A Harmonization with CMMI-SVC Practices for the Implementation of the ITIL Service Design Coordination Process

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***Abstract*—This paper proposes a strategy for the harmonization of the Information Technology (IT) service management framework, the Information Technology Infrastructure Library (ITIL) framework, and the process improvement model for service used in the IT industry, called the Capability Maturity Model for Service (CMMI-SVC). The focal point of this harmonization lies in the Design Coordination process included in the ITIL Service Design, which seeks to ensure that the design consists of appropriate services and coordinates all the design features involved in projects, changes, suppliers and support teams. The results of the harmonization were checked step by step (in a procedure that included a peer review) with the assistance of a specialist with a knowledge of the ITIL framework and the CMMI-SVC model. Hence, the aim of this work is to correlate the structures for these standards and thus obtain the benefits of being able to reduce the time and costs through a joint implementation and also to stimulate the implementation of several models designed for IT service management. Thus, the main contribution made by this paper is that it finds a way of implementing ITIL practices through the adoption of the organizational process assets included in CMMI-SVC. This form of implementation was evaluated by specialists with an expert knowledge of both frameworks and adjustments were requested before the final version was completed for this work.**

Keywords-service management; information technology services; IT organization; service management model; ITIL; CMMI-SVC; harmonization.

I. INTRODUCTION

In recent years, both public and private organizations, (regardless of their size), have increased their demand for IT services to achieve their strategic goals. This paradigm has led the IT area to be seen as a strategic partner of businesses by enabling them to act in a competitive way. As a result of this change, there is a need to improve standards when providing these IT services, by employing methodologies to guide their implementation and management. Since they are based on best practices, this has enabled companies to achieve successful results [1].

Several standards of best practice (including proprietary knowledge, norms, models and frameworks designed for IT service quality management) are available in the market, such as the ITIL framework [2], International Organization for Standardization / International Electrotechnical Commission (ISO / IEC) 20000 [3], CMMI-SVC [4] and Control Objectives for Information and Related Technology (COBIT) [5].

According to the Information Technology Service Management Forum (itSMF) UK [1], the ITIL framework offers the following benefits: a) providing value to customers through IT services, b) integrating a strategy for services for business and customer needs, and c) measuring, monitoring, optimizing and reducing the cost of IT services. Companies such as IBM, Microsoft, HP and HSB are success stories in the adoption of the ITIL framework and in the 2011 edition of itSMF. There are 5 stages in the service lifecycle; each stage has a book of its own, together with 26 processes and 4 functions, which assist in achieving the purposes and goals of each stage.

In contrast, the CMMI for Services (CMMI-SVC) [4] is focused on the processes of service companies that are designed to help these companies know and improve their IT service processes. According to the CMMI Institute, until now (2017), their assessment shows that 549 companies have been using this maturity and capability model.

Many organizations see the need to adopt two or more IT best practice models or frameworks to improve efficiency and effectiveness in providing suitable IT services and thus ensure the organization's survival and success in the competitive global market. A set of models or frameworks (rather than just one) is used because when implemented in isolation they may not be able to fully cover all the needs of an organization by improving its IT services. Regardless of differences in concept and structure, IT best practice frameworks and models are not in principle incompatible, which means that they can be combined to improve the organization's IT service management. Hence the challenge of implementing IT service management through more than one standard of best practice, can be overcome by means of harmonization. This task will help to establish the similarities and differences between the models discussed in this paper [6]. The harmonization technique is widely used and accepted by the regulators as a means of enhancing the quality of the products and services provided and managed by the IT organization.

The research question raised in this work is about how ITIL (the IT service quality framework) and CMMI-SVC

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(the process quality model) can lead to an organizational improvement in an integrated way, by making use of the assets (practices, processes and other features) that these standards have. In this way, this research is driven by the need for materials that can guide the implementation process of the multi-models (ITIL and CMMI-SVC) in companies through the provision of assets to determine their strengths and weaknesses. It is also the purpose of this research to show the relationship between the ITIL framework and the CMMI-SVC quality model, by harmonizing their characteristics to show the level of adherence between their structures and supporting the organizations that wish to implement the framework and model together. Thus, the description of the main goal concerns the application of the practices defined in the quality models for IT service management.

The scope of the business / scientific problem and its challenges is revealed by the number of existing models that are designed to improve the quality of IT services. The harmonization can help to identify the common features of these models by providing the area responsible for the organization's IT service management with an instrument to guide the joint implementation of their practices. In this way, time and costs can be reduced and value delivered to the customers by means of the IT quality services. Thus, the best means to solve this problem is to determine how many of the assets (practices, processes and other factors) that are needed to support the implementation of different standards, can be applied together in the area responsible for the organization's IT service management.

