integrity to enhance service development and provision. At the development level, CM can be an essential tool in project delivery strategy by reducing development time and minimizing risks or errors (Ali & Kidd, 2014), ultimately enhancing the quality of the final product (Fowler, 1996). This process serves as a core support tool for organizational operations by reducing delays in development and operations (Ali & Kidd, 2013). Additionally, many enterprises implement CM to ensure that their infrastructure complies with relevant legislation and policies (Baiôco et al., 2009).

The literature indicates that the CM process can deliver several benefits to an organization. It aims to reduce quality and compliance issues by providing critical information, increasing organizational capabilities and resources, and reducing risks. Properly implemented and monitored, CM can provide transparency, integrity, and greater control to enterprises, thereby enhancing service quality and client satisfaction. However, despite its importance, CM often does not receive adequate attention in strategic management (Ali & Kidd, 2013), as evidenced by the limited number of papers in high-quality journals and conference proceedings on the subject.

Poor or non-existent CM implementation can lead to service failures and performance deficiencies (Hashmi et al., 2010), increasing operational costs and reducing effectiveness and quality (Choi & Bae, 2001). Comparing the benefits of proper CM implementation with the losses from poor implementation underscores the importance of having a robust CM process and an improvement plan for organizations.

In immature organizations, processes are often improvised and implemented in an ad-hoc manner, making it challenging to derive benefits from them. Without a process improvement plan, achieving quality products becomes problematic. Conversely, mature organizations with constantly updated processes can achieve higher quality products and maintain better control over their projects and infrastructures (Reis, Mathias, & de Oliveira, 2017).

Maturity Models (MMs) can help immature organizations become more robust and sus-tainable. These tools support organizations by assessing their current process state and defining an improvement path (Achi et al., 2016). MMs help organizations adapt to their environment, become more agile (Mettler & Rohner, 2009), identify strengths and weak-nesses, and improve process quality (Achi et al., 2016), ensuring lower costs and quicker process execution (Hamel, Herz, Uebernickel, & Brenner, 2013).

Literature shows that MMs are being developed across various domains. In IT, these tools have contributed to creating best practices (Proença et al., 2013), aiding IT management (Curry et al., 2013). IT management practices are critical to IT business (Curley et al., 2008), necessitating these practices to reach their highest maturity level according to organizational objectives.

Using best practices following standards and frameworks in the IT service domain can significantly enhance organizational performance (Knahl, Bayro-Corrochano, & Hancock, 2013). Studies involving organizations that use frameworks like Capability Maturity Model Integration (CMMI) and Information Technology Infrastructure Library (ITIL) show that as process maturity levels increase, organizations experience more benefits and fewer issues, positively impacting business performance, profitability, and competitive leverage (Marrone & Kolbe, 2010, 2011; Salman, Daim, Raffo, & Dabic, 2018).Despite the benefits, the improvement process with MMs is slow and can take years to achieve a higher maturity level and realize the benefits (Jiang, Klein, Hwang, Huang, & Hung, 2004).

Considering the significant losses an organization may incur by undervaluing the Configuration Management (CM) process and the necessity to enhance this process through a strategic improvement plan, implementing a Maturity Model (MM) proves to be a viable solution. By analyzing the benefits and objectives of both the CM and MM domains, it becomes clear that the MM domain enhances the CM process by evaluating its current state and providing a structured improvement path, thereby transforming it into a robust and mature process. Consequently, the development of a Configuration Management Maturity Model (CMMM) based on established frameworks can serve as a crucial tool for organizations, delivering numerous benefits and mitigating the issues associated with an immature CM process.

Related Work

Configuration Management (CM) plays a crucial role in Information Technology (IT) and software

development processes. This research aims to develop a comprehensive Configuration Management Maturity Model (CMMM) grounded in widely recognized IT frameworks. Despite the limited number of Maturity Models (MMs) following this approach, this chapter presents similar MMs developed by the scientific research community to date.

Niknam et al. (2013) addressed the absence of roadmaps guiding organizations in assessing their CM process maturity level by developing a CMMM within the Product Lifecycle Management (PLM) domain. Their model evaluates CM process maturity in scientific facilities, helping identify gaps and improve processes. Through state-of-the-art analysis and examination of current maturity models and standards, they identified critical CM activities and dimensions, resulting in a final MM with four maturity levels (Niknam et al., 2013).

