Project Management and Maintenance on Information Systems Administration

Diogo Pinto - nº69905

Diogo.Reis.Pinto@tecnico.ulisboa.pt

Instituto Superior Técnico

Abstract. Information Systems administration on an organization requires handling requests for projects and maintenance operations, in a way it brings value to all concerned parties. For meeting this expectations, Information Systems management needs to implement processes for dealing with incoming requests, aligning it with business expectations and criteria (risk, priority, team capabilities). Frameworks like COBIT, ITIL or PMBOK provide guidance on achieving success in management operations on an IT organization, being an important asset to design and implement processes for project and maintenance requests. In this document we present the state of the art on management and governance processes for IT organizations, as the basis for an initial proposal of a process to handle requests for projects and maintenance operations on information systems administration.

Keywords:
Project Management, Maintenance, Software lifecycle Processes, COBIT, ITIL, PMBOK

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1 Introduction

Currently, information systems organizations moved from the limited perspective of profitability to a more wider view of the business, trying to maximize the business performance by increasing client satisfaction, products' quality and management efficiency in comparison with the concurrency. Information Technologies (IT) were applied to business activities to achieve this goal from early.

As stated in [25], "Information Technology (IT) enable, enhance, and are embedded in a growing number of goods and services. They are connecting consumers and producers of services in ways previously not feasible, while contributing to the productivity of numerous sectors of the services industry such as financial services, communications, insurance, and retail services."

Although it is undeniable that IT brings new ways of productivity and performance growth, it is fundamental that organization ensures processes for its management and governance, making IT an even more important asset and always aligned with the organization business objectives. Management on information systems is all about leadership, organizational structures and processes that ensure information systems support and alignment with organization's objectives. Information systems provide a competitive edge to concurrents, but an organization can only achieve management efficiency with well defined and matured processes.

One important part of business for an organization take advantage of its concurrency is the way how it deals with receipt and management of project execution and evolution maintenance requests. There is a inherent necessity to classify a new request in terms of opportunities and value to the business as well as the risk associated with it, making it an important asset for the organization. Furthermore, the organization needs to possess clearly defined processes and structures for managing this requests. when a new request is purposed to an organization, it should be dealt based on a pre-defined process that will, independently of its source or type, define activities, inputs, outputs and responsibilities during the whole request life cycle until its fulfillment.

For establishing standards on this subjects, business professionals came across with several frameworks and practical guides, making an attempt to provide and standardize many practices around management on information systems.

Considering the state of the art, COBIT assumes a major position on good practices for information systems management. It provides a complete framework for implementing management and governance processes, taking in account a set of enablers and goals, from IT-related to business.

For a more technical approach, oriented to IT services, we have ITIL V3, consisting in a good practices manual for managing IT services, during its life cycle. ITIL is divided in five volumes, comprising all the life cycle of IT services: service Strategy, service design, service transition, service operation and service continual improvement,

PMBOK is the project management guide widely accepted by professionals from all areas of knowledge. It explores the processes that make part of the project life cycle, presenting them in a general way to all areas, making it universally applicable.

Considering that cooperation among organizations is fundamental on the actual business definitions, processes compliance with international standards is important for better acceptance of process activities and objectives. Thus, we will consider a set of standards in project management areas as IT service, risk or auditing management.

Assuming the project management and maintenance management as the main focus areas for this project, we need to take in account the project portfolio aspects of the organization. It corresponds to a centralized management of processes, methods and technology, used by project

managers and project management offices to analyze and manage a set of projects. Considering this area, we can assume all aspects related to project portfolio are already defined or that we need to deal with the alignment of this processes with the business and technological goals of the organization for creating value.

Our purpose to overcome the problem of this project is to combine several frameworks and standards to achieve an integrated process framework supported by a responsibility structure and a logical application architecture. To design this framework we will provide a state of the art in related frameworks and standards to IT governance and management, as well as for market solutions on IT Service Support management and Project and Portfolio management tools.

For this project we will use the Design Science Research Methodology (DSRM)[28], presented in section 2, that will provide guidance on the research process for this project, from problem identification to solution demonstration and evaluation.

2 Research Methodology

To conduct this research we will use the Design Science Research Methodology (DSRM) [28] for presenting and validating a solution for this project's problem. As stated in [28], "It involves a rigorous process to design artifacts to solve observed problems, to make research contributions, to evaluate the designs, and to communicate the results to appropriate audiences. Such artifacts may include constructs, models, methods, and instantiations". The artifacts can be constructs (vocabulary and symbols), models (abstractions and representations), methods (algorithms and practices) and instantiations (implemented and prototype systems). In this project we will focus on models and methods.

This methodology is based in seven guidelines that describe well conducted researches: it most produce an artifact created to address a problem, the artifact must be relevant to the solution, its utility, quality and efficacy must be rigorously evaluated, the research should present a verifiable contribution, rigor must be applied in development and evaluation, development should be based in existing knowledge and finally the research should be effectively communicated to appropriate audiences.

Information Systems can take several advantages from the use of DSRM as a research methodology because Information systems is an knowledge area were theory from other areas are applied to solve problems at the intersection of IT and organizations.[28] This methodology has three main objectives: provide a nominal process for the conduct of design science research, build upon prior literature about design science in IS and reference disciplines and provide researchers with a mental model or template for a structure for research outputs.It consists in a iterative process composed by six phases:

- Problem identification and Motivation - Definition of problem's importance and the necessity of a solution-
- Define objectives of a solution - Presentation of requirements that should be fulfilled by the solution to implement.
- Design and Development - Key element of the DSR methodology where artifacts will be implemented to address requirements. This phase is iterative in the way it needs revisions and adjustments. It will receive feedback from ahead phases.
- Demonstration - Confirmation of application of artifact to the problem's requirements.
- Evaluation - Measurement of the level in which the artifacts produced fulfill the initial problem.
- Communication - Documentation and spreading of the artifacts as the problem's solution.

In figure XXX we present the mapping between the DSRM process and this project research methodology. The next sections follow the methodology steps: Section 3 (Problem contextualization) will define problem context and its importance. In section 4 and 5 we present the state of the art in frameworks and standards for management processes and governance as well as market solutions on ITSM and PPM tools. In section 6 we make a solution proposal, complemented by section 7 and 8 were we present a demonstration for a real case scenario and the evaluation methodology, respectively.

3 Problem Contextualization

Dealing and managing project execution and evolving maintenance requests has become one of the most important processes inside an information systems department, in the way it is essential a correct classification and management for the whole request life cycle until it has been fulfilled, in order to create value for the organization. When a request is submitted to the information systems management, it should be classified as a project execution request or an evolving maintenance one. Furthermore, the organization should have defined processes to manage the whole process for request fulfillment, defining activities, expected results and responsibilities, independently of the request type.

This project is aligned with a real case of an organization with 600 collaborators where the information systems department administration has 15 elements including the director and the team leaders. This management is composed by the department of evolving maintenance and the department of projects execution.

The request classification will depend on many factors. We can decide it by taking in account aspects like the risk to the business or the financial impact for the organization. In the end, it depends on the organizational culture and how it considers what is a maintenance operation and what is a project.

After classified, we need to define the request fulfillment in terms of processes to consider and communication channels between the project and the maintenance department, assuming they are independent but need to be coordinated.