This paper discusses the details of the harmonization of the Design Coordination process included in the ITIL Service Design, together with the process areas of the CMMI-SVC model. In describing the similarities and differences between the models, structures and the coverage criteria, an evaluation has been carried out to validate the correctness of the harmonization between the model and the framework. Thus, the purpose of this work is to design an instrument that can guide the joint implementation of the practices contained in both standards (ITIL Service Design and CMMI-SVC), and explain which CMMI-SVC strategies could be used to implement the ITIL set of practices. This harmonization does not aim to show the mapping between the assets but rather the coverage of ITIL obtained from the implementation of CMMI-SVC.

Several issues need to be addressed in this research, including how the nature and scope of the problem investigated are related to the IT service quality and the improvement of the IT service and process. It also involves attempting to ensure that the service improvement can take place during the IT service lifecycle.

The ITIL Service Design lifecycle consists of 8 processes. The choice of the Design Coordination process for this study, was based on the fact that this process seeks to ensure that the goals and objectives of the stage are met. It also provides and maintains a single point of coordination and control for all the activities and processes at this stage of the lifecycle.

It is hoped that the results of this research will: a) reduce the costs of organizations with joint implementation models, b) overcome the problem of inconsistencies and conflicts between the adopted standards, and c) reduce the costs incurred through this type of multi-model implementation. The difficulty is how to harmonize the ITIL framework with the CMMI-SVC model, as defined by different organizations and decide which practices should be integrated. Finally, this research is constrained by the fact that it is only focused on one process - Design Coordination - which is a part of the ITIL Service Design (although the harmonization of other processes included in the ITIL Service Design are available at the "SPIDER - Software Process Improvement: Development and Research Project SPIDER") and because only one expert has been invited to evaluate this harmonization.

The harmonization of ITIL with CMMI-SVC is significant because both standards include assets for the implementation of the IT process improvement. This means that an organization that is interested in this subject can implement an organizational improvement program with the good practices of different models. For this reason, it is clear that an organization that wishes to achieve this level of improvement, could derive the benefits of being able to reduce the costs and time of an individual implementation of each model, even though it could also carry out a joint implementation. With regard to the Design Coordination process, it is useful for an organization to move from a managed maturity level to a defined maturity level where the processes become standardized, structured and institutionalized.

This paper is structured as follows. Section II examines some related work that harmonize the two standards for IT service management and discusses in detail the fundamental principles of the two standards selected for this research study. Section III describes the harmonization between the Design Coordination process included in the ITIL Service Design and the practices in the CMMI-SVC process areas, as well as examining the evaluation undertaken for this research and the guidelines on how harmonization should be used. Finally, Section IV concludes the paper with some final considerations, including the results obtained and the limitations of this research, followed by some suggestions for possible future work.

II. RELATED WORKS AND BACKGROUND

This section provides an overview of the concepts of the CMMI-SVC model and the ITIL framework and some related works.

A. Related Works

Bridges and Albuquerque's work [7] set out a hybrid model based on equivalences found between the Service Availability and Continuity Management areas of Information Technology Services Management (ITSM) and the guides for service management, such as CMMI for Services, COBIT, ISO 20000, ITIL and Brazilian Software

Process Improvement (MPS.BR). These are concerned with encouraging the use of a quality improvement model in both areas (harmonically), with a view to consulting the Database of a Supplemental Health Operator in Brazil.

In [8], Ali, Soomro and Brohi mapped some ITIL processes for similar processes in IT standards and best practices in IT services: COBIT, ISO / IEC 27002-2005, Six Sigma, The Open Group Architecture Framework (TOGAF), enhanced Telecom Operations Map (eTOM), CMMI, Payment Card Industry Data Security Standards (PCI DSS) and the Common Security Framework (CSF). This mapping found similarities that enable the simultaneous implementation of ITIL in conjunction with these standards and norms in organizations and thus improve the productivity of business and IT services. Although this work took account of the harmonization between ITIL and CMMI, the CMMI model that was used was CMMI for Development (CMMI-DEV), which is concerned with software development and not IT process management, which is the focal point of the good practices in ITIL and CMMI-SVC used in this paper.

