Project Management and Maintenance on Information Systems

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Abstract. Information Systems Management on an organization requires handling requests for project execution 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 architecture and a logical application architecture to handle requests for project execution and maintenance operations on Information Systems Management.

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 clients' satisfaction, products' quality and management efficiency in comparison with concurrency. Information Technologies (IT) were applied to business activities to achieve this goal from early.

As stated in [29], *"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 culture. Information systems provide a competitive edge to concurrents, but an organization can only achieve management efficiency with well defined and matured processes.

One important aspect for an organization take advantage of its concurrency is the way how it deals with receipt and management of project execution and evolutive 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 predefined 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 industries, 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.

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

For this project we will use the Design Science Research Methodology (DSRM)[32], presented in section 2, that will provide guidance on the research process for this project, from problem identification to solution's demonstration and evaluation.

2 Research Methodology

To conduct this research we will use the Design Science Research Methodology (DSRM) [32] for presenting and validating a solution for this project's problem. As stated in [32], *"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 it is an knowledge area were theory from other areas are applied to solve problems at the intersection of IT and organizations.[32] 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 Information Systems 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.

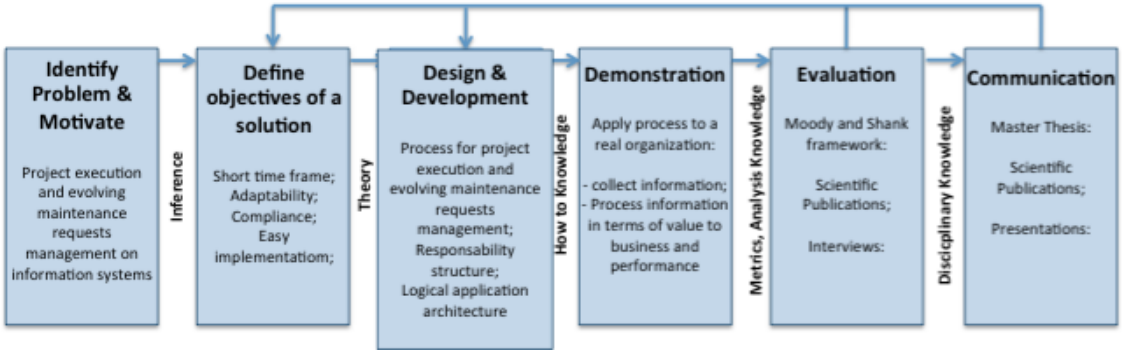

Fig. 1. Project Mapping to DSRM Process

In Figure 1 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 and governance processes. In section 6 we present the state of the art for market solutions on ITSM and PPM tools. In section 7 we make a solution and demonstration proposal being section 8 reserved for the evaluation methodology.

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 request or an evolutive maintenance. 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.

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 aspects the organization defines as the ones which makes the distinction between a project request or evolutive maintenance.

After classified, we need to define the request solution 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[17] analyzed in more detail in section 5.1, 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 that are important for our objectives, defining activities and responsibilities for the requests management and its solution.

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 processes. 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.

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 in [1], *"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).".*

By the COBIT 5 view for this question [11], 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. On 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."*

Taking in account 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 [11], *"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"*. 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. Figure 2 presents the COBIT 5 enablers previous defined and how they relate among themselves in terms of its importance for the organization. Each enabler has stakeholders, a set of goals, a life cycle and can be defined good practices for each one.

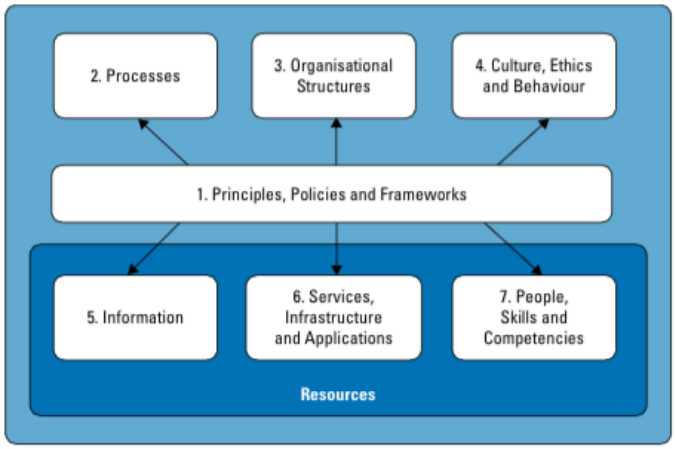

Fig. 2. COBIT 5 enablers. Extracted from [11].

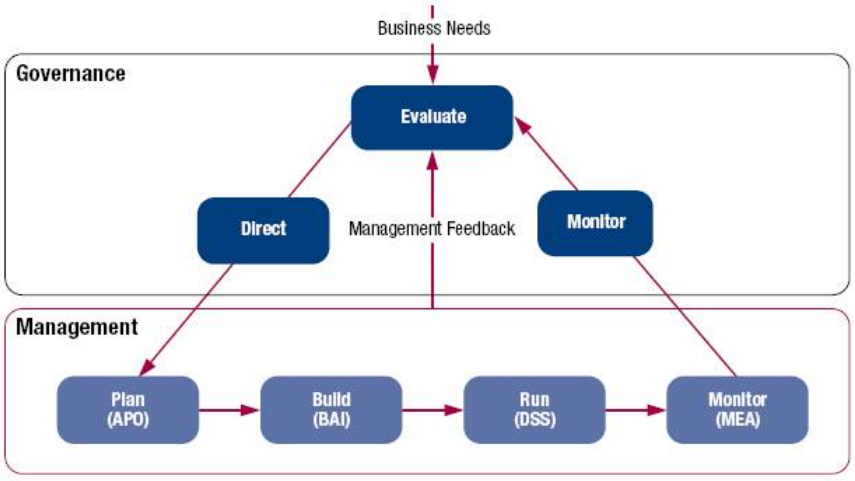

Fig. 3. COBIT 5 domains. Extracted from [11].

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 B and all the implementation details explained in COBIT 5: Enabling Processes[12], a detailed reference guide to the processes defined in the COBIT 5 process reference model. This includes the COBIT 5 goals cascade, a process model explanation and governance and management practices.

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[26, 27, 28, 29, 30], ISO/IEC 20000[20], PMBOK[10] and CMMI[38], 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.

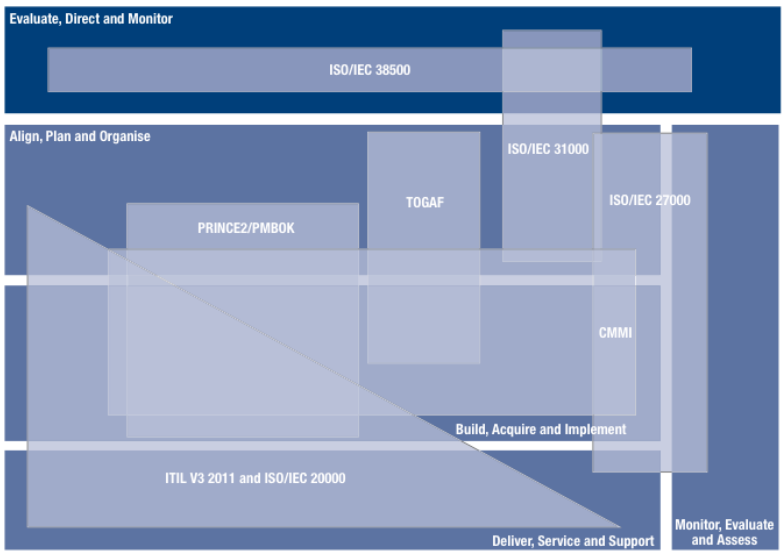

Fig. 4. COBIT 5 coverage on other frameworks. Extracted from [11].

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 models, training and appraisal methods. Currently on version 1.3, it defines areas of interest that group collections of CMMI components for models, training and appraisal construction. The three areas of interest are:

- **CMMI for Acquisition (CMMI-ACQ)[37]** - 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)[38]** - 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)[39]** - 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 16 core process areas, covering processes that are fundamental to improve the organization's processes. Each one of the areas is a set of related practices that, when implemented, will achieve goals important for process improvement.