Considering the software life cycle processes, presented by the International Standard ISO/IEC 12207[12] presented in more detail in section X, we can divide this processes in two groups: Software Specific Processes and System Context processes.

The system context processes are more focused on systems engineering, providing a system context for dealing with a standalone software product or service or a software system. The software specific processes are, on the other hand, used for implementing a software product or service that is an element of a larger system.

The main challenge of our problem is to identify and implement the necessary processes from the software life cycle processes that are important for our objectives, defining activities and responsibilities inside the organization.

As long as we are dealing with an established organization in the market, we need to take in account that our process will be implemented in an existent organizational structure. It is necessary to develop a logical application architecture, using market solutions from the area of Project management and IT Service Support Management, that will be architecturally integrated to support our process. We will need to assess the market solutions already available to conclude which are the best in terms of features and interest for the project.

4 A State of the Art in Frameworks for Information Technology Governance and Management

In this section we will present a set of literature references on the subjects related to this project. We will present the most important frameworks on Information Systems Management and Governance with the objective of coming up with a choice of a framework or a set of them to implement our processes for project and maintenance management.

Our choice is centered in three frameworks we consider the most relevant for this project: COBIT 5, ITIL V3 and PMBOK. This three frameworks provide, from different perspectives, guides and principles for IT Governance and Management, presenting processes for achieving a successful implementation of this principles in an organization.

4.1 IT Governance and IT Management

One important concept to define is the difference between IT Governance and IT management. They are many times confused and some authors already tried to explain the difference between the two concepts.

Considering the definition given by Van Grembergen *et al.*, "IT Management is focused on the internal effective supply of IT services and products and the management of present IT operations. IT Governance in turn is much broader, and concentrates on performing and transforming IT to meet present and future demands of the business (internal focus) and the business' customers (external focus).".

Considering the COBIT 5 view for this question, there is a "clear distinction between governance and management, in the way these two disciplines encompass different types of activities, require different organizational structures and serve different purposes. Governance ensures that stakeholders' needs, conditions and options are evaluated to determine balanced, agreed-on enterprise objectives to be achieved. it sets direction through prioritisation and decision making and monitors performance and compliance against agreed-on direction and objectives.ï£ijOn the other hand, management plans, builds, runs and monitors activities in alignment with the direction set by the governance body to achieve the enterprise objectives."[6]

Considering both definitions, we can conclude that IT Governance has a bigger dimension that IT Management, but both need to be related and complementary to achieve success inside an organization. It is not possible for an organization to have well defined and matured management processes that are no related to governance aspects, but governance needs management to achieve goals and objectives settled to achieve success.

4.2 COBIT 5

Control Objectives for Information and Related Technology (COBIT) is a framework created by the Information Systems Audit and Control Association (ISACA) for IT Management and IT Governance.

As stated by ISACA,"COBIT 5 provides a comprehensive framework that assists enterprises in achieving their objectives for the governance and management of enterprise IT. Simply stated, it helps enterprises create optimal value from IT by maintaining a balance between realizing benefits and optimizing risk levels and resource use" [6]. The framework is built on five basic principles:

- Meeting the Stakeholders Needs
- Covering the Enterprise End-to-end
- Applying a Single, Integrated Framework
- Enabling a Holistic Approach
- Separating Governance from Management

It also defines seven enablers, explained by COBIT as factors that, individually and collectively, influence whether governance and management over enterprise will work or not. This enablers can be categorized as:

- Principles, Policies and frameworks
- Processes
- Organizational structures
- Culture, ethics and behavior
- Information
- Services, infrastructure and applications
- People, skills and competencies

Figure 2 presents the COBIT 5 enablers previous defined and how they relate among themselves int terms of its importance for organization. Each enabler has stakeholders, a set of goals, a life cycle and can be defined good practices for each one.

Considering figure 3, COBIT 5 process reference model considers two big domains of processes: Governance and Management. The governance domain contains five processes in the domain Evaluate, Direct and Monitor(EDM). The management domain has four internal domains of processes: Align, Plan and Organise(APO), Build, Acquire and Implement(BAI), Deliver, Service and Support (DSS) and Monitor, Evaluate and Assess(MEA).

All processes for management and governance are presented in the appendix and all the implementation details explained in COBIT 5: Enabling Processes, A detailed reference guide to the processes defined in the COBIT 5 process reference model. This includes the COBIT 5 goals

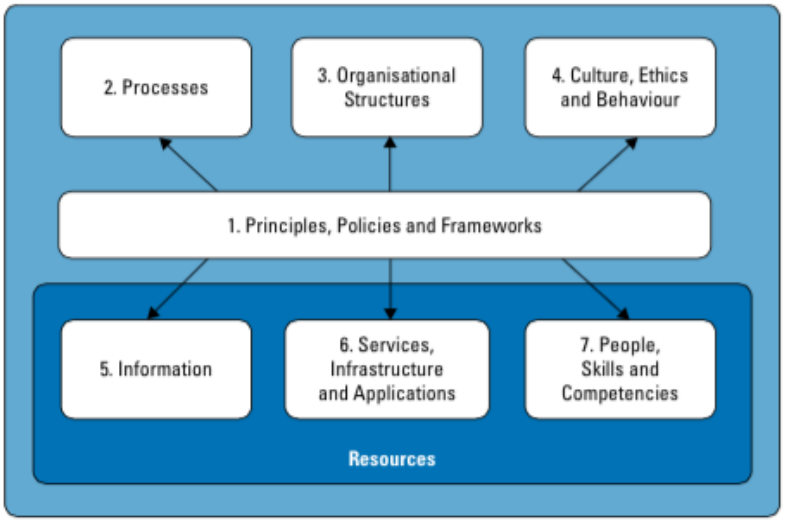

Fig. 1. COBIT 5 enablers

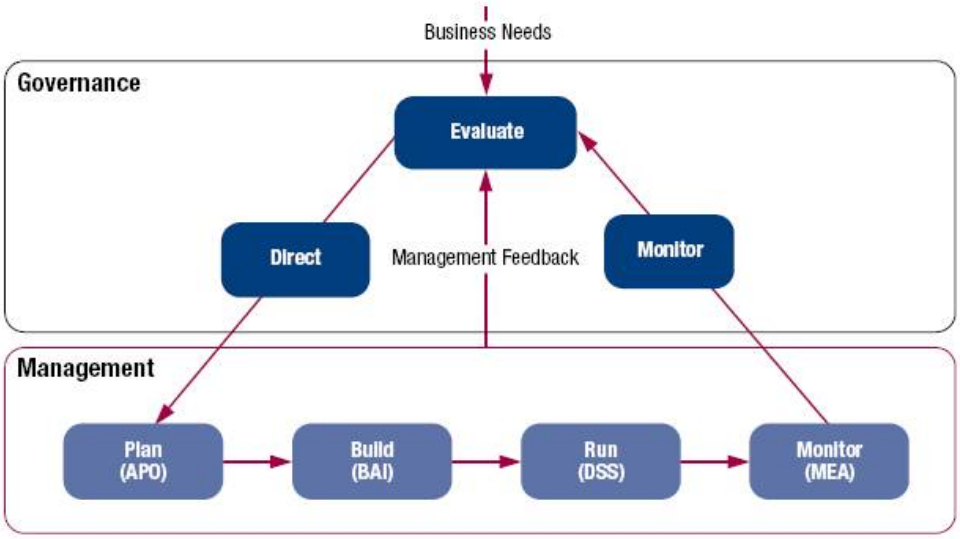

Fig. 2. COBIT 5 domains

cascade, a process model explanation, governance and management practices, and the process reference model[7].