In a study by Pardo *et al.* [9], an integrated model is devised that harmonizes multiple approaches related to IT Governance for the Banking sector, including the Technology Governance Model for Banking (ITGSM). This involved six models and norms, namely Basileia II, COBIT 4.1, RISK IT, VAL IT, ISO 27002 and ITIL V.3, and these were integrated in pairs in an interactive and incremental way to create the ITGSM model. As a result, benefits were obtained for banking organizations, on the basis of a system that harmonized these models and norms.

Espindola and Audy [10] adopt an evolutionary approach to integrate quality models, which define a method that systematically executes a meta-model in Unified Modeling Language (UML). This is based on the features included in the mapping table for a quality framework and several models (CMMI, ISO / IEC 15504, ISO / IEC 20000 and COBIT). As a means of confirming the applicability of the method, the Reference Model of Brazilian Software Process Improvement (MR-MPS) quality model was added to validate if the addition of a model that had not been used in the development of the meta-model, was able to ratify it.

Kusumah, Sutikno and Rosmansyah [11] carried out a case study in an organization called INTRAC, which introduced the Model Design of Information Security Governance Assessment with Collaborative Integration of COBIT 5 and ITIL. This integration was, as far as possible, aimed at eliminating risks and their effects on the organizations, in situations where this had previously been fully ensured through the use of a single standard such as ISO / IEC 27001:2009 and ISO / IEC 27002:2005.

Finally, Garcia, Oliveira and Salviano [12] show the mapping between CERTICS (a national Brazilian model) and CMMI-DEV (an international model), in a situation where the main purpose of harmonization was to improve the area of Information Technology Competence Management of CERTICS. Each stage was evaluated by a specialist in the CERTICS and CMMI-DEV models, 1) to ensure the methodology had been formulated correctly, 2) to ensure the methodology was being employed correctly and 3) to ensure it was appropriate to have this kind of methodology. The main value of this was the reduction of time and costs during the implementation and, in particular, theability to implement several joint projects in the software development.

Organizations can find a wide range of best practices in the frameworks and models available which can lead to improvements in their processes and make their businesses profitable, by attracting companies and customers in very different areas. These frameworks and models have some similarities, strengths and weaknesses. A notable feature of the related work on the harmonization of these practices is that they enhance the organizational processes in business, without the need to employ a large number of quality models, since they are harmonized. As a result of this harmonization, the regulatory agencies of these standards, models and frameworks can find failings in their good practices and correct them in their quality models.

B. The ITIL Framework

ITIL is a public framework owned by AXELOS (a joint venture set up in 2014 by the Government of the United Kingdom and Capita) and based on best practices i.e., “activities or processes that have proven to be successful when used in many organizations” [2], that are widely recognized in the world for IT service management (ITSM). The ITIL Library is made up of a set of 5 books, one for each stage of the service lifecycle, where IT services effectively contribute to the best practices that can be adopted and adapted. It depends on the need and convenience of each organization to obtain business value. “Stages of the lifecycle work together as an integrated system to support the ultimate objective of service management for business value realization” [2].

The ITIL framework and its 5 service lifecycle stages consist of a core publication, which provides a set of best practice guidelines for each stage. This model provides an insight into the service stages from conception to retirement. When each stage is examined, a set of processes and activities can be found for planning each objective in a sequence. The stages of the lifecycle are as follows:

- **ITIL Service Strategy** - this formulates IT strategies and plans that must be appropriately aligned to the business and determine which services the provider must offer to meet the needs of customers or businesses,
- **ITIL Service Design** - at this stage, the design of appropriate and innovative IT services, including their architectures, processes, policies and documentation, to meet current and future agreed business requirements,
- **ITIL Service Transition**, - this aims at transferring

a new or changed service to the work environment in a controlled way,

- **ITIL Service Operation -** this is responsible for keeping the service within the work environment in a good operational condition and ensure that users and customers are satisfied with the efficient operation of the service, and
- **ITIL Continual Service -** this provides improvements in services and processes to maintain the value of the service for the customer and business.

Each stage of the ITIL lifecycle has a set of structured processes with activities to achieve a particular goal. The processes start with defined triggers and inputs, which result in defined outputs [2]. The processes of the ITIL Service Design domain are:

- **Design Coordination**, a process that aims at ensuring that the goals and objectives of the stage are properly met and controlled by a single point of coordination and control for all the other processes and activities within this stage of the service lifecycle,
- **Service Catalog Management**, a process responsible for providing and maintaining a consistent flow of information with regard to all the services in operation, as well as the one that is still being carried out to start the operation,
- **Service Level Management**, a process that seeks to ensure that current and planned IT services are delivered in accordance with the goals established in the agreements,
- **Availability Management**, a process that is designed to guarantee the availability levels for IT services and in this way efficiently and effectively meet the requirements for availability and service level goals agreed with the customer or business,
- **Capacity Management**, which is responsible for ensuring that services, service components and the IT infrastructure have the required capacity and performance and can operate in a timely and efficient way, while justifying its costs,
- **IT Service Continuity Management**, a process that manages business risks, which have the potential to cause serious damage to IT services and can draw up contingency plans and / or redundancy to mitigate the possible efects of these risks,
- **Information Security Management**, a process that seeks to align IT security with business security and ensure the confidentiality, integrity and availability of IT assets, information, data and services, as agreed with the IT service provider, and
- **Supplier Management**, a process that must be involved with all stages of the service lifecycle in ITIL, because in this stage the suppliers are required to design new and / or updated services and must comply with their contractual obligations.

Owing to the limited space in scope of this paper, we decided to select the Design Coordination process of ITIL Service Design. This process is structured in two categories [13], each with its respective activities, namely:

- **For the overall service design lifecycle stage:**
  - Define and maintain policies and methods,
  - Plan design resources and capabilities,
  - Coordinate design activities,
  - Manage design risks and issues, and
  - Improve service design.
- **For each design:**
  - Plan individual designs,
  - Coordinate individual designs,
  - Monitor individual designs, and
  - Review designs and ensure handover of service design package.

C. The CMMI-SVC Model

The Capability Maturity Model Integration for Services (CMMI-SVC) is a maturity model for assessing, defining, implementing and improving the quality of an organization's processes and its ability to manage the service. This model was created by the Software Engineering Institute (SEI), and contains 24 Process Areas (PA), 16 of which are core, 1 is shared and 7 are service-specific process areas of CMMI-SVC. This model was designed to meet the need for development and improvement in the maturity of service practices and hence make improvements in the performance of the service provider leading to customer satisfaction [4].

In 2010, the CMMI version 1.3, which brings together three constellations, was published by SEI: CMMI for Development (CMMI-DEV), which deals with development processes, CMMI for Acquisition (CMMI-ACQ), where processes of acquisition are worked out, as well as outsourcing of products and / or services, and CMMI for Services (CMMI-SVC), aimed at improving service processes.

There is a chapter devoted to describing the components in the CMMI-SVC model. Understanding these components is regarded by the model as a critical factor since it seeks to ensure the use of the information is understood. These components are grouped into 3 categories:

- **Required Components -** components considered to be essential to achieve process improvement in a particular process area, and comprising Specific and Generic Goals,
- **Expected Components -** components that describe the activities that are needed to achieve a required component, and are formed of Specific and Generic Practices, and
- **Informative Components -** components that help the model to be understood, and thus have components such as Subpractices, and Examples of Work Products.

The CMMI-SVC consists of process areas (PA) with specific purposes and goals related to each particular

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process area, as well as generic goals related to all the process areas. Specific goals (SG) are also defined that refer to the unique features of each process area and generic goal (GG) responsible for defining the characteristics that are common to all the process areas. For each specific goal, a set of specific practices (SP) will be outlined, which are activities that need to be completed to ensure that the goal is satisfied in each PA.

The three CMMI-SVC process areas considered in this harmonization are:

- **Organizational Process Definition -** the purpose of this is to establish and maintain a usable set of organizational process assets and work environment standards. This process area includes the following specific practices:
  - SP 1.1 Establish Standard Processes,
  - SP 1.2. Establish Lifecycle Model Descriptions,
  - SP 1.3 Establish Tailoring Criteria and Guidelines,
  - SP 1.4 Establish the Organization's Measurement Repository,
  - SP 1.5 Establish the Organization's Process Asset Library,
  - SP 1.6 Establish Work Environment Standards,
  - SP 1.7 Establish Rules and Guidelines for Teams,
- **Organizational Process Focus -** the purpose of this is to plan, implement, and deploy organizational process improvements based on a thorough understanding of the current strengths and weaknesses of the organization's processes and process assets. This process area includes the following specific practices:
  - SP 1.1 Establish Organizational Process Needs,
  - SP 1.2 Appraise the Organization's Processes,
  - SP 1.3 Identify the Organization's Process Improvements,
  - SP 2.1 Establish Process Action Plans,
  - SP 2.2 Implement Process Action Plans,
  - SP 3.1 Deploy Organizational Process Assets,
  - SP 3.2 Deploy Standard Processes,
  - SP 3.3 Monitor the Implementation,
  - SP 3.4 Incorporate Experiences into Organizational Process Assets,
- **Integrated Work Management -** the purpose of this is to establish and manage the work and involve the stakeholders concerned through an integrated and defined process that is adapted to the organization's set of standard processes. This process area includes the following practices:
  - SP 1.1 Establish the Defined Process,
  - SP 1.2 Use Organizational Process Assets for Planning Work Activities,
  - SP 1.3 Establish the Work Environment,
  - SP 1.4 Integrate Plans,
  - SP 1.5 Manage the Work Using Integrated Plans,
  - SP 1.6 Establish Teams,
  - SP 1.7 Contribute to Organizational Process Assets,
  - SP 2.1 Manage Stakeholder Involvement,
  - SP 2.2 Manage Dependencies,
  - SP 2.3 Resolve Coordination Issues.