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 maturity levels and the staged representation will achieve capability 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 [36] and must use an CMMI model and an appraisal method in conformance with the appraisal Requirements for CMMI, as the SCAMPI appraisal method[40].

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 this 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 times 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 the next subsection. 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.

COBIT 5 also considers CMMI as a related framework, as stated in Figure 4, and identifies, as stated in [11], 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.[16] 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 [9], 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 problem, we will analyze a more operational framework on IT service management, the ITIL V3 framework[26, 27, 28, 29, 30, 31] 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[10].

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.[5]

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. The core set, 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 that are important for developing and implementing service management policies, guidelines and processes across the ITIL Service Life cycle.[29] 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 [27], *"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."*. 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 [30], *"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."*. 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 [28], *"Guidance is provided on how to maintain stability in service operations, allowing for changes in design, scale, scope and service levels."*. 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 [30], 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.”. 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

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 more on management details, providing a more practical guidance for implementation, namely managing services during its life cycle. De Haes and Van Grembergen state, in [1], 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.

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 ITIL, 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 cycles.[10]

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 knowledge that is applicable to a majority 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 in Figure 5, relating them with the knowledge area they belong. 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.

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.

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.

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. Extracted from [10].

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 references in some areas of project management.

We will analyze the ISO/IEC 12207[17], 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 correlated to it, as the ISO/IEC 20000[19, 20, 21, 22, 23], a set of international standards for IT service management, and ISO/IEC 27000[15], a set of international standards for information security management systems.

For other standards more general to all frameworks we will present the ISO 31000[6, 13], a set of standards that provide principles, framework and a process for managing risk, and ISO 19011[14], 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 [17], 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."*. 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 6.

It may be used standalone or jointly with ISO/IEC 15288[18], 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[16], 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 of its scope. We will use this standard, specifically Figure 6, 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:

- **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.[20]

- **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 [21], *"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."*.

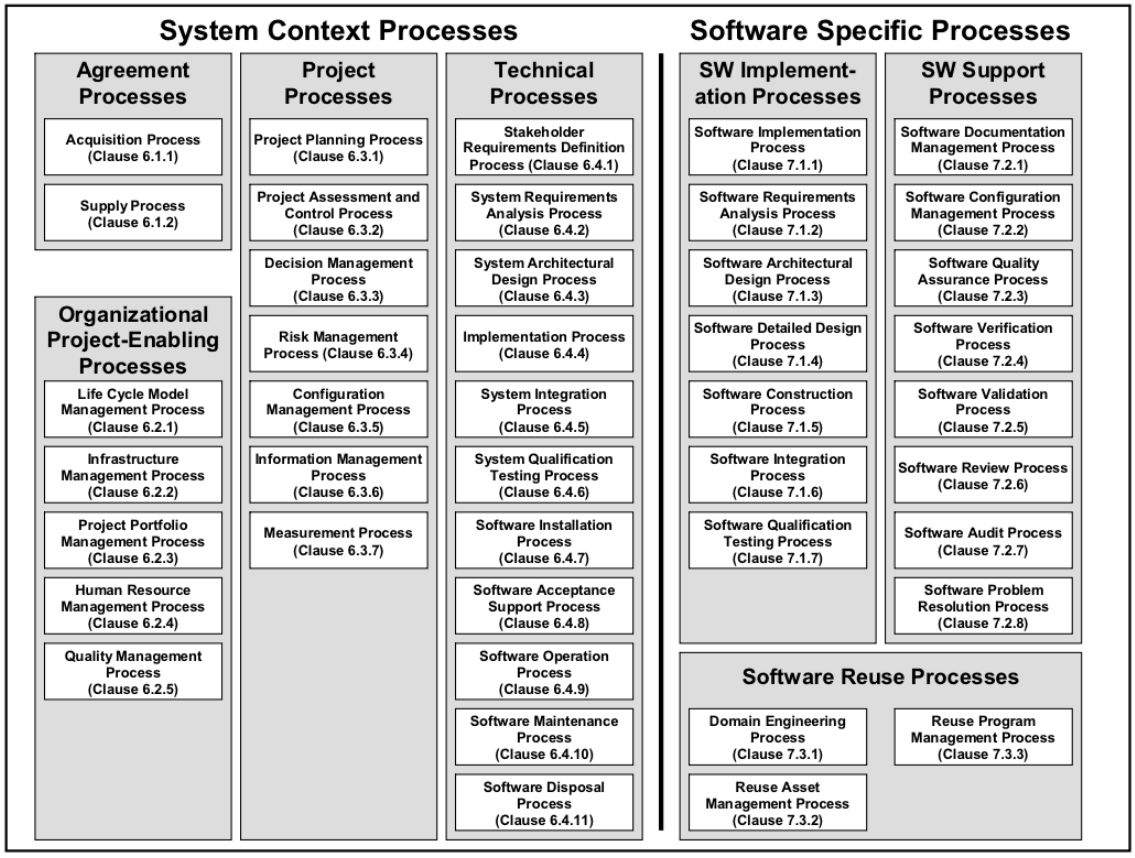

Fig. 6. ISO/IEC 12207 processes. Extracted from [17].

– **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.[22]

– **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.[19]

– **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.[23]

  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[15] 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.

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 [13], *"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."*.

In Figure 7, 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 8 are presented the processes for Risk management implementation.

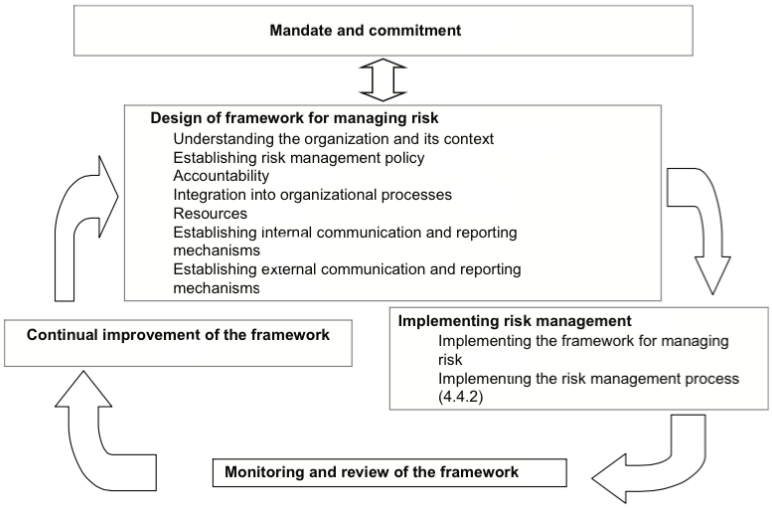

Fig. 7. ISO 31000:2009 framework for Risk Management. Extracted from [13].

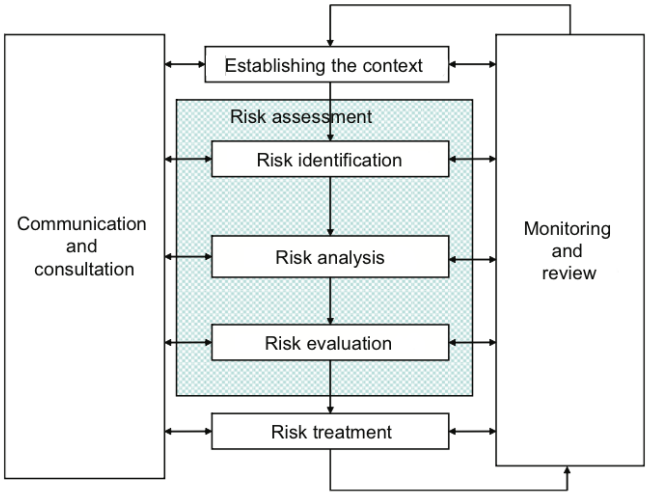

Fig. 8. ISO 31000:2009 Risk Management Processes. Adapted from [13].