Relating to other frameworks and standards, COBIT tries to establish a framework that is compliant with the most widely accepted standards in IT governance and management. In figure 4 we can see the standards COBIT 5 relates by processes domain, with special attention to ITIL V3[22, 23, 24, 25, 26], ISO/IEC 20000[15], PMBOK[5] and CMMI[29], that are closely related to this project's problem. This compliance with other standards is fundamental for a widely adoption of COBIT 5, in the way it tries to establish goals, metrics, practices, roles, inputs and outputs for each process, making it necessary being compliant with international standards. This will improve COBIT application and acceptance on organizations.

4.2.1 CMMI CMMI (Capability Maturity Model Integration), first developed at the Software Engineering Institute at Carnegie Mellon University and currently operated by the CMMI Institute, consists on a set of practices and process improvement goals that organizations can use to evaluate and improve its processes. The CMMI framework provides all structures to produce CMMI models, training and appraisal methods. CMMI, currently on version 1.3, defines areas of interest that group collections of CMMI components for models, training and appraisal construction. The three areas of interest for CMMI are:

- CMMI for Acquisition (CMMI-ACQ) - Provides guidance to organizations that manage the supply chain to acquire and integrate products and services to meet the needs of the customer.
- CMMI for Development (CMMI-DEV) - Provides guidance to improve the effectiveness, efficiency, and quality of their product development work. Used for process improvement in organizations that develop products.
- CMMI for Services (CMMI-SVC) - Provides guidance to organizations that establish, manage, and deliver services that meet the needs of customers and end users.

For this areas of interest, CMMI defines 22 core process areas, covering processes that are fundamental to improve the organization processes. Each one of the areas is a set of related practices that, when implemented, will achieve goals important for process improvement. The process areas are presented in Appendix section XXX.

CMMI supports two types of improvement paths, depending on the organization objectives. One is used for the organization to improve processes related to a specific process area, named the continuous representation, and the other one is used for organizations to improve a set of relating processes by incrementally consider sets of process areas, named the staged representation. As stated by CMMI, the continuous representation will allow to achieve capability levels and the staged representation will achieve maturity levels.

For the staged representation, the following capability levels are defined:

- Level 0 - Incomplete - Process not performed or only partially performed. Specific goals of process area not achieved.
- Level 1 - Performed - Process performs the needed work to produce work products and satisfies the specific goals of the process area.
- Level 2 - Managed - Performed process that is planned and executed according with policy.
- Level 3 - Defined - Managed process that is tailored from the organization's set of standard processes according to the organization's tailoring guidelines.

For the continuous representation, the maturity levels defined are:

- Level 1 - Initial - Chaotic and Ad-Hoc processes. Organization does not provide a stable environment to support processes. Organizations are characterized by easily abandoning its processes and being unable to repeat them.
- Level 2 - Managed - Projects establish the foundation for an organization to become an effective acquirer of needed capabilities by institutionalizing select project management and acquisition engineering processes. Processes, projects, products and services are managed and periodically evaluated. Processes are maintained in times of crisis.

- Level 3 - Defined - Acquirers use defined processes for managing projects and suppliers. Project management and acquisition practices are embedded in the standard process set. Organization set of standards is established and improved over time. Processes described more rigorously than in level 2.
- Level 4 - Quantitatively Managed - Acquirers establish quantitative objectives for quality and process performance and use them as criteria in managing processes. Process performance becomes predictable, controlled using statistical and quantitative techniques for prediction.
- Level 5 - Optimizing - Process performance continuous improvement based on the organizations' objectives and performance needs comprehension. optimization is achieved through incremental and innovative process and technological improvements.

CMMI does not provide certification to organizations. Instead, it can be used to conduct appraisals, measuring the organization progress and earning maturity or capability levels face to CMMI Levels. These appraisals can be used for comparing the current practices with the CMMI best practices, finding areas to improve, for outside accreditation by suppliers and other stakeholders of conformance to a specific level of CMMI and to meets contractual requirements.

To conduct an CMMI appraisal, the organization must follow the appraisal Requirements for CMMI document [INSERT REFERENCE HERE] and must use an CMMI model and an appraisal method conformant with the appraisal Requirements for CMMI, as the SCAMPI appraisal method [INSERT REFERENCE HERE]

4.2.2 CMMI importance for COBIT 5 CMMI can be used by COBIT for process improvement purposes. Considering COBIT as a framework for governance and management processes, providing guidance and control, it is fundamental for it to also consider improvement as an important part of these processes. Also, and considering COBIT application for this project, we will apply its guidance on a real-case organization, that deals with suppliers and other stakeholders, many time interested in the processes level of maturity conducted by the organization, in accordance to CMMI levels. Considering this, its fundamental for COBIT application to consider the CMMI body of knowledge and application.

COBIT 5 presents an process capability model, based on ISO/IEC 15504 Software Engeneering - Process Assessment standard, presented in section XXX. This standard has many similarities and guidelines presented by CMMI, but is not as widely accepted as this one. In fact, it has appeared after CMM, that was been replaced by the CMMI, and cannot face with some benefits CMMI presents face to this standard.

COBIT 5 also considers CMMI as a related framework, as stated in figure XXX, and identifies, as stated in [REFERENCE HERE], that some areas and domains are covered by CMMI, namely application-building and acquisition-related processes in the Build And Acquire domain and some organizational and quality-related processes from the Acquire, Plan and Organize domain.

4.2.3 COBIT 5 process capability model COBIT 5 includes a process capability model based on ISO/IEC 15504 Software Engineering - Process Assessment standard.[11] This model allow to measure the current level of maturity of enterprise processes, presenting the gap between the current level and the desired one the enterprise wants to achieve. This new capability model is an improvement of the previous on COBIT 4.1 [4], being more simplified and compliant with a generally accepted process assessment standard.

4.2.4 COBIT 5 critical analysis The COBIT 5 is one of the most interesting frameworks widely accepted by organizations in the IT management and Governance area. It arises as the main framework for establishing processes to guide us on management and governance and establish ways to control them. However, it is a complex framework that needs time and practice to be fully implemented.

For this project, we will consider only the domains relevant for our objectives, making a selection of the processes we pretend to implement. This will allow us to get the bigger value COBIT has to offer, making it possible, in the time-frame available, achieve our implementation objectives.

One important aspect of the use of COBIT is that it provides a more business and strategic view of IT on organizations, presenting a lack of operational approach to some themes that are

relevant for our project. To overcome this, we will analyze a more operational framework on IT service management, the ITIL V3 framework[22, 23, 24, 25, 26, 27] and a project management guide considered by the main specialists on the area as the reference for project management, the Project Management Book of Knowledge[5].