The CMMI-SVC model should be consulted for a better understanding of the purpose of each specific practice [4]. This list of specific practices will be used in the section describing the harmonization set out in this paper.

III. THE HARMONIZATION BETWEEN THE ITIL FRAMEWORK AND CMMI-SVC MODEL

Both the ITIL framework and the CMMI-SVC model share the same goal of providing the IT Managers and organizations with a set of best practices to manage information technology services of quality and create value for the organization's business area during the service lifecycle. Although these models have different structures, similarities can be found in the set of specific requirements for the IT service management, as shown in Table I.

TABLE I. ELEMENTS THAT CAN INFLUENCE THE ITIL FRAMEWORK AND CMMI-SVC MODEL

ITIL Elements	CMMI-SVC Elements	
Process	Process Area	
Objectives	Specific Goals (SG)	Generic Goals (GG)
Activity, Methods and Techniques	Specific Practices (SP)	Generic Practices (GP)
Policies, Principles and Basic Concepts	Subpractices	Generic Practice Elaborations
Triggers, Inputs and Outputs	Example of Work Products (WP)	

In each service lifecycle, the ITIL framework has a set of Processes, that are structured by a set of Activities to achieve a certain objective. Similarly, the CMMI-SVC model contains a set of Process Areas (PA), where several Specific and Generic Practices, (component of the PA), are described and must be implemented.

The Objectives element of the ITIL framework is equivalent, in certain respects to the Specific Goals and Generic Goals of CMMI-SVC. This is because they include a set of characteristics that, must be identified in the respective Process of the ITIL by the Objectives element and in the Process Area of CMMI-SVC for the Specific and Generic Goals before they can be certified by the model in the organization. Similarly, the Activities, Methods and Techniques of the ITIL framework include areas that must be defined to achieve a specific result. This can be compared to the Specific Practices and Generic Practices of CMMI-SVC, because this includes the details of how to

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carry out a practice to meet the goals of the model.

Another similarity that was found refers to the elements that are designed to provide guidelines for the appropriate implementation process of the models. The fact that ITIL framework is present in the Policies, Principles and Basic Concepts and in the CMMI-SVC model, can be observed in the Subpractices and Generic Practice Elaborations.

The Triggers, Inputs and Outputs of the ITIL framework have similar objectives to the Example Work Products of CMMI-SVC, since these elements must be sought during the implementation process in each model to ensure that the requirements have been met correctly.

The integration recommended by this paper refers to the set of concepts in the ITL framework and the CMMI-SVC model elements. It also includes the definition of a set of equivalent technologies that assist in the evaluation and improvement of IT products and services. In this domain, there are tools, techniques, procedures, processes, roles, methodologies, frameworks, languages, standards, patterns, and so on.

It should be emphasized that the mapping between the elements contained in the ITIL and CMMI-SVC were validated through the same correlation in the work [8], which confirms that the results for the relationship between the elements defined in Table I is correct.

A. A Conformance Analysis of the Design Coordination Process

The Design Coordination process in the category of **activities relates to the overall service design lifecycle stage**, where the standard service process that needs to be adopted is constructed [13]. It includes the following activities which are mapped in each subsection below.

1) Define and Maintain Policies and Methods

This activity is intended to ensure that a Consistent and Accurate Design(s) for the Service(s) is produced in accordance with the required business outcomes. When made available in the IT Service Operational Environment, it helps (and continues to help) the organization to achieve its goals. To do this, this activity requires a Process Area and Specific Practices (SP) of CMMI-SVC.