As confirmed by ISO 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 management and governance goals as well as the suitability of the risk control activities already in place.[6]

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 [14], *"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."*.

In Appendix C it 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.

6 A State of the Art in Market Solutions

Considering we are interested in developing a logical application architecture, we need to analyze solutions available on the market to compose this architecture. This solutions should be evaluated accordingly with its importance and benefit for project's purposes.

Considering this two areas of interest for this project, we will perform an analysis of the solutions available on the market for Project and Portfolio Management (PPM) and for IT Service Support Management (ITSM) tools. There are hundreds of solutions available for both tools, so we need to find mechanisms for narrowing and evaluating some of them fairly and taking in account its

functionalities and benefits for this project. Thus, we will use researches performed in this areas by Gartner and Forrester, two companies focused on IT research and advisory. Both companies provide techniques to evaluate PPM and ITSM tools, providing us the necessary information to evaluate the market offers and perform a usage proposal based on this results.

6.1 Research Methodologies

In this section we present the research methodologies from Gartner and Forrester that we will use to assess PPM and ITSM solutions. These methodologies were chosen considering we want to evaluate both solutions and providers, namely their performance on PPM and ITSM markets and their supported functionalities.

From Gartner Research we will use the Gartner Magic Quadrant and Gartner Capabilities methodologies. From Forrester Research, we will use the Forrester Wave methodology.

6.1.1 Gartner Magic Quadrant

As stated in [8], the objective of the Gartner Magic Quadrant is to *"provide a wide-angle view of the relative positions of a specific market's competitors."*. It is used to analyze how each solution's provider performs on the market, considering its view for it. This methodology is based on a graphical representation (see figure 9) of how each provider is positioned considering four types of technology's providers. Gartner defines those providers in [8] as:

- **Leaders** - Execute well against their current vision and are well positioned for tomorrow.
- **Visionaries** - understand where the market is going or have a vision for changing market rules, but do not yet execute well.
- **Niche Players** - Focus successfully on a small segment, or are unfocused and do not out-innovate or outperform others.
- **Challengers** - Execute well today or may dominate a large segment, but do not demonstrate an understanding of market direction.

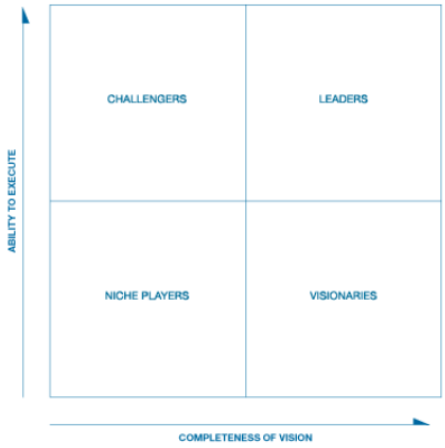

Fig. 9. Gartner Magic Quadrant representation. Extracted from [8].

This methodology is fundamental to analyze technology's providers we can consider for adoption, but we need to take in account on how each provider aligns with the business goals of the organization. Focusing on the Leaders' quadrant is not always the best option and we need to know what specific objectives we want to achieve to select the best provider for fulfilling our requirements.

6.1.2 Gartner Critical Capabilities

As stated by Gartner[7], *"a Critical Capabilities document is a comparative analysis that scores competing products or services against a set of critical differentiators identified by Gartner. It shows you which products or services are a best fit in various use cases to provide you actionable advice on which products/services you should add to your vendor shortlists for further evaluation."*.

This methodology offers better benefits when applied in line with the Magic Quadrant methodology, providing deeper insight on providers' offering that Magic Quadrant evaluates. When available, we will consider these two methodologies together for evaluating PPM and ITSM solutions.

6.1.3 Forrester Wave Methodology

This methodology[33] is provided by Forrester to evaluate providers in Software, Hardware or Service markets, presenting the criteria and the weights for this evaluation. This methodology is transparent for the client, being only based in criteria's weighting performed by Forrester's research professionals. In addition, all the methodology's process and participants are presented, making clear how the evaluation was conducted.

We will present, for the PPM an ITSM tools, the corresponding Forrester Wave reports, complementing the Gartner's evaluation and making our analysis for this tools more valuable and rich.

6.2 Project and Portfolio Management Tools analysis

To perform our analysis on available market solutions for Project and Portfolio Management tools we will use the Gartner Magic Quadrant for IT Project and Portfolio Management from June 2010 [34], the last published Magic Quadrant for this type of tools. For complementing our analysis, we will also present the the Forrester Wave Project/Program Portfolio Management from Q4 2012.[41]

6.2.1 Gartner Magic Quadrant for IT Project and Portfolio Management (June 2010)

This Magic Quadrant was the last one published in this area by Gartner, due to the innovations and new requirements for Cloud-based solutions presented in Gartner Magic Quadrant for Cloud-Based IT Project and Portfolio Management Services[35]. Gartner defines a set of main functionalities each PPM solution's provider must implement to fulfill the market's needs. This functionalities are defined in [34]:

- **IT PPM** - Support to Internal IT Project and Portfolio Management.
- **NPD** - New Product Development.
- **PSA** - Professional Services Administration.
- **AEC** - Traditional architecture, engineering and construction (AEC) environments.
- **ITPC** - IT Planning and Control.
- **APM** - Application Portfolio Management.
- **EPPM** - Enterprise PPM.

In Figure 10 we have the Magic Quadrant for IT Project and Portfolio Management from June 2010. Ability to execute and completeness of vision evaluation's criteria presenting the weightings used on the evaluation of each supplier can be consulted in [34].

For this Magic Quadrant, based on our project objectives, we will consider only the quadrant for the Leaders taking in account we are looking for the most complete solution on all PPM market areas. The Leaders' quadrant presents a full coverage of the core areas considered by Gartner the most important in PPM. From the results shown in [34], we choose this quadrant taking in account that all PPM areas are addressed, while Challengers' quadrant lacks of coverage's depth in some of them.

Leaders also offer flexible deployment solutions, some of them presenting already Cloud-Based solutions. This is specially important when considering the new requirements PPM market is facing over the recent years, in new deployment options to suit clients' needs.

The Leaders quadrant is composed by Planview with the product Planview Enterprise, Compuware with ChangePoint, CA with CA Clarity EPM, HP with HP PPM Center, Microsoft with EPM and Oracle with Primavera. In [34] is presented the main strengths and cautions for each one of this solutions, based on Gartner's analysis.

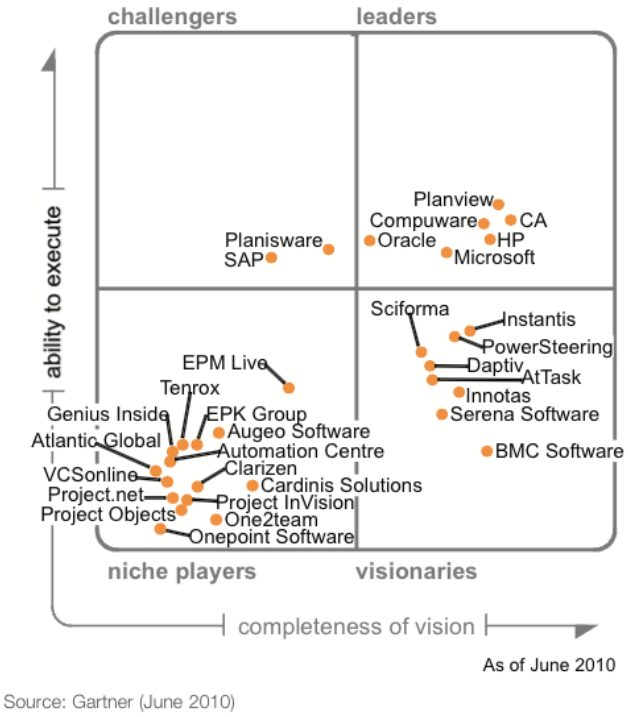

Fig. 10. Gartner Magic Quadrant for IT Project and Portfolio Management (June 2010). Extracted from [34].