In the medical device industry, Caffery and Coleman (2007) developed a MM to address compliance with directives and the necessity for maintaining historical records of software components used in device development. Their research compared medical device regulations with best practices in the CM process area of the CMMI model, resulting in a MM with five maturity levels (Caffery & Coleman, 2007).

Given the scarcity of CM-specific MMs, this chapter also explores various MMs with similar approaches. Pereira and Mira (2010) developed a MM to assist organizations in assessing their ITIL implementation and creating an improvement roadmap. Based on the IT Service Capability Maturity Model (ITSCMM) and the Capability Maturity Model Integration for Services (CMMI-SVC), their model features both continuous and staged models with five maturity levels each (Pereira & Mira, 2010).

Lã (2011) developed a MM to help IT service providers analyze their IT service strategy by relating IT management practices with IT service management (ITSM) practices. This model integrates the COBIT, ITIL, and CMMI frameworks and comprises five maturity levels (Lã, 2011).

Machado et al. (2012) created a MM compliant with ISO/IEC 20000, CMMI-SVC, the Brazilian program Melhoria do Processo de Software Brasileiro (MPS.BR), and ITIL practices. Their model, aimed at supporting IT service providers in improving IT service management, features seven maturity levels (Machado et al., 2012).

Niessink and van Vliet (1998) developed a MM focusing on service providers, aiming to help organizations assess their capabilities and provide a service capability improvement path. Based on the CMM, this model includes five maturity levels (Niessink & van Vliet, 1998).These various MMs demonstrate the ongoing efforts in the scientific community to address maturity assessment and improvement in different IT-related domains, providing valuable insights for the development of a comprehensive CMMM.

Table 1 – Related Maturity Models Proposed in the Literature

Source	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 et al., 2012)	Services	IT organizations	Management practices overall	Ad-Hoc	Ad-Hoc	Treated	ISO/IEC 200, CMMI-SVC, MPS. BR, ITIL	7

Continuation of the table

Source	Scope	Area	Directed to	Methodology adopted	Guidelines Adopted	Frameworks overlap	Based on	Maturity Levels
(Niknam et al., 2013)	PLM	Scientific facilities	CM process	Ad-Hoc	(Bruin, Freeze, & Rosemann, 2005)	Treated	CMMI, SPICE-BOOTSTRAP, PMMM, SECM. Quality and management standards: IAEA, ISO 9000-3, 12207, 9001, 10007:2003, EIA-649-B, MIL-STD-3046.	4
(João Aguiar, Pereira, Vasconcelos, & Bianchi, 2018)	Services	IT organizations	IM process	DSR	(Becker et al., 2009)	Treated	ITIL, COBIT, CMMI	5
Note – compiled by the authors								

On the other hand, the research (João Aguiar, Pereira, Vasconcelos, & Bianchi, 2018) created an overlapless MM, focused on IT service management, more precisely on the Incident Management (IM) process. This MM was developed by eliminating all the overlapped IM process activities of the ITIL, COBIT, and CMMI frameworks. The MM 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 1. Despite the fact that two MMs already exist for the CM process, they do not have the scope on IT Services and are not concerned with the framework's overlap problem. To this day, no articles of any MM creation that take aim of these concerns were found. Nevertheless, models were found that have the focus on improving and assessing the practices of IT service providers, which demonstrates that IT services start to be an area of concern, especially the consideration that process's improvement is an important strategy that IT service providers should implement.

Given that no MM for CM processes has been discovered that solves the above listed difficulties, the development of this model can contribute to the scientific community by assisting IT providers in «adding value» to their CM processes. This methodology can help IT firms evaluate their CM process and design an improvement route that leads to increased profit and improved control over their IT infrastructure. Because the construction of this model solves the overlap problem of numerous frameworks, this MM can assist to reduce the expenses associated with the need to apply various frameworks in order to comply with environmental legislation and politics.

Following Table 1, the investigation ('An Overlapless Incident Management Maturity Model for Multi-Framework Assessment (ITIL, COBIT, CMMI-SVC)', 2018) was the most "completed" in terms of methodology adoption, since the guidelines and the methodology were both established and described by the authors. The Becker et al. (Becker et al., 2009) guidelines are instructions specific to develop MMs. The DSR methodology already aims to provide generic steps to develop an artefact. It seems that the adoption of these methodologies can be possible and make the investigation more complete and sustained by the scientific «tools».

This research intends to follow the same approach done for the IM process, with the difference that the development of this MM focuses on the CM process. The explanation and review of both methodologies is described in next sections.