In the *Organizational Process Definition (OPD)* area, SP.1.1 defines and maintains a set of standard processes that can be instantiated to address a particular area of the organization's business. SP.1.2 attempts to describe the lifecycle models that are suited to the needs of the workgroup, the organization, the definitions of the service standard and the environment. SP.1.3 is concerned with drawing up the guidelines that will set out the procedure for the conduct and execution of the defined process. These are based on the information contained in the set of standard processes and in the assets of the organizational process. SP.1.4 aims to design and maintain the Organization Measurement Repository which provides the necessary information to understand and interpret the set of common measurements for products and processes related to the set of standard processes of the organization. Finally, SP.1.5 designs and implements the organizational process asset library, where the procedures are specified for the storage, updating and retrieval of items such as policies, process descriptions, procedures, development plans, and other assets, as well as making these items available for use in workgroups.

The coverage in the *Define and Maintain Policies and Methods* activity was complete, because the CMMI-SVC had met the requirements of this activity.

2) Plan Design Resources and Capabilities

The purpose of this activity is to plan the resources and capabilities of the Design Coordination process, based on the information obtained from the Service Portfolio activities (Service Pipeline) and the Change Management process of the ITIL Service Transition stage. This is because this activity requires a Process Area and Specific Practices of CMMI-SVC to achieve its goals.

In the *Organizational Process Definition (OPD)* process area, SP.1.6 aims to establish and maintain a standard work environment, i.e what resources are required for team work. SP.1.7 allocates people to work in the process and defines the assignments of these people.

There was complete coverage for the *Plan Design Resources and Capabilities*, because the CMMI-SVC had met the requirements of this activity.

3) Coordinate Design Activities

This area coordinates all the design activities in projects and changes, management planning, resources, and conflicts with suppliers and support teams when necessary. It thus requires a Process Area and Specific Practices of CMMI-SVC to achieve its goals.

In the *Integrated Work Management (IWM)* process area, the aim of SP.2.2 is to manage the task dependencies between the activities of the process, since these depend on the inputs of other activities for their execution and must be carefully managed to avoid process gaps. Thus, the SP identifies any critical dependencies and plans the work schedule, while taking account of these critical variables in the process.

The coverage of the *Coordinate Design Activities* was complete, because the CMMI-SVC had met its requirements.

4) Manage Design Risks and Issues

This activity is responsible for assessing risks in design, technical management, managing the risks involved in design activities, and tackling the number of problems that might be subsequently traced to poor design. It requires a Process Area and Specific Practices of CMMI-SVC to achieve its goals.

In the *Integrated Work Management (IWM)* process area, in SP.2.3 the task of management entails the identification, follow-up (status) and communication of the person responsible for tackling and solving the problem.

The coverage in the *Manage Design Risks and Issues* activity was complete, because the CMMI-SVC had met the

requirements of this activity.

5) Improve Service Design

The purpose of this activity is to ensure that there is a continuous awareness of the goals and objectives of the service design phase to improve the effectiveness and efficiency of service design activities and processes. This activity requires a Process Area and Specific Practices of CMMI-SVC to achieve its goals.

In the *Organizational Process Focus (OPF)* process area, SP.1.1 records the needs and goals of the organizational process in the context of the business to ensure that it is fully understood. SP.1.2 evaluates and delivers the results of the documents needed with regard to methods and evaluation criteria. These include the following: the CMMI process model, the International Organization for Standardization (ISO) or benchmarking. SP.1.3 seeks to discover if there is a need for improvement in the processes and process assets of the organization and involves training for teams, and improvement of the tools used, among other factors. In SP.2.1 the focus is on how to enable the organization to establish and maintain plans for improvement. These are subsequently implemented in accordance with the organizational needs defined in SP.2.2. SP.3.1 plans, records and executes the implementation of the Organizational Process assets and their changes, as well as determining what resources are needed to support this implementation and thus ensure its compliance with the organization's current goals and objectives. The aim of SP.3.2 is to implement the organization's standard processes, and work groups, by periodically updating them, and incorporating the latest changes made to the standardization. This ensures that all the work activities can benefit other work groups in the process. SP.3.4 attempts to bring about improvement in the planning and execution of the organizational process and in particular, the lessons learned, measurements periodically measured, and records of improvements in the organizational process activities.

The coverage in the *Improve Service Design* activity was complete, because the CMMI-SVC had met the requirements of this activity.

With regard to Design Coordination Process in the category of **activities relating to each individual design**, each process must be instantiated to allow a service project to be implemented [13]. This includes the following activities, which are mapped in each subsection below.

1) Plan Individual Designs

This activity involves carefully planning each individual project or change to ensure the required business results are obtained. This activity requires a Process Area and Specific Practices of CMMI-SVC to achieve its goals.