6.2.2 The Forrester Wave: Project/Program Portfolio Management, Q4 2012

As stated by Forrester [41], *"Agile development disrupts operations and governance processes such as project/program portfolio management (PPM). That disruption drives a bifurcation in the tools market Traditional PPM doesn't suit the lighter-weight/lean governance processes that Agile projects require."*. Considering this bifurcation in PPM market's needs, Forrester performed a evaluation of PPM vendors, selecting and evaluating the ten most significant ones.

This research was performed considering two Forrester Wave Models. As defined by Forrester in [41], *"Above-the-line vendors serve enterprises primarily interested in portfolio planning, with linkage to tactical work planning and execution. Below-the-line vendors support enterprises seeking immediate help with planning, execution, and work management."*.

As presented in [41], the solutions' providers evaluation criteria is divided in three groups: Current Offering (deployment options, global support, and features for top-down portfolio planning or work-driven execution), Strategy (product strategy, deployment options, support, and pricing) and Market Presence (revenue growth, financial strength, sales and support services, and the ability to support global implementations).

In Figure 11 we can see the Forrester Wave for Above-The-Line Project/Program Portfolio Management and in Figure 12 the detailed scores by high-level criteria. HP, CA Technologies, Planview, and Daptiv are Leaders for this market, being followed by Microsoft, Planisware, Rally, AtTask, and Clarizen that offers competitive solutions, with less strategic alignment capabilities than the Leaders group. Considering the Leaders group and the results presented, HP is clearly the strongest solution in terms of strategy criteria. Planview has its strength in current offering criteria while Daptiv is, from the Leaders quadrant, the one that presents the worst results. CA Technologies is a very complete provider in all criteria, being the most balanced.

In Figure 13 we can see the Forrester Wave for Below-The-Line Project/Program Portfolio Management and in Figure 14 the detailed scores by high-level criteria. HP, Planview, and CA Technologies are clearly the big Leaders, proving good features on all criteria. Microsoft, Rally, and Daptiv are also Leaders, but with lower scores on current offering and strategy criteria groups. AtTask, Clarizen, and Planisware offer competitive solutions facing Leaders solutions, but are designed for different types of work environments.

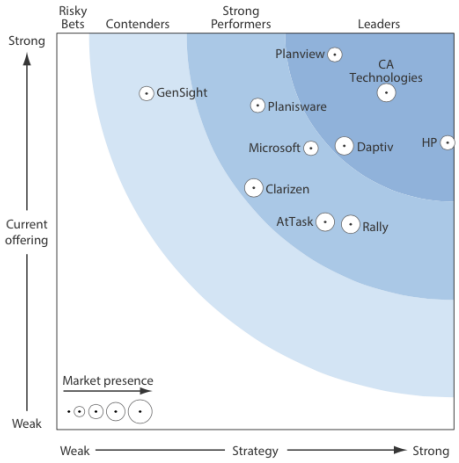

Fig. 11. Forrester Wave for Above-The-Line Project/Program Portfolio Management. Extracted from [41].

	Forrester's Weighting	AtTask	CA Technologies	Clarizen	Daptiv	GenSight	HP	Microsoft	Planisware	Planview	Rally
CURRENT OFFERING	50%	2.62	4.25	3.05	3.58	4.24	3.62	3.55	4.09	4.73	2.59
Product fundamentals											
Deployment options	2%	3.60	4.60	2.60	3.20	2.00	3.80	3.80	4.60	3.40	3.80
Global support	2%	2.70	4.20	2.50	3.80	2.55	4.50	4.60	3.30	3.50	1.85
Administration	1%	3.00	5.00	5.00	5.00	5.00	2.50	3.00	5.00	2.50	3.00
Integration and customization	5%	3.00	5.00	3.00	4.00	3.00	3.00	2.00	3.00	5.00	3.00
Demand management	14%	2.60	4.20	4.20	4.20	4.20	4.20	4.20	3.80	5.00	3.00
Portfolio management	40%	2.20	4.00	2.10	3.30	4.80	3.00	3.00	4.10	5.00	2.30
Project management	2%	4.40	4.40	4.60	4.00	2.00	4.00	5.00	4.60	5.00	4.60
Resource management	15%	3.80	5.00	5.00	3.20	4.40	5.00	4.40	4.80	4.40	3.30
Business intelligence	10%	2.30	3.90	1.80	4.30	5.00	3.90	4.60	4.60	5.00	1.90
IT-specific functionality											
Application life-cycle management (ALM)	2%	3.50	4.50	4.00	4.00	2.50	3.50	4.00	4.50	4.50	4.50
Service management	5%	1.75	4.50	4.00	4.00	3.50	3.00	3.00	3.50	5.00	1.50
Application portfolio management (APM)	2%	1.00	2.25	0.75	0.75	0.75	2.50	0.75	1.00	0.75	0.75
STRATEGY	50%	3.38	4.15	2.48	3.62	1.13	4.92	3.20	2.53	3.50	3.70
Support for implementations	25%	5.00	5.00	3.50	5.00	1.50	5.00	4.50	5.00	5.00	4.50
Product strategy	65%	3.00	4.00	2.00	3.00	1.00	5.00	3.00	1.50	3.00	3.50
Price	10%	1.80	3.00	3.00	4.20	1.00	4.20	1.20	3.00	3.00	3.00
MARKET PRESENCE	0%	3.63	3.15	3.30	4.00	3.00	2.40	2.31	2.30	2.99	3.40
Installed base	25%	4.50	5.00	4.50	5.00	4.50	5.00	1.25	5.00	0.75	4.00
Financial strength	50%	5.00	3.00	3.75	4.50	3.75	1.50	3.00	1.50	5.00	4.50
Support services	25%	0.00	1.60	1.20	2.00	0.00	1.60	2.00	1.20	1.20	0.60

All scores are based on a scale of 0 (weak) to 5 (strong).

Fig. 12. Forrester Wave for Above-The-Line Project/Program Portfolio Management detailed scores by high-level criteria. Extracted from [41].

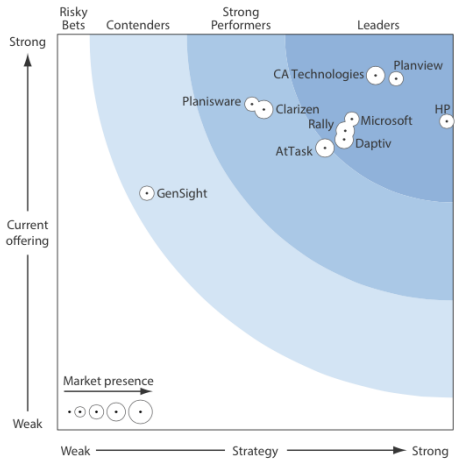

Fig. 13. Forrester Wave for Below-The-Line Project/Program Portfolio Management. Extracted from [41].