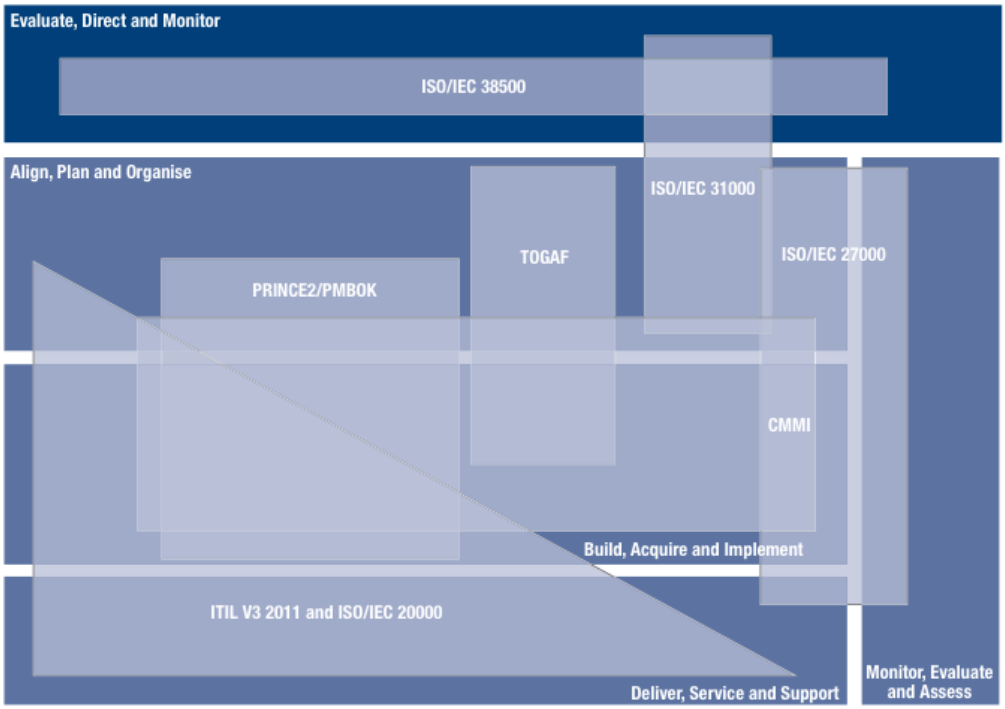

Fig. 3. COBIT 5 coverage on other frameworks

4.3 ITIL V3

First developed in the 1980s by the actual Office of Government Commerce (OGC), a branch of the British Government, ITIL defines processes for IT Service management at a high level. Each organization that intents to apply ITIL for service management should adapt and implement it in the most suitable manner to accomplish particular objectives and needs.[2]

On the last years, ITIL became an important standard worldwide for organizations as the guideline for IT service management (ITSM) processes. Its guidance can be used to transform service management capabilities into strategic assets, that will become fundamental to build distinctiveness to the concurrents and deliver services with higher performance and costumer satisfaction.

The ITIL service management practices are comprised of three main sets of products and services: ITIL service management practices (core guidance), ITIL service management practices (guidance specific to industry sectors, organization types, operating models and technology architectures) and ITIL web support services.

The core set, presented in figure 5 and the one we will consider for this project, consists of six publications: Introduction to ITIL Service Management Practices, Service Strategy, Service Design, Service Transition, Service Operation and Continual Service Improvement. Each one of this volumes share the same conceptual structure, being composed by practice fundamentals and principles, life cycle processes and activities, supporting organization structures and roles, technology considerations, practice implementation and challenges, risks and critical success factors.

4.3.1 Service Strategy Service Strategy volume provides guidance on achieving strategic assets by improving actual service management capabilities. It presents principles for service management

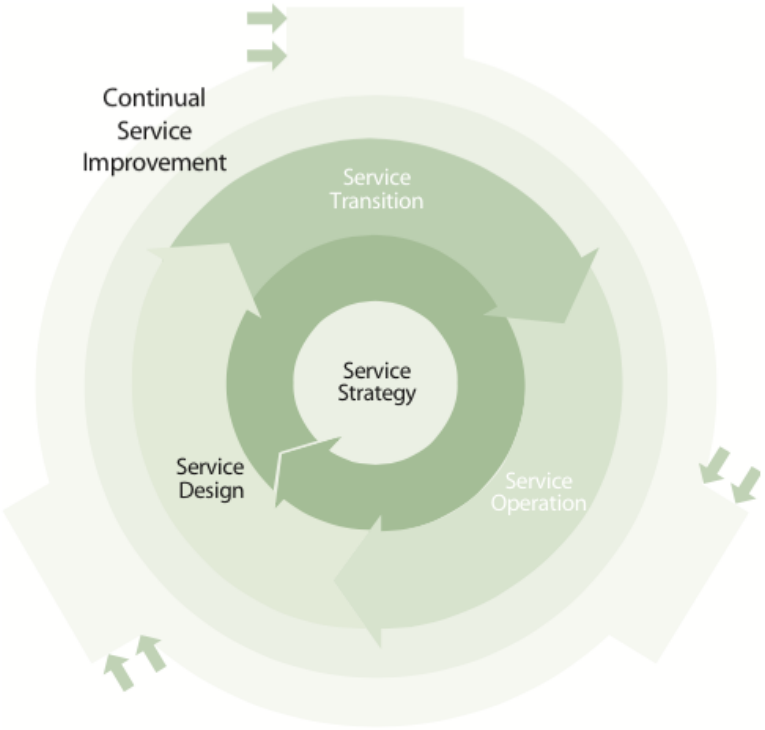

Fig. 4. ITIL V3 volumes

that are important for developing and implementing service management policies, guidelines and processes across the ITIL Service Life cycle.[25] The processes included in Service Strategy volume are:

- Financial Management
- Service Portfolio Management
- Demand Management

4.3.2 Service Design Service Design volume provides guidance for the design and development of services and service management practices. As stated on this volume, "It covers design principles and methods for converting strategic objectives into portfolios of services and service assets. The scope of Service Design is not limited to new services. It includes the changes and improvements necessary to increase or maintain value to customers over the life cycle of services, the continuity of services, achievement of service levels, and conformance to standards and regulations."[23] The processes included in Service Design volume are:

- Service Catalogue Management
- Service Level Management
- Capacity Management
- Availability Management
- IT service Continuity Management
- Information Security Management
- Supplier Management
- Application Management
- Data and Information Management
- Business Service Management

4.3.3 Service Transition Service Transition volume provides guidance for implementing and improve processes for transitioning services in developing or maintaining operations into live service

operation. As stated in this volume, "This publication provides guidance on how the requirements of Service Strategy encoded in Service Design are effectively realized in Service Operation while controlling the risks of failure and disruption."[26] The processes included in Service Transition volume are:

- Change Management
- Service asset and Configuration Management
- Release and deployment Management
- Knowledge Management
- Stakeholder Management
- Transition Planning
- Support and Service Evaluation

4.3.4 Service Operation Service Operation volume presents practices and operations needed to deal with the day-to-day operation of services that are already in live service operation. Pretends to guide on the effectiveness and efficiency achievement on delivering and supporting services, ensuring that it creates value for the customer and for the organization. It is a fundamental capability because is directly connected with IT management and organization's strategic objectives . As stated in the volume, "Guidance is provided on how to maintain stability in service operations, allowing for changes in design, scale, scope and service levels."[24] The processes included in Service Operation volume are:

- Event Management
- Incident Management
- Request Management
- Problem Management
- Access management

4.3.5 Continual Service Improvement As explained in the Continual Service Improvement volume, it "provides instrumental guidance in creating and maintaining value for customers through better design, transition and operation of services. It combines principles, practices and methods from quality management, change management and capability improvement. Organizations learn to realize incremental and large-scale improvements in service quality, operational efficiency and business continuity."[26] This volume also pretends to link service improvement with the guidelines expressed in all other volumes, making it cover the all service life cycle. The processes included in Continual Service Improvement volume are:

- The 7-Step Improving Process
- Service Level Management

Not different from COBIT, ITIL takes public frameworks and standards as a form of the organization to have advantage on the market. Organizations should build their proprietary knowledge considering all the knowledge provided by public frameworks and standards. In addition with this, collaboration and coordination between organizations became easier due to a set of shared practices and standards. According to a research performed by the UK Department of Trade and Industry (DTI), the value to the UK economy from standards is estimated to be about £2.5 billion per annum [19].

For related standards and frameworks to ITIL V3, we have ISO/IEC 20000 (service management system standards), ISO/IEC 27001 (standard providing requirements for an information security management system), PMBOK (manual for a set of standard terminology and guidelines for project management)[5] and COBIT[6], already presented. This are the standards we will cover for our project by being directly related to ITIL V3 and its implementation.

4.3.6 ITIL V3 critical analysis One crucial aspect for the importance of ITIL on this project is the operational view that it provides for IT Service Management. ITIL tries to focus on more management details, providing a more practical guidance for implementation. It is focused on IT Service Management and presents concrete guidance for managing services during its life cycle. De Haes and Van Grembergen state that COBIT tells what to do and ITIL explains how to do it, what makes COBIT adopting a process-focused approach and ITIL a service level-oriented one [1].

The main objective to include ITIL knowledge for this project is to provide a complementary guidance on IT management, enhancing the business oriented view of COBIT with a operational view. COBIT 5 will allow us to take advantage of this complementarity, related to the concern of ISACA to make it more compliant with other frameworks, including COBIT, on the new version (relating to COBIT 4.1).

4.4 PMBOK: A Guide to the Project Management Book of Knowledge

The Guide to the Project Management Body of Knowledge provides guidance on individual projects management and the concepts inherited to it. To achieve this, it presents the processes involved in the project management and project life cycle.[5]

This guide is considered by many professionals in all business management areas as the main reference for processes and good practices in project management, because it compiles a set of good practices that are applicable to most of the projects in most of the contexts, bringing value to all organizations and managers that use it as a reference.

The processes are presented relating them with the knowledge area they belong. The PMBOK presents the following areas of project management:

- Integration Management
- Scope Management
- Time Management
- Cost Management
- Quality management
- Human resource management
- Communications management
- Risk management
- Procurement management
- Stakeholder management

Each group of processes is related with the life cycle of a project, being also grouped in five categories: Initiating, Planing, Executing, Monitoring and Control and Closing, directly related to the phase they are applied on the life cycle. For each process, it is presented the inputs, tools, techniques and outputs that are required to successfully implement it. All processes organized by group and area are presented in figure 6

This guide also provides some background on the project management area, defining common vocabulary and establishing concepts necessary to fully understand all processes. Presents characteristics of projects, programmes and portfolios, roles of project managers and organizational aspects that influence the management process, like organizational structures, culture, assets or stakeholders.

Another important aspect of PMBOK is that is a more general framework, making it necessary to complement with other frameworks or guides when applying to a specific area. This guide only presents the general processes for project management, lacking on implementation details for specific areas, like the area of IT Management.

4.4.1 PMBOK critical analysis The importance of PMBOK for this project is related to its widely acceptance and adoption as the reference guide to project management by many professionals in the area, being tested and evaluated its importance in terms of good practices adopted in project management. Despite being more general and lacking in specificity to IT management, it can be complemented with the two previous frameworks presented (COBIT and ITIL), using some more detailed guidance of ITIL and COBIT to improve PMBOK focus to this project.

Knowledge Areas	Project Management Process Groups				
	Initiating Process Group	Planning Process Group	Executing Process Group	Monitoring and Controlling Process Group	Closing Process Group
4. Project Integration Management	4.1 Develop Project Charter	4.2 Develop Project Management Plan	4.3 Direct and Manage Project Work	4.4 Monitor and Control Project Work 4.5 Perform Integrated Change Control	4.6 Close Project or Phase
5. Project Scope Management		5.1 Plan Scope Management 5.2 Collect Requirements 5.3 Define Scope 5.4 Create WBS		5.5 Validate Scope 5.6 Control Scope	
6. Project Time Management		6.1 Plan Schedule Management 6.2 Define Activities 6.3 Sequence Activities 6.4 Estimate Activity Resources 6.5 Estimate Activity Durations 6.6 Develop Schedule		6.7 Control Schedule	
7. Project Cost Management		7.1 Plan Cost Management 7.2 Estimate Costs 7.3 Determine Budget		7.4 Control Costs	
8. Project Quality Management		8.1 Plan Quality Management	8.2 Perform Quality Assurance	8.3 Control Quality	
9. Project Human Resource Management		9.1 Plan Human Resource Management	9.2 Acquire Project Team 9.3 Develop Project Team 9.4 Manage Project Team		
10. Project Communications Management		10.1 Plan Communications Management	10.2 Manage Communications	10.3 Control Communications	
11. Project Risk Management		11.1 Plan Risk Management 11.2 Identify Risks 11.3 Perform Qualitative Risk Analysis 11.4 Perform Quantitative Risk Analysis 11.5 Plan Risk Responses		11.6 Control Risks	
12. Project Procurement Management		12.1 Plan Procurement Management	12.2 Conduct Procurements	12.3 Control Procurements	12.4 Close Procurements
13. Project Stakeholder Management	13.1 Identify Stakeholders	13.2 Plan Stakeholder Management	13.3 Manage Stakeholder Engagement	13.4 Control Stakeholder Engagement	

Fig. 5. PMBOK processes organized by group and area of knowledge

PMBOK presents processes for all phases of the life cycle of a project, being too extensive considering the theme of this project and the time-frame available. For this scope, we will only be able to consider a subset of all processes presented, being necessary, in the solution's architecture phase of this project, present a mapping between processes covered on PMBOK relating with processes of COBIT and ITIL.

5 Relevant International Standards

In this section we will present the international standards that are referenced or important to complement the frameworks previously presented. These standards will allow us to design processes in conformance with practices that are considerer as the reference in some areas of project management.

We will analyze the ISO/IEC 12207[12], an systems and software engineering international standard for Software life cycle processes. This standard will allow us to define the processes that are important to consider in the scope of this project. It will provide an high-level process reference for the complete life cycle of a software system

Relating to COBIT, we have standards that are directly related to it, as the ISO/IEC 20000[14, 15, 16, 17, 18], a set of international standards for IT service management, and ISO/IEC 27000[10], a set of international standards for information security management systems. COBIT also relates with CMMI[29], the Capability Maturity Model Integration that is a framework for process improvement in business comprising models, appraisal methods, and training.