Methodology

This research decided to address the problem found by adopting the Design Science Research – DSR methodology (Peffers, Tuunanen, Rothenberg-

er, & Chatterjee, 2007), complemented with Becker et al. guidelines (Becker et al., 2009). This section reveals the methods and the methodology adopted to develop the artefact.

Design Science Research

Design is a fundamental process to the 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 its flexibility in any area. In fact, this methodology is constantly evolving (Peffers et al., 2007), and is specialized for specific areas.

Hevner et al. (Hevner et al., 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 (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 (Peffers et al., 2007), as the research methodology . This methodology is composed of six activities.

Becker Guidelines

Becker et al. guidelines (Becker et al., 2009) are descendant of the DSR methodology since for the development of this procedure model, they are based on the seven guidelines of the DSR established by Hevner et al. (Hevner et al., 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.

Design Science Research and Becker Guidelines

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 (Becker et al., 2009). Several steps of both methodologies are the same since Becker et al. instructions are descendant of DSR methodology. However, with the facts referred and in the point of view and interpretation of this research, the conjunction of both methodologies makes perfect sense: the Peffers methodology as the main methodology, and Becker et al. guidelines (Becker et al., 2009) 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 3 shows the relation between them.

By observing Figure 3, it 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 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 performed in the middle of both phases, these steps were added;
- The same occurred with the "Implementation of Transfer Media" and "Evaluation" Becker guidelines phases. The evaluation of the MM and the results discussion will be in this section;
- The process iteration only 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 techniques merged, the "final methodology" followed by this research contains eight steps, each of which is discussed in the corresponding section, as illustrated in Figure 1. The last phase will involve the publication of a scholarly article.

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

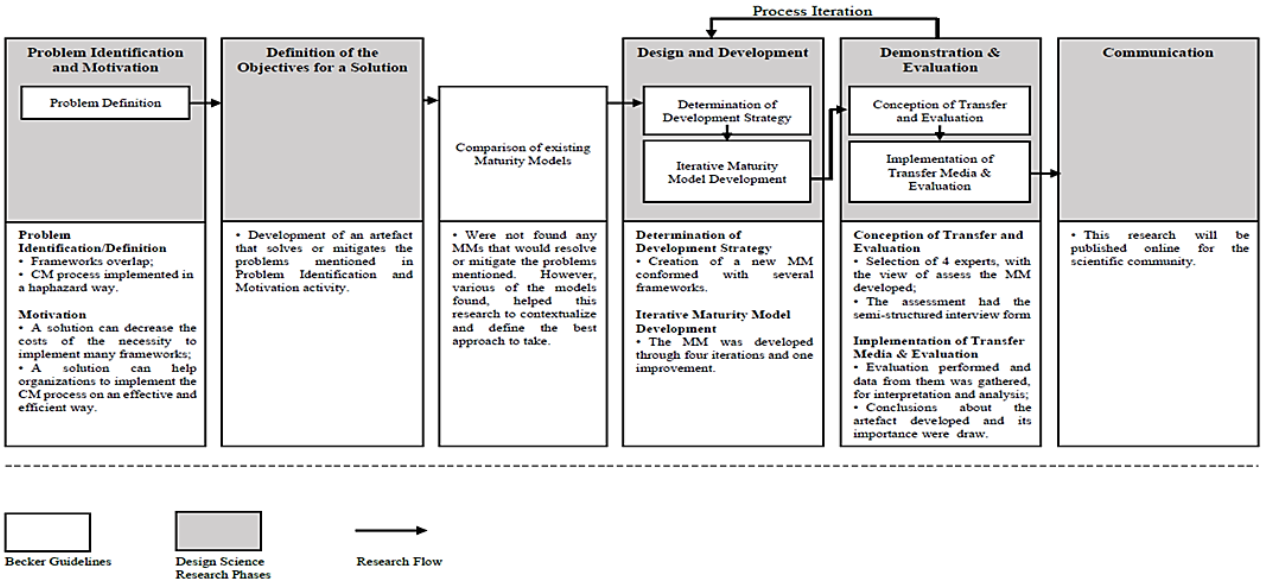

Figure 1 – Design Science Research Activities with Becker Guidelines Followed in this Research
Note – compiled by the author based on the source (Becker et al., 2009) and (Peffers et al., 2007)

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 et al. (Becker et al., 2009) defends that three types of strategies exist: 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 one of the strategies mentioned by Becker would be adopted. As described earlier, this investigation did not find any MM that would resolve the problems defined, so this investigation addressed the problem by developing a new MM.