	Forrester's Weighting	AtTask	CA Technologies	Clarizen	Daptiv	GenSight	HP	Microsoft	Planisware	Planview	Rally
CURRENT OFFERING	50%	3.56	4.48	4.05	3.67	2.99	3.90	3.93	4.12	4.44	3.78
Product fundamentals											
Deployment options	5%	3.60	4.60	2.60	3.20	2.00	3.80	3.80	4.60	3.40	3.80
Global support	5%	4.10	3.50	3.10	3.00	2.25	4.70	4.50	2.90	3.40	3.95
Administration	1%	3.00	5.00	5.00	5.00	5.00	2.50	3.00	5.00	2.50	3.00
Integration and customization	5%	3.00	5.00	3.00	4.00	3.00	3.00	2.00	3.00	5.00	3.00
Demand management	17%	2.40	4.00	4.60	4.00	4.00	4.00	4.00	3.40	5.00	3.00
Portfolio management	5%	2.02	4.40	2.36	3.80	4.70	3.00	3.00	3.42	5.00	2.80
Project management	20%	4.60	4.60	4.60	3.80	1.80	3.80	5.00	4.60	5.00	4.60
Resource management	20%	4.60	5.00	5.00	3.40	3.80	5.00	3.80	4.60	3.80	3.60
Business intelligence	2%	2.20	4.00	1.60	4.20	5.00	4.00	4.80	4.80	5.00	2.00
IT-specific functionality											
Application life-cycle management (ALM)	18%	3.20	4.50	3.70	3.70	2.20	3.20	3.70	4.50	4.50	4.80
Service management	1%	1.75	4.50	4.00	4.00	3.50	3.00	3.00	3.50	5.00	1.50
Application portfolio management (APM)	1%	1.00	2.25	0.75	0.75	0.75	2.50	0.75	1.00	0.75	0.75
STRATEGY	50%	3.38	4.02	2.61	3.62	1.13	4.92	3.72	2.46	4.28	3.64
Support for implementations	25%	5.00	5.00	3.50	5.00	1.50	5.00	4.50	5.00	5.00	4.50
Product strategy	65%	3.00	3.80	2.20	3.00	1.00	5.00	3.80	1.40	4.20	3.40
Price	10%	1.80	3.00	3.00	4.20	1.00	4.20	1.20	3.00	3.00	3.00
MARKET PRESENCE	0%	3.63	3.15	3.30	4.00	3.00	2.40	2.31	2.30	2.99	3.40
Installed base	25%	4.50	5.00	4.50	5.00	4.50	5.00	1.25	5.00	0.75	4.00
Financial strength	50%	5.00	3.00	3.75	4.50	3.75	1.50	3.00	1.50	5.00	4.50
Support services	25%	0.00	1.60	1.20	2.00	0.00	1.60	2.00	1.20	1.20	0.60

All scores are based on a scale of 0 (weak) to 5 (strong).

Fig. 14. Forrester Wave for Below-The-Line Project/Program Portfolio Management detailed scores by high-level criteria. Extracted from [41].

Considering the Leaders group, CA Technologies is the most balanced solution, presenting good results in all criteria. HP stands out for the strategy criteria while the other Leaders solutions have lower score in all criteria, even though they constitute good alternatives to the other Leaders.

6.3 IT Service Support Management Tools analysis

To assess the available market solutions for IT Service Support Management tools we will use the Gartner Magic Quadrant for IT Service Support Management Tools from August 2014[4]. Also from Gartner, we will analyze the Critical Capabilities for IT Service Support Management Tools from August 2014[3]. To provide a more wider and heterogeneous view for this type of tools, we will consider the Forrester Wave: ITSM SaaS Delivery Capabilities, Q3 2014[2]

6.3.1 Magic Quadrant for IT Service Support Management Tools

This Magic Quadrant provides a precious support on ITSM tools' analysis for professionals in IT Service Management. ITSM tools helps on management processes of IT services delivered by the organization, automating the tasks and workflows for quality IT services delivery to the business.

As stated by Gartner in [4], *"the market for ITSSM tools is segmented according to the vendors' abilities to provide strong ITSSM capabilities and high levels of ease of integration with broader IT operations management functionalities."*. Therefore, we can have basic, intermediate and advance vendors considering its ability to integrate with third-party IT Operations Management solutions and the set of ITSM functionalities. Each organization should analyze its own Infrastructure and Operations (I&O) maturity level and choose an adequate solution. Basic or intermediate vendors are suitable for low maturity I&O organizations while advance vendors are better option for the high maturity ones.

In Figure 15 we have the Magic Quadrant for IT Service Support Management Tools from August 2014. Ability to execute and completeness of vision evaluation's criteria presenting the weightings used on the evaluation of each supplier can be consulted in [4].

Fig. 15. Gartner Magic Quadrant for IT Service Support Management Tools (August 2014). Extracted from [4].

For this Magic Quadrant, and considering our project objectives, we will consider only the Leaders' and Challengers' quadrants, taking in account we are interested in a complete ITSM solution suited for different levels of maturity on I&O management. For the Leaders quadrant, composed by BMC and ServiceNow, we have providers more complete in terms of market's needs understanding, providing solutions that are better aligned with the Gartner's vision of the market.

In the challengers quadrant, CA Technologies and Cherwell Software offer competitive solutions in terms of ability to execute criteria. Aspects as Customer Experience or Pricing are well covered by these providers.

Considering the results presented in this Magic Quadrant, we will consider the following solutions: ServiceNow IT Service Automation Suite from ServiceNow, BMC Remedy ITSM Suite, BMC FootPrints Service Core and BMC Remedyforce from BMC Software, Cherwell Service Management from Cherwell Software and CA Service Management and CA Cloud Service Management from CA Technologies.

6.3.2 Gartner Critical Capabilities for IT Service Support Management Tools

For complementing the vendors' analysis performed by the Gartner Magic Quadrant for ITSM Tools, we will also consider the Gartner's Critical Capabilities for IT Service Support Management Tools from August 2014[3], providing an evaluation of ITSSM tools' critical capabilities in five use cases.

As defined by Gartner in [3], the use cases evaluated are:

- **Low to Medium Maturity** - Focused on incident and problem management capabilities, high ease-of-use levels, and out-of-the-box best-practice capabilities.
- **Medium to High Maturity** - Focused on incident and problem management capabilities, with increased weighting for integrated change, configuration and release management capabilities.
- **High Maturity** - Places significant weight on change, configuration and release capabilities, as well as integration with broader ITOM functionalities.
- **Digital Workplace** - Focuses on high weights for IT service request management and IT knowledge management. This scores the products' ability to appeal to business users.
- **Total ITSSM** - Organizations focus on a single tool or suite of tools from one vendor to provide broad service support management functions.

For product capabilities ratings, Gartner uses the following capabilities:

- Incident and Problem
- Change, Configuration and Release
- Service Request Management
- IT Knowledge Management
- Reporting and Dashboards
- Out-of-the-Box Best Practices
- Data Source/ITOM Tool Integration
- Telephony/UCC Platform Integration
- Product Setup and Complexity

In [3] it is provided the products' or services' scores for each use case considered. For Low to Medium Maturity use case, Cherwell and EasyVista solutions are the ones that have the higher score, presenting good incident and problem management capabilities, high ease-of-use levels, and out-of-the-box best-practice capabilities. For the all other use cases, ServiceNow and BMC solutions lead the market, providing good scores for all the desired capabilities on an ITSM tools.

6.3.3 Forrester Wave: ITSM SaaS Delivery Capabilities for Q3 2014

As stated by Forrester in [2], *"How an IT or business service is delivered directly affects the quality of experience for the service consumer and the reputation of the infrastructure and operations (I&O) team that delivers the services."*. The need for ITSM vendors' solutions evaluation lead to this Forrester evaluation of the top ten most significant vendors in ITSM market.

The solutions' providers evaluation criteria is divided in three groups: Current offering (client feedback, scope of predefined service, breadth of offering, availability and resiliency, security and compliance, updatability and services activation time), Strategy (customer experience, digital disruption, big data and mobile mind shift) and Market Presence (number of enterprise customers, corporate profitability and ITSM SaaS growth).

Considering the features and functionality assessment of ITSM's vendors, the main core areas are: enabling of the most commonly adopted ITSM capabilities (incident, service request, problem, change, knowledge, service-level, and configuration management), the configuration management database (CMDB) or better service information system (SIS), a service portal (or exchange) with self-service capabilities and enabling of social, mobility, and automation capabilities.

In Figure 16 we can see the Forrester Wave: ITSM SaaS Delivery Capabilities for Q3 2014 and in Figure 17 the detailed scores by high-level criteria. SysAid Technologies, Cherwell Software and ServiceNow are Leaders for this market while all the other vendors follow them, being rated as Strong Performers. The Leaders show high ITSM SaaS delivery capabilities and stand apart in customer's feedback. While the Strong Performers vendors present good results for some criteria, they lack on other ones, making them a less complete solution for the ITSM Market

All the Leaders' solutions are aimed for all markets, making the difference stand only on specific features or details of each solution. Customers should conduct a detailed analysis to the detailed scores in Figure 17 to conclude what is the best solution for a given criteria type.