For other standards more general to all frameworks we will present the ISO 31000[3, 8], a set of standards that provide principles, framework and a process for managing risk, and ISO 19011, a international standard for providing guidelines for auditing management systems. This standards will complement complex areas of project management providing some additional and specific knowledge.

5.1 ISO/IEC 12207

As described by ISO/IEC 12207:2008, it "establishes a common framework for software life cycle processes, with well-defined terminology, that can be referenced by the software industry. It contains processes, activities, and tasks that are to be applied during the acquisition of a software product or service and during the supply, development, operation, maintenance and disposal of software products.".[12] The main objective of this standard is to present standardized processes that will make easier the communication among all stakeholders in the software product life cycle.

This standard groups the processes to be performed during the life cycle of a software project in seven groups . It presents, for each process, its objectives and expected results as well as the necessary activities to implement it. The processes are grouped in 7 groups, related to the phase they are applied during the software life cycle. All processes are listed in figure 7.

- Agreement processes
- Organizational Project-Enabling Processes
- Project Processes
- Technical Processes
- Software Implementation Processes
- Software Support Processes
- Software Reuse Processes

It may be used standalone or jointly with ISO/IEC 15288[13], an international standard for system life cycle processes, and supplies a process reference model that supports process capability assessment in accordance with ISO/IEC 15504[11], a set of technical standards documents for the computer software development processes assessment.

This standard is important for this project in the way it standardize the processes for the whole life cycle of the software, grouping the processes for a better understanding its scope. We will use this standard, specifically figure 7, to present the processes that make part of the scope of this project, after what we will relate them with the frameworks previously presented.

5.2 ISO/IEC 20000

ISO/IEC 20000 corresponds to a standard on IT Service Management. Initially was developed to reflect best practice guidance contained in some frameworks like ITIL, COBIT or Microsoft operations. This standard in composed by 5 parts:

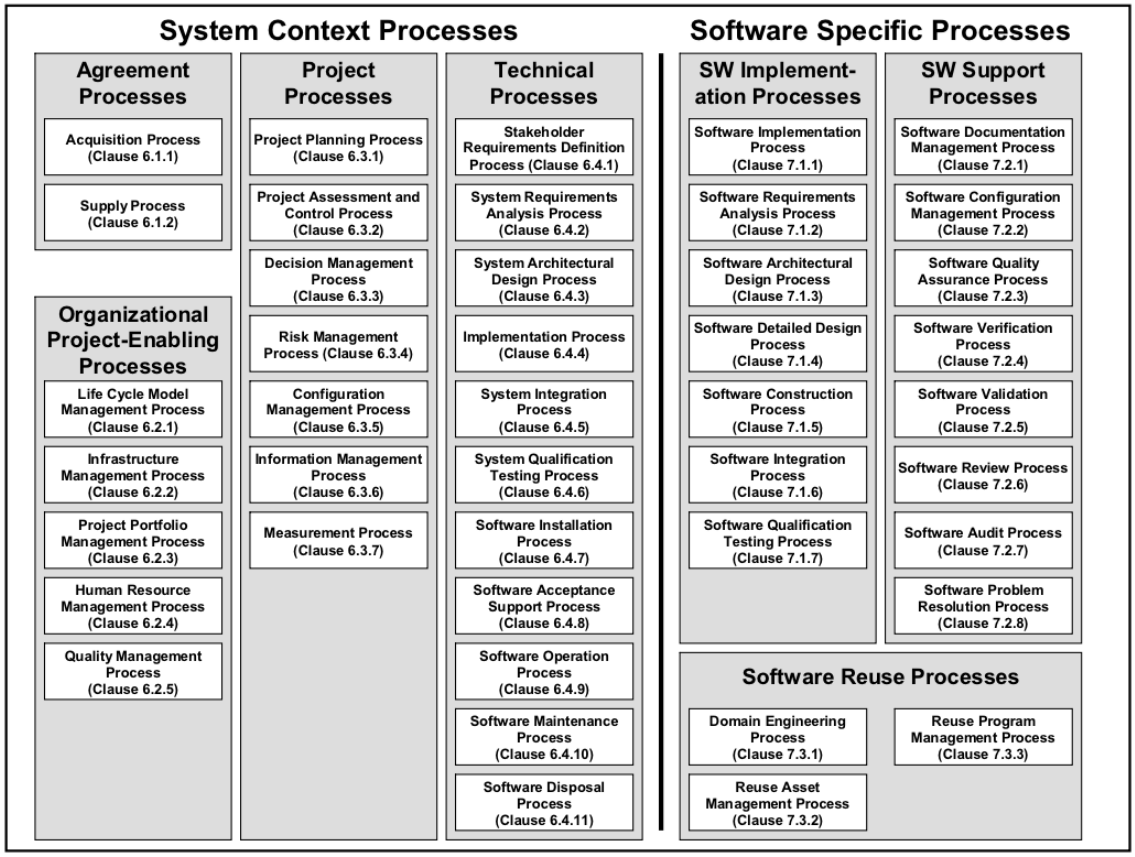

Fig. 6. ISO/IEC 12207 processes

– **ISO/IEC 20000-1:2011** - Corresponds to the most relevant part of the ISO/IEC 20000 standard. It specifies requirements for the service provider to manage the whole system life cycle. Similar to the ITIL V3 view, the requirements include the design, transition, delivery and improvement of services to agree with the service requirements established.[15]

– **ISO/IEC 20000-2:2012** - Provides guidance on implementing Service management systems defined by the requirements of ISO/IEC 20000-1. As presented by ISO/IEC 20000-2, "Enables organizations and individuals to interpret ISO/IEC 20000-1 more accurately, and therefore to use it more effectively. The guidance includes examples and suggestions to enable organizations to interpret and apply ISO/IEC 20000-1, including references to other parts of ISO/IEC 20000 and other relevant standards."[16]

– **ISO/IEC 20000-3:2012** - Used by service providers, consultants and assessors, provides guidance on scope definition, applicability and demonstration of conformity to ISO/IEC 20000-1 requirements specification. It also contains assessment standards.[17]

– **ISO/IEC TR 20000-4:2010** - This standard acts as a facilitator for developing a process assessment model according to ISO/IEC 15504 process assessment principles. Related to ISO/IEC 15504, ISO/IEC 15504-1 describes the concepts and terminology used for process assessment and ISO/IEC 15504-2 describes the requirements for the conduct of an assessment and a measurement scale for assessing process capability.[14]

– **ISO/IEC TR 20000-5:2013** - This standard presents an implementation plan on how to implement a service management system to fulfill the requirements of ISO/IEC 20000-1:2011.

This standard is planned to be used by service providers but can also be used for his advisors to provide guidance on how to implement an service management system.[18]

This standard is a clear complement to the ITIL framework, providing a similar view for the framework previous presented but being more complete in terms of requirements identification and process assessment. ITIL lacks of a process assessment model and detailed implementation plans, being this standard a way to fulfill those problems.

5.3 ISO/IEC 27000

ISO/IEC 27000 is family of international standards related to Information Security management systems (ISMS). This set of standards intent to help organizations of any size to implement and operate an ISMS. As stated by ISO, this family of standards contain information on:

- Requirements definition for an ISMS and for certification of those systems.
- Support and guidance for the overall process to establish, implement, maintain and improve and ISMS.
- Conformity assessment for ISMS.
- Terms and definitions related to Information security management.