To develop the MM, this research followed three frameworks: COBIT 5, CMMI-SVC 1.2 and ITIL v3. These frameworks were chosen 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 COBIT, CMMI-SVC, ITIL frameworks and that would address the overlap problem.

Iterative Maturity Model Development

Becker guidelines focus on an iterative process for the development of MMs, that is, for the creation of a MM it 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 the extraction of the process activities of each framework; at this point and along with all the activities extracted, the elimination of the overlapped activities was performed; 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 2.

First Iteration: Activities Extraction

The authors decided that the final MM would be constituted of practices in the form of a question that was called an "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 it 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, two "types" of activities were defined: 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 2.

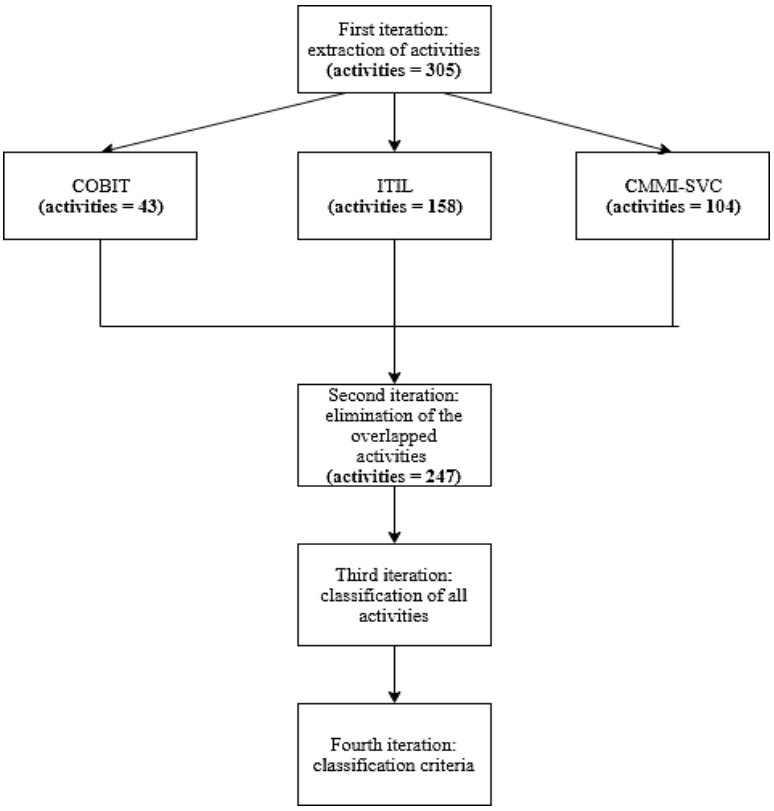

Figure 2 – Flow of the Maturity Model Development
Note – compiled by the authors

Table 2 – The Two Types of Question

Activity extracted from Frameworks	Assessment Question	Type	Number of Activities
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?	Single question	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.)	Are the quantitative objectives based on: • the client needs? • the business objectives?	Multiple questions	2
Note – compiled by the authors			

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

Second and Third Iterations: Overlapped Activities Elimination and Activities Classification

With all the activities extracted it was necessary to eliminate those that were overlapped. In order to remove all the duplicated 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 3. Altogether, after the elimination, 247 activities remained which correspond to the elimination of 19% of the total activities (58 activities were merged).

Table 3 – 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?
Note – compiled by the authors			

Being this MM of the CM process area, the activities were not organized by dimensions, being this tool a non-dimensional MM. Thereafter, this investigation proceeded with the activity's classification stage. By classifying the final activities, the MM was completed. This step followed the Capability Maturity Model (CMM) described by the CMMI-SVC framework, which is composed of six maturity levels. 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.

Fourth Iteration: Classification Criteria

With the purpose of adapting this MM to the "practical environment" that IT Service Management is, it 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, it seems to this research that this number is a suitable percentage since that it is not too hard or too easy to achieve.

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 4. In total, 16 questions were changed. The support tool remained with 238 activities, which makes a total of 4% of activities reduction.

Table 4 – 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
Note – compiled by the authors		

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

- Not applicable: The activity for the organization is not worth implementing 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 interviewee 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.

Results and discussion

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.

Conception of Transfer and Evaluation

In several occasions, in the MMs development area, 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, it 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, it was decided to use the MM in a questionnaire format, where the questions were the activities that MM is composed of, as described in the previous chapter. 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 a 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, it 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 the 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, of either 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 at, with a CM process implemented, semi-implemented or with a plan for the implementation of this process. In the end, a sub-questionnaire was developed to evaluate the MM overall.