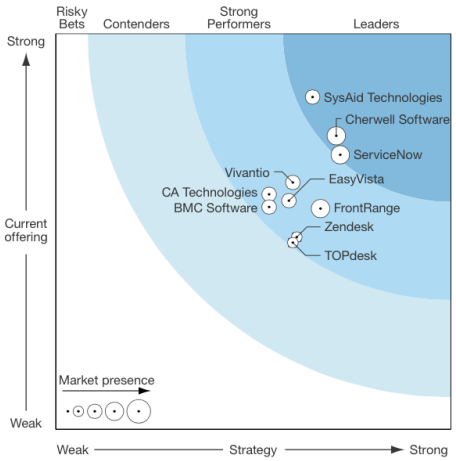

Fig. 16. Forrester Wave: ITSM SaaS Delivery Capabilities. Extracted from [2].

	Forrester's Weighting	BMC Software	CA Technologies	Cherwell Software	EasyVista	FrontRange	ServiceNow	SysAid Technologies	TOPdesk	Vivantio	Zendesk
CURRENT OFFERING	50%	2.81	2.97	3.71	2.89	2.79	3.47	4.20	2.36	3.12	2.43
Client feedback on overall satisfaction*	10%	3.00	2.00	4.00	4.00	1.00	5.00	4.00	2.00	3.00	3.00
Client feedback on value for money*	15%	1.00	4.00	4.00	1.00	1.00	3.00	5.00	1.00	3.00	3.00
Scope of predefined service	15%	2.50	2.00	3.30	2.70	2.60	3.10	3.60	2.80	0.90	2.10
Breadth of offering	10%	2.80	3.60	3.60	2.00	3.80	3.60	3.80	1.80	3.40	2.80
Availability and resiliency	20%	2.90	2.70	4.40	4.00	3.60	3.70	4.40	2.50	3.30	0.90
Security and compliance	15%	3.80	3.00	2.50	3.00	4.00	3.80	3.80	2.70	3.20	1.90
Upgradability	10%	3.00	3.68	5.00	4.32	3.02	2.32	4.34	3.00	5.00	3.68
Services activation time	5%	5.00	3.00	2.00	1.00	3.00	3.00	5.00	4.00	5.00	5.00
STRATEGY	50%	2.70	2.70	3.55	2.95	3.35	3.60	3.25	3.00	3.00	3.05
Vision	35%	3.00	3.00	5.00	4.00	4.00	4.00	3.00	4.00	3.00	2.00
Planned enhancements	10%	3.00	3.00	3.00	3.00	3.00	5.00	3.00	3.00	3.00	3.00
Pricing structure	15%	1.00	1.00	2.00	3.00	3.00	2.00	2.00	2.00	3.00	3.00
Sharing of configurations	20%	3.00	3.00	5.00	3.00	3.00	5.00	5.00	3.00	1.00	3.00
Release schedule	20%	3.00	3.00	1.00	1.00	3.00	2.00	3.00	2.00	5.00	5.00
MARKET PRESENCE	0%	2.90	3.00	3.40	2.50	3.60	3.20	2.90	2.00	2.50	1.70
ITSM SaaS growth rate (year-over-year)	20%	3.00	5.00	4.00	2.00	3.00	2.00	3.00	2.00	2.00	0.00
Corporate profitability	30%	4.00	5.00	4.00	1.00	5.00	1.00	5.00	3.00	4.00	0.00
Installed base	50%	2.20	1.00	2.80	3.60	3.00	5.00	1.60	1.40	1.80	3.40

All scores are based on a scale of 0 (weak) to 5 (strong).

Fig. 17. Forrester Wave: ITSM SaaS Delivery Capabilities detailed scores by high-level criteria. Extracted from [2].

7 Solution's Architecture Proposal

Considering this project's problem and the objectives presented in problem contextualization section, we want to develop a process architecture for project and maintenance management to be applied to an Information Systems administration, supported by a logical application architecture.

As long as this project is aligned with a real-case scenario for an organization, we will take the main design decisions considering the stakeholders' needs and concerns for this project, namely the processes to consider for the architecture development and the solutions chosen for integrating the logical application architecture. It will also provide a demonstration scenario for our solution, allowing us to achieve the demonstration and evaluation steps of the DSRM process.

7.1 Real-case Scenario

The real-case organization scenario will provide constraints and assumptions for this project, made available by the organization's stakeholders. Being so, some design decisions were made considering specific requirements from this scenario.

We are dealing with an organization from the utilities sector of Business (Energy), composed by a unique administration for Applications (software) area. This administration will receive two types of requests: project execution and evolving maintenance requests.

Considering the stakeholders for this project, we have two types: Internal and External. Considering internal stakeholders, we have the Business area, composed by the organization administration (Sponsor of this project), the financial and logistic departments, and the Technology area, composed by the Information Systems department (Project execution and Maintenance departments). Considering the external stakeholders, we have the third-parties responsible for project implementation, suppliers, consumers and regulatory entities.

Project Execution department will outsource project implementation to a third-party but internally will maintain processes for project management, independent from the third-party. Evolving maintenance requests are filtered by a Help-Desk service, Wherefore only the major changes requests arrive to the evolving maintenance department.

A project only enters in production phase after approval from the maintenance department. When in production phase, project belongs to the maintenance department. It can, accordingly with a strategical plan previously defined, outsource the maintenance's implementation, being only responsible for its management.

This real-case scenario will allow us to extract some requirements and also take design decisions accordingly to organization's stakeholders' needs and concerns, deciding which processes must be included in the processes architecture and the ones we should not focus, to reduce unnecessary complexity.

7.2 Process Architecture

Taking as reference ISO/IEC 12207, detailed in section 5.1, that standardizes the processes for the whole life cycle of software, we will present the areas we will address in our processes architecture and the reasons for not considering others.

The two main processes areas we can address are governance and management processes. Considering the extensibility of both, we could not focus on the two, giving the time-frame available. Being so, we decided, accordingly with the stakeholders, to not detail governance processes. This type of processes need maturation and organization's insight, being too much complex in the scope of this project. Areas as organization strategy or project portfolio will not be addressed.

Despite this, there are governance processes that will have direct influence on the subjects covered by this project, namely risk, budget and quality management. These subjects will be addressed considering a more operational approach, assuming that organization's strategy for this areas is already defined, being our mission design processes that implement it in practice.

We are considering the use of BPMN 2.0 (Business Process Model and Notation) for processes modeling. It provides a graphical representation for specifying business processes, being the standard for business processes modeling. Due to its large adoption by organizations for business processes' specification, it is the best option for designing a processes architecture.

7.2.1 Processes definition

Using an interview approach with the organization's stakeholders for a more deeper analysis on the problem scope, we defined the areas of interest we need to cover. This areas can change during project execution phases, since requirements are volatile and can be changed. Also, more areas can be covered in the future, if we consider it brings an added value for this architecture.

In Figure 18 we can observe the processes of interest for this project highlighted from the ISO/IEC 12207 international standard. As explained before, processes directly related to governance areas are not considered for this project due to its increased complexity. As consequence, Agreement processes and Organizational Project-Enabling processes are outside the scope for this project.

Technical Processes and Software Implementation processes are also not considered in the scope, based on the requirements presented by the stakeholders and the organization scenario provided. As stated in section 7.1, we will assume these processes will be either outsourced, or managed by the organization according to already defined processes for that purpose.

Software Reuse Processes are also outside the scope of this project. It is a shared opinion of stakeholders that this processes are not related to this project's problem and would only increase its complexity without adding any value.

The processes we will address in detail are the Project processes and the Software Support processes, directly related to project and maintenance management. It constitutes the core of this project and is fundamental for establishing the proposed processes architecture.

Regarding Project processes, and accordingly to the concerns extracted from the stakeholders' interview, we will consider all processes with exception of configuration management process and measurement process, that are not in the scope of interest for this particular project. Considering Software Support Processes, we will only address the Software Configuration Management process and the Software Validation process.