This family of standards is commonly used by organizations to implement frameworks for managing information security, protecting important assets as financial data or customers details. Information security is one of the main concerns on any organization, because information leaks or losses can have severe consequences for the overall organization.

International standards as ISO 31000 and ISO 19011 are also related to this family of standards, making risk management and auditing management systems, respectively, areas that have direct impact on information security management systems. Dealing with information security is impossible without considering risk. The overall ISMS need to take account processes for risk identification, treatment and assessment for establishing a secure management system. Furthermore, and also related to risk, ISMS need to consider auditing management as a way to ensure information security and its correct management.

This standard will be important for our project considering we deal with processes that consume and produce information, and all information is an important asset for any organization implement this processes, making this standard fundamental to establish an information security management system to protect all the information we deal with.

5.4 ISO 31000

ISO 31000 is a set of standards related to risk management. ISO 31000:2009, Risk management - Principles and guidelines, provides principles, framework and a process for managing risk. It can be used by any organization independently of its context of operation (size, sector, activity). As presented by this standard, "Using ISO 31000 can help organizations increase the likelihood of achieving objectives, improve the identification of opportunities and threats and effectively allocate and use resources for risk treatment."[8]

In figure 8, we can observe the purposed framework by ISO 31000:2009, used to implement risk management on the management system of the organization. Many organizations have already frameworks for implementing risk management, distinct from ISO 31000, but that can be evaluated and reviewed against this international standard in order to check its suitability. In figure 9 are presented the processes for Risk management implementation.

As confirmed in this standard, it cannot be used for certification purposes, in the way it doesn't provide guidance for audit programmes, but can be used to compare the risk management processes of the organization with international standard benchmarks.

Risk management is a very complex area on project management. It is connected to the whole life cycle of a project and need to be controlled and assessed in many phases and by different forms. IEC 31010:2009, Risk management - Risk assessment techniques focuses on risk assessment. Risk assessment helps organizations understand the risks that could jeopardize the achievement of

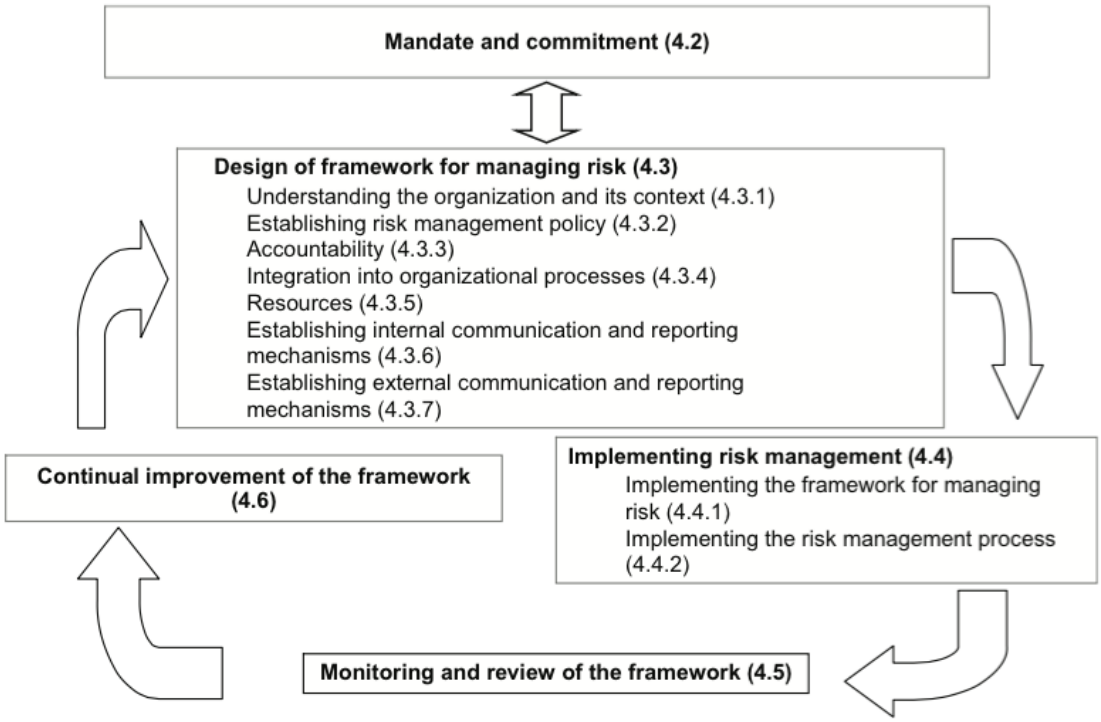

Fig. 7. ISO 31000:2009 framework for Risk Management

management and governance goals as well as the suitability of the risk control activities already in place.[3]

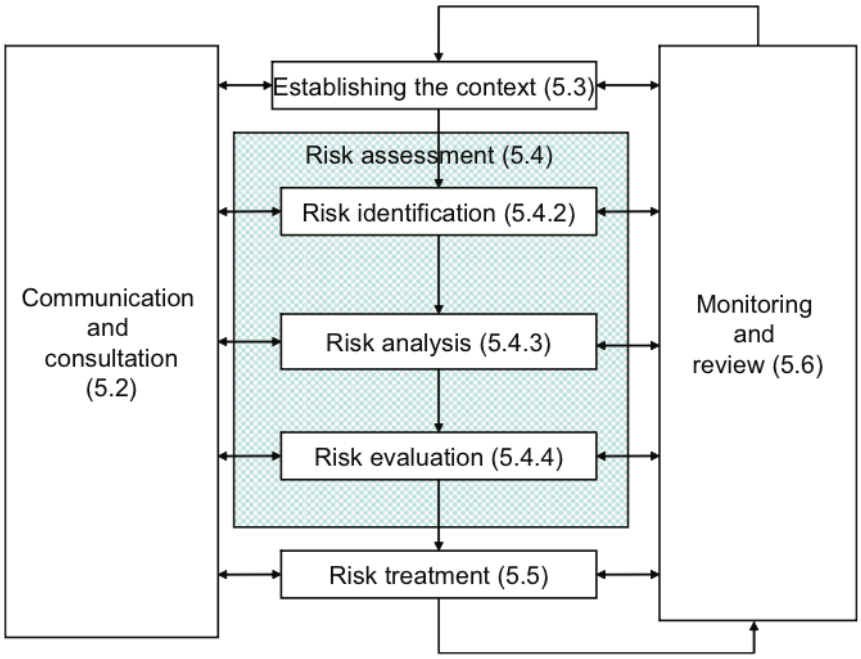

Fig. 8. ISO 31000:2009 Risk Management Processes

The relevance of ISO 31000 for this project focuses on its orientation to an important and complex area of project and maintenance management, providing a framework for Risk management, as well as a set of processes to implement it. It is important to clearly define the scope of this standard related to this project, trying to reduce the complexity and increase its utility for the processes we pretend to design.