Implementation of Transfer Media & Evaluation – Organization A

In the first organization three semi-structured interviews were conducted, with three experts in the ITSM area. The information of the interviewed is visible in Table 5.

Table 5 – 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
Note – compiled by the authors					

The organization of these experts is from the banking area, which already has several processes implemented, providing a stable structure and services for their internal and external clients. The details of this organization are visible in Table 6.

The interviews had on average a 58 minute 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

Table 6 – Information of the Organization A

Industry Area	Multinational Organization	Number of Organization Employees	Number of Organization IT Department Employees
Banking	No	5000	150
Note – compiled by the authors			

Organization A – Demonstration

Organization A does not have the CM process formalized however, this enterprise gave internal priority to other processes, having a variety of activities related with the activities proposed by the process in study. 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, it was settled that the assessment process would follow the questionnaire of the interviewed E1, given that he has more years of experience 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 4.3. The E2 and E3 just provided feedback on the overall MM.

Considering that this enterprise does not have the process formalized already and is fragmented, 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 3.

By looking at Figure 3, it is feasible to conclude that 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, it seems to be a good start and a robust "foundation" to begin the formalization and adoption of the CM process good practices.

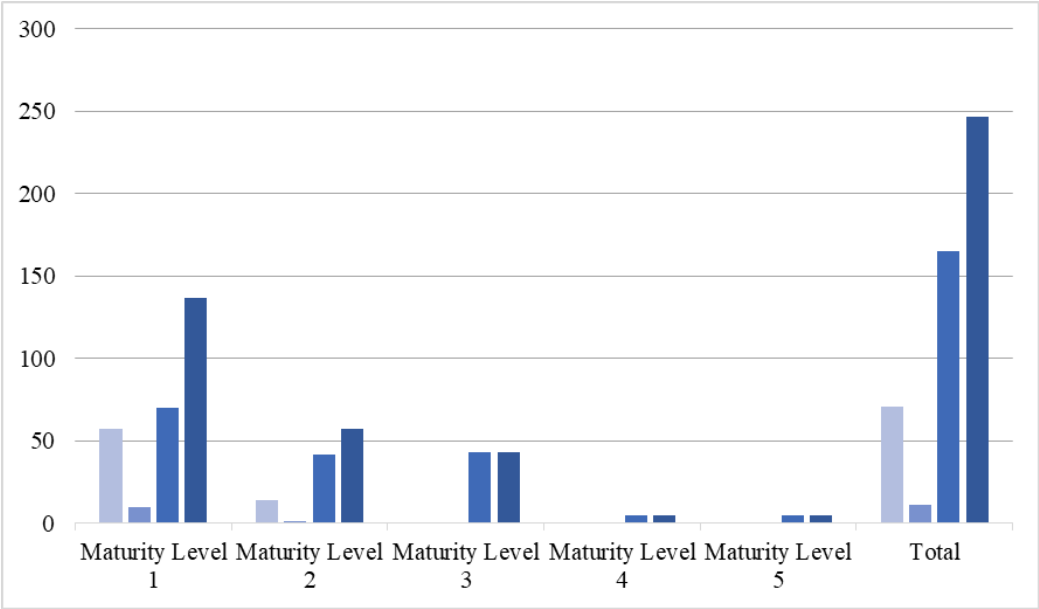

Figure 3 – Activities Already Implemented by Organization A
Note – compiled by the authors

Organization A – Evaluation

As previously stated, it was important to evaluate the MM, reflecting it in the questionnaire, since a range of companies was not found 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:

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

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 ?;

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

All the answers given to this sub-questionnaire are presented in Table 7.

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 organization A found the questionnaire useful and complete, allowing management to have a tool for decision support.

Table 7 – 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.	
Note – compiled by the authors				

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 organization A found the questionnaire useful and complete, allowing 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 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 organizations fully applied this MM, it could bring risks and monetary costs. With the same opinion was the expert E4, who evaluates this MM as very detailed which has 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 easily guide through the process implementation and evaluation.

Although, it 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.

Implementation of Transfer Media & Evaluation – Organization B

After the assessments done by the experts from organization A, a fourth interview was conducted 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 8.

This expert's organization is from the IT area and has the CM process already implemented and consistent. The information of organization B can be seen in Table 9.