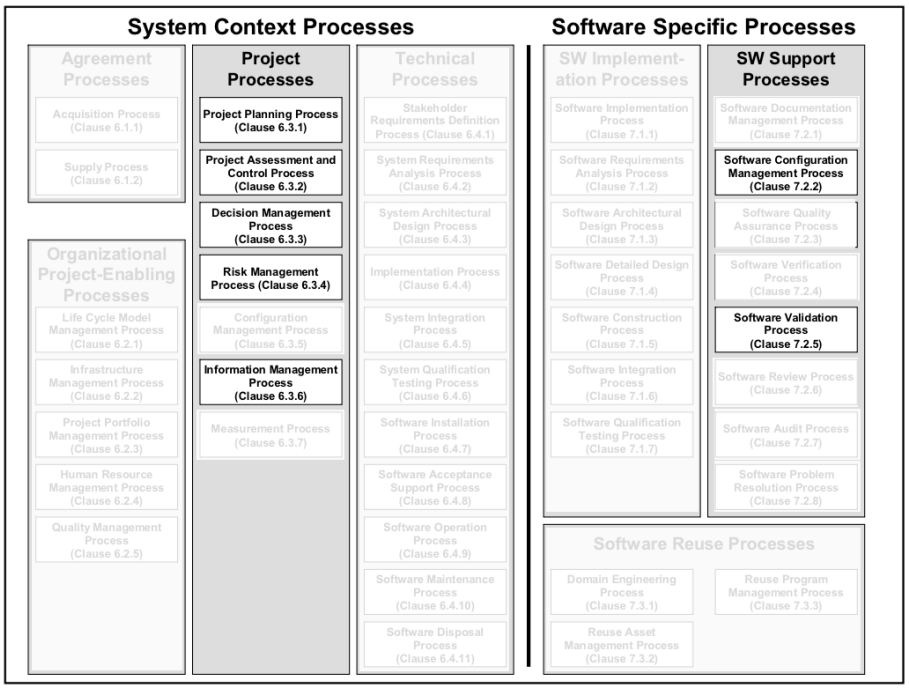

Fig. 18. Processes areas considered for this project. Adapted from [17].

Apart from processes presented by ISO/IEC 12207, the stakeholders presented specific concerns regarding processes on Capacity Management, Issues Management, Financial Management and Document Management. They need to be taking in account on this project's scope considering stakeholders' needs.

Capacity Management, as stated in [27], "ensure that cost-justifiable IT capacity in all areas of IT always exists and is matched to the current and future agreed needs of the business, in a timely manner.". Deals with performance achievement and capacity availability, considering resources and services itself. It tries to balance costs against resources needed and supply against demand.

The main areas are Business Capacity Management (requirements for service and IT infrastructure), Service Capacity Management (performance and capacity management of IT services operation) and Component Capacity Management (performance, capacity and utilization management of individual IT technology components).

Issues Management is the process of identifying and resolving issues, as staff, suppliers, technical or material problems. Many times confused with risks, they can arise from project processes with no warning or no expectation at all. Most organizations find difficult to manage issues from an effectively manner and many times it a process that is not implemented across the complete organization, making more difficult its resolution.

Financial Management, as stated in [29], "provides the business and IT with the quantification, in financial terms, of the value of IT Services, the value of the assets underlying the provisioning

of those services, and the qualification of operational forecasting". Core areas for IT Financial Management are Budgeting (Expenditures planning and controlling), IT accounting (Cost analysis on IT services providing) and Charging (Costs assignment to IT services provided). Financial Management is a complex area and we need a more deeper analysis on its importance for our architecture, in order to remove unnecessary complexity.

Documentation Management corresponds to an area that deals with all documentation concerns on an organization, from technical to project management documentation. This area groups processes for plan, production, tracking and communication of documents produced by the organization in project and maintenance contexts. This processes are also related to the supporting artifacts we want to develop.

In Table 2 we present the processes we will consider for this project and a description of some activities each process implements.

Processes	Description
Project Planning	Scope and goals definition; Requirements establishment; Activities and deliverables identification; Schedule definition; Resources identification; Responsibilities assignment; Quality, Risk and Cost Analysis;
Project Assessment and Control	Project monitoring; Project control; Project assessment;
Decision Management	Decision Planning; Decision analysis; Decision tracking;
Risk Management	Risk Management planning; Risk Profile Management; Risk Analysis; Risk Treatment; Risk Monitoring; Risk Management process evaluation;
Capacity Management	Capacity Plan definition; Performance Monitoring; Performance Analysis; Performance tuning;
Issues Management	Issue Identification; Issue Prioritization; Issue Resolution; Issue Communication;
Financial Management	Budgeting definition; IT Accounting planning; Charging planning; Financial control; Financial communication;
Documentation Management	Documentation definition; Documentation production; Documentation validation; Documentation communication; Documentation tracking;
Software Configuration Management	Software configuration management plan developing; Configuration Identification; Configuration Control; Configuration Status Accounting; Configuration Evaluation;
Software Validation	Validation plan definition; Test requirements, test cases and test specifications preparation; Tests Execution; Software validation against the requirements execution;

Table 1. Processes areas and main activities.

7.2.2 Processes Mapping to frameworks

In this section we will present how each one of the processes in the scope for this project is addressed and mapped into the frameworks and standards presented in section 4 and 5. This will provide us an initial guidance on how we should approach the problem, analyzing what objectives are already covered by the frameworks and which ones need more original work.

Our objective is to use only the important knowledge from sections 4 and 5 for this project, reducing the complexity of implementing a complete framework for the organization. In Table 3 we present the mapping between each processes group in the scope for this project with the framework or standard that covers some aspects for it:

Processes	COBIT 5 Domains				ITIL V3 Volumes					PMBOK	ISO/IEC 20000	ISO/IEC 27000	ISO 31000
	APO	BAI	DSS	MEA	SS	SD	SO	ST	CSI				
Project Planning	✓	✓								✓	✓		
Project Assessment and Control	✓	✓	✓	✓						✓	✓		
Decision Management	✓	✓	✓	✓	✓					✓	✓		
Risk Management	✓					✓				✓		✓	✓
Capacity Management	✓	✓				✓							
Issues Management			✓				✓						
Financial Management	✓				✓								
Documentation Management	✓	✓								✓		✓	
Software Configuration Management		✓						✓					
Software Validation	✓							✓		✓			

Table 2. Processes Mapping to frameworks and standards.

7.2.3 Processes Supporting artifacts

Considering the processes architecture we want to develop, we need some artifacts to support this processes, namely communication and decisions artifacts that will allow us to support the activities' inputs and outputs. For this, we will identify all artifacts needed, clearly defining its purpose, content and participants.

This artifacts will be defined during the designing of the process architecture. The frameworks and standards previously presented define some of them, being our work to address new artifacts that are not already covered and adapt others to better suit to our objectives.

7.2.4 Responsibility Structure

The developed architecture needs to have an inherent responsibility structure, defining the processes' participants accounted for decisions and activities. This structure is particularly important when considering we are dealing with a real-case organization, having an organizational structure already defined and for which our processes should be applied.

For designing this responsibility structure we will consider the work already done in responsibility assignment for the frameworks and standards previously presented. Despite that, we need also to have some original work on this area, considering we are not implementing directly any of those frameworks. This work will be accomplished during the processes' design and taking in account the common responsibility structures on IT organizations.

7.3 Logical Application Architecture

A proposal for a logical application architecture is one of the objectives of this project, being important to support the processes architecture. To achieve this, we evaluated a set of PPM and ITSM solutions available in the market with the objective of achieving a proposal of applications that can be a part of this architecture.

We will only consider proprietary solutions, due to explicit requirements from the organization's stakeholders. This was a precondition that we did not take in account in the state of the art on section 6 but that in this phase will restrict our PPM and ITSM solutions' proposal.

For evaluation purposes, we used Gartner and Forrester research, presented in section 6, that allow us to independently evaluate how these tools stand a position in the PPM and ITSM Market and also what are the solutions more complete in terms of features and capabilities.