5.5 ISO 19011

As defined by this International Standard, "ISO 19011 provides guidance on auditing management systems, including the principles of auditing, managing an audit programme and conducting management system audits, as well as guidance on the evaluation of competence of individuals involved in the audit process, including the person managing the audit programme, auditors and audit teams. It is applicable to all organizations that need to conduct internal or external audits of management systems or manage an audit programme."[9]

In figure 10 is presented the process flow for the management of an audit programme, described in this international standard. This process can be specially important for our project if we pretend to introduce the auditing processes in the scope of the processes to design. We can use the process flow presented in figure 10 to help designing a auditing process.

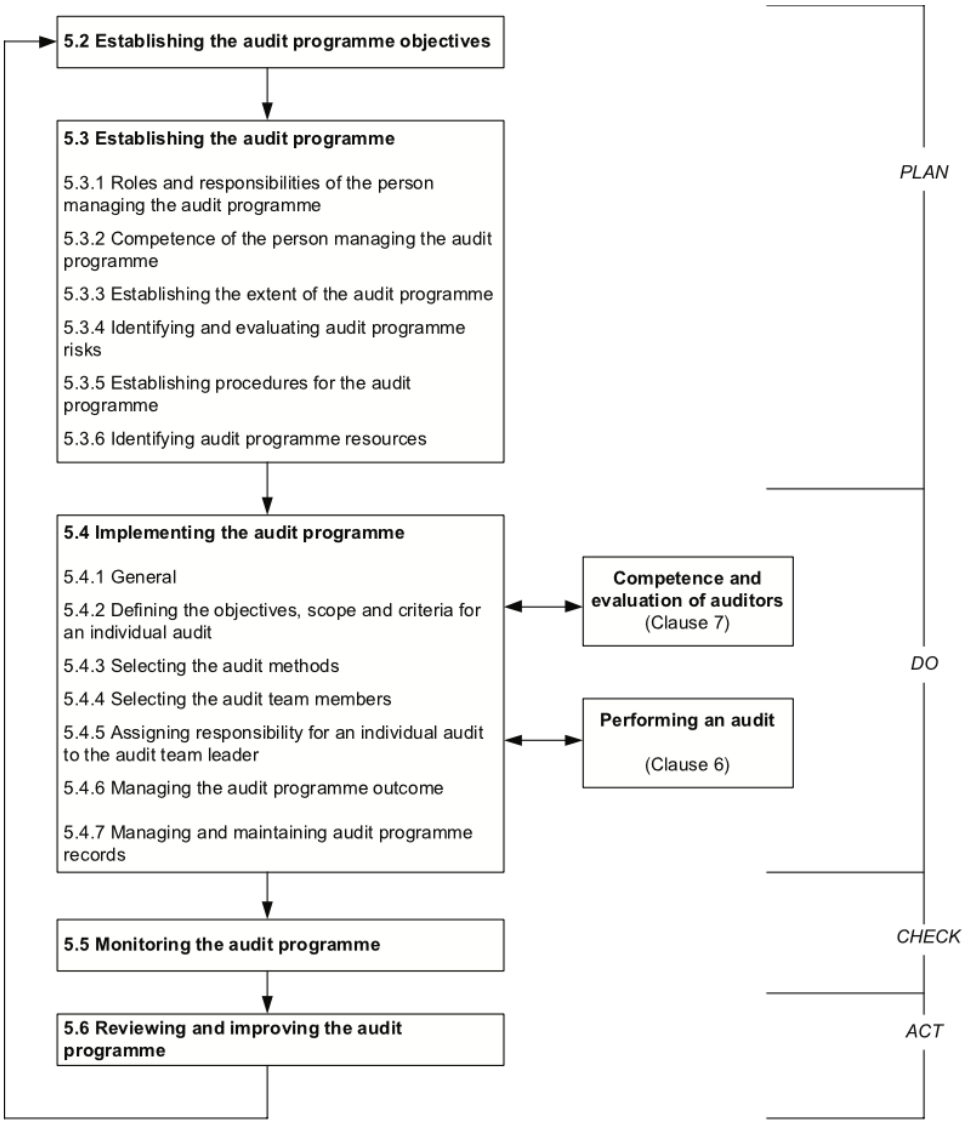

Fig. 9. ISO 19011 process flow for the management of an audit programme

6 A State of the Art in Market Solutions

6.1 Project Management

6.2 IT Service Management

7 Solution's Architecture

7.1 Stakeholders

7.2 Processes

8 Work's Evaluation Methodology

This section corresponds to the "Evaluation" phase of DSRM methodology. We will present how we intent to evaluate our solution. For this project, besides the demonstration evaluation, where we will apply our processes to a real case scenario of a information systems administration of an organization, we will evaluate our solution using the Moody and Shanks Framework [21], a framework to evaluate the quality of data models.

We pretend to evaluate our processes through interviews with the main stakeholders of this project, considering their opinion on the processes suitability and adequacy to the problem purposed. This will allow us to have feedback from the demonstration and evaluation steps of the DSRM process.

Finally, and considering also the communication step of DSRM process, we will submit articles to conferences and journals where our solution will be evaluated and where we can receive feedback from specialists in the area. This articles will be developed in conformance with the conferences and journals calendar, being necessary to evaluate the available conferences and journals and also our project calendar.

8.1 Moody and Shanks Framework

This framework presents a set of metrics to evaluate and improve quality of data models. It has arise from the necessity of guidelines to evaluate quality of data models, trying to achieve agreement between experts on what is a good quality model. This framework consists of five primary constructs:

- Quality factors are the characteristics that contribute to the overall quality of the data model.
- Stakeholders are people involved in developing or using the data model, and therefore have an interest in its quality.
- Quality metrics define ways of measuring particular quality factors.
- Weightings define the relative importance of different quality factors and are used to make trade-offs between them.
- Improvement strategies are techniques for improving the quality of data models with respect to one or more quality factors.

For quality factors, that define how can we measure the quality of our model, this framework presents:

- Completeness refers to whether the data model contains all user requirements.
- Simplicity means that the data model contains the minimum possible entities and relationships.
- Flexibility is defined as the ease with which the data model can cope with business and/or regulatory change.
- Integration is defined as the consistency of the data model with the rest of the organisationâĂŹs data.
- Understandability is defined as the ease with which the concepts and structures in the data model can be understood.
- Implementability is defined as the ease with which the data model can be implemented within the time, budget and technology constraints of the project.

For each quality factor, a set of metrics are presented for evaluation in [20]. The objective of this metrics is to refine these quality factors in specific and concrete measures for evaluating the quality of data models.

8.2 Interviews

Interviews are an evaluation method that will provide us feedback from the stakeholders, defining acceptance criteria for the solution. This interviews will be made, in majority, with the objective of after presenting a solution proposal, discuss which aspects of the solution are already covered and which ones need to be developed or iterated. This will allow us to apply better the DSRM process, taking advantage of its iterative character to achieve a more complete and quality solution.

The results of each interview will be defined later, considering the project phase they are inserted and the concrete objectives, but will in majority be based in open interviews were we pretend, in closer collaboration with the stakeholders, define what is already achieved and what needs improvements and new iterations.

9 Conclusions

A Appendix

Appendix files and refs will go here. Such as your thesis work scheduling.

A.1 Work Scheduling Example

Simple work schedule is presented in Table **??**. You can do something more fancy link a Gantt chart or whatever.

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