Table 8 – 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
Note – compiled by the authors					

Table 9 – Information of Organization B

Industry Area	Multinational Organization	Number of Organization Employees	Number of Organization IT Department Employees
IT	Yes	100	800
Note – compiled by the authors			

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

Organization B – Demonstration

Organization B was in contrast with organization A, for having 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, the evolution that the CM took and the benefits of transferring the "control" to third-party tools was discussed. All the activities that are implemented, are visible in Figure 4. The other two options of answer are not presented in Figure 4 since they were not chosen in any question.

By observing Figure 6, it can be declared that 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 more mature process since it 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 are levels 4 and 5 where organization B has 80% and 60%

of activities applied respectively. Which reveals that this company already has a big concern with this process, trying to optimize and measure 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 favorable position to easily improve the process itself.

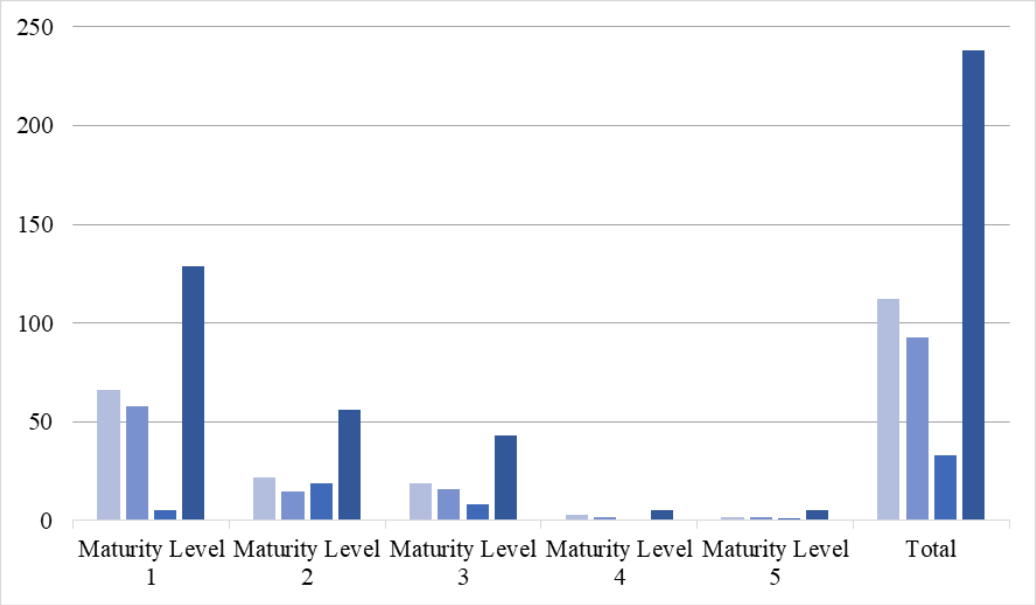

Figure 4 – Activities Already Implemented by Organization B
Note – compiled by the authors

Furthermore, with the support of the MM developed in this investigation, it is possible to visualize that 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.

Organization B – Evaluation

The expert from organization B was very critical, considering the MM as a tool that would not be useful for an organization that already has 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 observed in Table 10.

Table 10 – 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.
Note – compiled by the authors				

Interviews Conclusions

Taking into account all the feedback provided by the experts, 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 do 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 better control;
- For organizations that 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, overall, received good feedback in the interviews, the evaluation had a lack of scientific criterion, since the suggested improvements of the first interviewee were not assessed by the others in a bi-directional discussion. In an attempt to mitigate as much as possible this lack of scientific rigor, several times in the interviews the experts were asked if they agreed with the improvements suggested by 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 the chapter of the Introduction, 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 to a "stable version". In terms of the frameworks overlap issue, this MM can help mitigate this problem in various situations, by extracting the best insights of each framework removing the necessity to implement several standards.

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 the 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. This research decided that it would address the development by adopting the DSR as a research methodology. An analyzation of the COBIT 5, CMMI-SVC 1.2 and ITIL v3 frameworks was made and in total 247 activities were extracted 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, four semi-structured interviews were conducted 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, in only one interview were improvements to the questionnaire provided. The other three interviews contributed with overall questionnaire feedback, characterizing the questions as understandable and well designed.

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

- In IT organizations where their focus is the IT industry and already have 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 already have 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 creation 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 conclusion, 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 any idea of how to improve the process and companies that have the process applied in a careless way, and for CM process self-assessment.

Furthermore, it can be a feasible option for organizations that need to have several standards implemented.

For future work, a robust and thorough MM validation should be done, where the objective would be to measure the medium and long term 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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