In the *Integrated Work Management (IWM)* process area, SP.1.1 seeks to define and maintain a process in accordance with its contractual obligations, operational needs, opportunities and constraints. SP.1.2 uses the tasks and work products of the process defined for the work as a basis for planning the work activities. SP.1.3 seeks to plan, design and implement a work environment, in terms of its equipment, tools, facilities, operations and manuals. SP.1.4 is concerned with the management of integrated work plans, and ensuring the controlled participation of human resources in integrated projects to avoid labor conflicts. The objective of SP.1.6 is to form the teams that will work in the process.

The coverage in the *Plan Individual Designs* activity was complete, because the CMMI-SVC had met its requirements.

2) Coordinate Individual Designs

This activity is often carried out by a project manager or someone else with direct responsibility for the project. He / she is also responsible for making changes in the coordination of activities and in the instantiation of the standard process in response to the customer's demands. This activity requires a Process Area and Specific Practices of CMMI-SVC to achieve its goals.

In the *Integrated Work Management (IWM)* process area, SP.2.1 undertakes the management and scheduling of the collaborative activities of the stakeholders (the integrated work plan has already been defined in SP.1.4). The coordination of people's dependencies and the negotiation of critical issues (contingencies) is carried out in SP 2.2 in case there is a need to change the agenda and introduce collaborative schedules for the stakeholders. SP.2.3 is designed to tackle issues that are important for the stakeholders. The ability of the appropriate manager to solve these problems depends on their scale.

The coverage in *Coordinate Individual Designs* was complete, because the CMMI-SVC had met the requirements of this activity.

3) Monitor Individual Designs

The purpose of this activity is to monitor all aspects of the project to ensure the following: a) the agreed methods are being adhered to, b) there is no conflict of interest with other ongoing design projects, c) the website design milestones are reached, and d) the development of a design is comprehensive enough to support the required organizational results. This activity requires a Process Area and Specific Practices of CMMI-SVC to achieve its goals.

In the *Integrated Work Management (IWM)* process area, SP.1.5 focuses on monitoring and controlling work activities. It is also concerned with work products from the defined processes, work plans, and other plans that can affect the work.

The coverage in *Monitor Individual Designs* activity was complete, because the CMMI-SVC had met the requirements of this activity.

4) Review Designs and Ensure Handover of SDPs

The final review of the individual designs is carried out to ensure that the standards and conventions are being fully complied with in the service design package (SDP). Problems should be documented and there is a need to determine if alterations are needed in any part of the service design or if they can be viewed as a part of the service

transition plan. This activity requires two Process Areas and Specific Practices of CMMI-SVC to achieve its goals.

In the *Integrated Work Management (IWM)* process area, SP.1.7 establishes the following: a) the contributions made by the defined process information to the work, b) organizational process assets and c) proposed improvements. The processes and product measurements are stored in the organization's measurement repository. In the *Organizational Process Focus (OPF)* area, the SP.3.4 is responsible for the improvement of planning and execution of the process in the organizational process assets. Its activities depend on what has been found out about its strengths and weaknesses in the SP.1.7.

The coverage in the *Review Designs and Ensure Handover of SDPs* activity was complete, because the CMMI-SVC had met its requirements.

B. An Evaluation of the Harmonization of Technology Management

The peer review technique was employed to evaluate the harmonization that was obtained between the requirements of the ITIL framework and CMMI-SVC model, as outlined in the last section. This was overseen by an expert, who has over 5 years of experience of implementing quality models in IT (Information Technology) companies. He has a recognized certification in ITIL and CMMI-SVC, as well as being a certified SCAMPI High Maturity lead appraiser. The expert was given the document that contains the harmonization of ITIL and CMMI-SVC. He carried out the review in accordance with a set of criteria, which were defined on the basis of Araújos's work [6], as shown in Table II.

TABLE II. CRITERIA DEFINED FOR THE HARMONIZATION EVALUATION.

Criteria	Definition
TH (Technical High)	Indicates that a problem in a harmonization item was found and, if not changed, would impair the system.
TL (Technical Low)	Indicating that a problem in a harmonization item was found and a change would be appropriate.
E (Editorial)	Indicating that a Portuguese language error was found or the text can be improved.
Q (Questioning)	Indicating that there were doubts about the content.
G (General)	Indicates that in general a comment is needed.

When reviewing the harmonization of Design Coordination process, the expert detected a problem, which was classified as General (G). It was suggested that an analysis should be conducted of all the CMMI-SVC specific and generic practices that have been mapped in the ITIL process with the aim of determining whether they are listed and described at the end of the document. If any mapped practice had not been listed, the expert suggested that it should be included in the document, as a means of enabling the purpose e of these practices to be understood.

The specialist found a problem in the 4 ITIL activities, which was classified as TL. Since in this outcome the Specific Practice was unnamed, the expert suggested that its name should be included in the harmonization document. These problems were caused by the following: a) a lack of a suitable relationship between some good practices of ITIL with CMMI-SVC, b) a lack of detail about what level of coverage was determined after the relationship had been established between the assets of the two frameworks, c) a lack of clarity about what each asset represents (i.e., ITIL and CMMI-SVC), and d) a lack of an explanation for the relationship between the elements of ITIL and CMMI-SVC.

The expert did not find any problem classified as TH, E or Q.

After this first peer review the authors of this paper sent the corrected harmonization to 3 other experts in the field, who are certified and have more than 7 years of experience of implementing the two models used in the work. However, none of these experts suggested any adjustments should be made, although they showed an interest in the use of this harmonization for making improvements to the implementation of the program.

C. How should the Harmonization be used?

The purpose of the harmonization of the ITIL framework and CMMI-SVC model is to help businesses that wishing to obtain certifications through multi-model implementations or even by making evaluations of the two standards. The use of harmonization can optimize cost-effectiveness, time and effort because the standards now have their structures harmonized and interrelated.

It was possible to highlight the differences and similarities included in the requirements of ITIL and CMMI-SVC. Hence, it can be seen that although some requirements of the standards are similar or even complementary, they are not always able to achieve their goals in the same way. According to the Association for Promoting Excellence in Brazilian Software (SOFTEX) [14], this may occur because of the different requirements of some of the practices, outcomes and expected results of the standards.

The harmonization spreadsheets have become an important support tool for the joint evaluation or implementation of the standards, because they provide inputs that allow their frameworks to be adapted / harmonized and predict their expected results, practices and outcomes. This can enable the multi-models to be implemented in companies.

As a result, the company benefits from the implementation of joint standards, because it will not have to spend time on separately analyzing the frameworks for the standards. This means that there is a need to determine in what way one standard can suit another one, because all the structures and requirements, (which are the same for all the standards), have been identified, harmonized and documented in the spreadsheet used for the standards.

A qualitative criterion for the successful harmonization in the design coordination process can be defined as a standard process that is well structured, and is subject to rules for its adaptation and institutionalization, as well as the

fact that it can be integrated with different projects.

IV. Conclusion and Suggestions for Future Work

This research study examined the harmonization of the Design Coordination process with the ITIL framework by carrying out the practices defined in the CMMI-SVC process areas. Its goals were achieved by seeking to determine the similarities and differences between the structures of ITIL and CMMI-SVC, and investigating their degree of harmonization. To avoid misunderstandings and inconsistencies, an expert in these standards evaluated the harmonization by means of the peer review technique. The results of this review were analyzed and changes were suggested to remove any inconsistencies or failure to understand the problems detected by the expert.

The lessons learned from this research stem from the fact that there is both an analytical and comparative domain between the framework and the object model of this research. Thus, it is recommended that more than one person should undertake it so that any conflicts or uncertainties can be discussed and addressed by a peer review.

A limitation of this study is that the harmonization was not evaluated in a public / private company or organization, but only assessed by peer review. However, an assessment of the harmonization of a public company is now being completed in Brazil and its processes are in accordance with the practices of maturity level 3 of CMMI-SVC. As a result, it will be possible to determine if the harmonization had a positive or negative influence on a multi-model implementation. A further limitation is the fact that the peer review was only conducted by a single expert, which means that there can only be a limited view of the results obtained from the research. However, this expert has extensive experience with the implementation of the CMMI-SVC model and the ITIL framework, and this should reduce the risk of bias in the results obtained from the review.

In a future work, we intend to continue to expand this research and apply it to other organizations, so that the positive and negative aspects of the use of harmonization can be quantified through a multi-model implementation (ITIL framework with CMMI-SVC). Another future study could involve defining the complete cycle of harmonization based on the results of Araújo's research [6] and the CMMI guide [4].

So far, it has not been possible to finalize the case study, although it is worth drawing attention to the benefits of multi-model implementation. These include, the reduction of costs and time needed to comply with the expected results and practices of the ITIL framework and the CMMI-SVC, as well as the creation of a unified and standardized system to achieve the two standards. Finally, there is the advantage of being able to standardize the technical language that is used among them to define the process of IT service management.

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