In this section we will present the solutions we consider the best for our objectives, being part of a proposal for the project's stakeholders. After deciding what solution we will consider for this project, we need to design a logical application architecture, describing how processes are supported and integrated.

7.3.1 PPM Tools

For PPM solutions, that we evaluate in section 6.2, we used the Gartner Magic Quadrant and the Forrester Wave methodologies for evaluation.

In Magic Quadrant results, that performs an evaluation of the PPM solutions' providers adequacy to the market, we will just consider the leaders quadrant, composed by Planview, Compuware, CA, HP, Oracle and Microsoft. Planview and CA are the suppliers with the best results but are closely followed by the rest. A deeper analysis on strengths and cautions presented by Gartner for each one of this solutions is presented in [34].

For the Forrester Wave results, that evaluates providers by criteria and respective weightings, we will consider the two models explained in section 6.2.2, the above-the-line and below-the-line. For the first one, the leaders quadrant is composed by Planview, CA Technologies, HP and Daptiv. All presents good results but is CA Technologies who is the most complete provider, in terms of current offering, strategy and market presence. Other providers present better results in some of this criteria but are substantially worse in others. For the below-the-line evaluation, we have CA Technologies and Planview very close to each other and HP with an excellent result in strategy criteria. Microsoft, Rally and Daptiv are also part of the leaders, but with results slightly worse.

In Table 3 we can observe the PPM Tools Evaluation results. In green we have the solutions we consider the best for this project taking in account the evaluation results. We also present the alternatives in orange. CA Technologies with CA Clarity PPM, Planview with Planview Enterprise and HP with HP PPM Center are the solutions we will purpose for the PPM Tool to consider for this project.

Solutions Providers	**Gartner Magic Quadrant**	**Forrester Wave**	
		Above-The-Line	**Below-The-Line**
CA Technologies	Leader	Leader	Leader
Planview	Leader	Leader	Leader
HP	Leader	Leader	Leader
Microsoft	Leader	Strong Performer	Leader
Oracle	Leader	-	-
Compuware	Leader	-	-
Rally	-	Strong Performer	Leader
Daptiv	-	Leader	Leader

Table 3. PPM Tools evaluation results.

7.3.2 ITSM Tools

For ITSM solutions, that we evaluated in section 6.3, we used the Magic Quadrant , the Critical Capabilities and the Forrester Wave methodologies for evaluation.

In Magic Quadrant results we will just consider the leaders and challengers quadrants, composed by ServiceNow and BMC Software for the leaders and Cherwell and CA Technologies for

challengers. ServiceNow is the best provider in terms of ability to execute with some advantage to concurrency but really close of BMC Software in terms of completeness of vision. Cherwell Software and CA Technologies present a considering lower result for completeness of vision considering the leaders quadrant. A deeper analysis on strengths and cautions presented by Gartner for each one of this solutions is presented in [4].

In Critical Capabilities results, we will only consider the High-Maturity, Digital Workplace and Total ITSM Use Cases, the ones that are more adequate to our objectives and to the organization's scenario. We will also only consider the solutions provided by the suppliers in the leaders and challengers quadrants presented by Gartner. In all the use cases considered, BMC Remedy ITSM Suite and ServiceNow IT Service Automation suite have the higher scores, being followed by some distance by CA Service Management and Cherwell Software Service Management.

For the Forrester Wave results, we have Cherwell Software and Service Now as the leaders, very close to each other and with a very good result in terms of market presence. BMC Software and CA Technologies are considered Strong Performers, but at some distance of the other two. Forrester establishes big differences between the two leaders providers and the two strong contenders in terms of the three criteria considered.

In Table 4 we can observe the ITSM Tools Evaluation results. In green we have the solution we consider the best for this project taking in account the evaluation results. ServiceNow with ServiceNow IT Service Automation is the solution we will purpose for the ITSM Tool to consider for this project. We also present other alternatives in orange. It should be taken special attention to CA Technologies tool as alternative solution if we consider the CA Technologies PPM tool due to easier integration between the PPM and ITSM tools.

Solutions Providers	**Gartner Magic Quadrant**	**Gartner Critical Capabilities**			**Forrester Wave**
		High Maturity UC	**Digital Workplace UC**	**Total ITSM Use Case**	
ServiceNow	Leaders	3,68	3,49	3,56	Leader
Cherwell Software	Challengers	3,15	3,12	3,22	Leader
BMC Software	Leaders	3,74	3,49	3,52	Strong Performers
CA Technologies	Challengers	3,39	3,31	3,22	Strong Performers

Table 4. ITSM Tools evaluation results.

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 an information systems administration of an organization, we will evaluate our solution using the Moody and Shanks Framework [25], a framework to evaluate the quality of data models.

We also pretend to evaluate our processes through interviews with the main organization's scenario stakeholders of this project, considering their opinion on the processes' suitability 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 analyze the available options considering our project's 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 organization's 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 [24]. The objective of this metrics is to refine these quality factors in specific and concrete measures for evaluating the quality of data models.

Our objective is to use this framework on our final solution, analyzing the metrics presented in [24] to evaluate each quality factor and how it is achieved in our solution, providing a well-defined evaluation method for this project.

8.2 Interviews

Interviews are an evaluation method that will provide us feedback from the organization's scenario 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 it are already covered and which ones need to be developed or iterated. This will allow us to apply the DSRM process, taking advantage of its iterative character to achieve a more complete solution.

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

9 Conclusions

In this project we purpose to design a processes architecture for project execution and evolving maintenance requests management inside a Information Systems Management of an organization. This architecture will be supported by a set of artifacts and a responsibility structure. We also pretend to design a logical application architecture considering PPM and ITSM tools to support the processes architecture implementation.

We analyzed COBIT, ITIL and PMBOK frameworks, considered by professionals in the area the most important on IT Governance and Management processes, with the objective to extract the most important guidances on management processes. This frameworks are complex and extensive, being necessary to consider only the processes areas that bring added-value for this project and constitute concerns for the stakeholders. We also considered a set of international standards on IT service, Risk, Information Security and Audit Management to complement our knowledge on these areas.

Considering we pretend to develop a logical application architecture, we also made a state of the art in PPM and ITSM solutions available in the market, evaluated using Gartner and Forrester research methodologies. This methodologies allowed us to come with a proposal of PPM and ITSM solutions to adopt.

As future work, we pretend to design the process architecture considering the processes scope presented in this project, as well as to provide a logical application architecture to support this architecture. We also want to apply this architecture to a Information Systems department of a real-case organization, demonstrating the appliance of our solution and evaluating its performance. In Appendix A we present a Gantt chart with these activities scheduled in time.

A Appendix

A.1 Appendix A - Work Scheduling Plan

The next Figure presents the Gantt Chart for this project. In Table 6 we have a description of objectives for each task.

Task ID	Task Name	Duration	Start
1	**Proposal**	**20 days**	**Fri 09-01-15**
1.1	Project Discussion	20 days	Fri 09-01-15
2	**Processes Architecture Design**	**65 days**	**Sat 10-01-15**
2.1	Processes Modelling	21 days	Sat 10-01-15
2.2	Artifacts Definition	11 days	Fri 06-02-15
2.3	Responsibility Structure Definition	11 days	Fri 20-02-15
2.4	Evaluation Interview	6 days	Fri 06-03-15
2.5	Second Iteration on Processes	11 days	Fri 13-03-15
2.6	Evaluation Interview	6 days	Fri 27-03-15
2.7	Final Processes Architecture Proposal	6 days	Fri 03-04-15
3	**Logical Application Architecture**	**26 days**	**Fri 10-04-15**
3.1	PPM Solution Architecture	6 days	Fri 10-04-15
3.2	ITSM Solution Architecture	6 days	Fri 17-04-15
3.3	Integrated Architecture Design	6 days	Fri 24-04-15
3.4	Evaluation Interview	6 days	Fri 01-05-15
3.6	Final Logical Application Architecture	6 days	Fri 08-05-15
4	**Demonstration**	**11 days**	**Fri 15-05-15**
4.1	Processes Architecture and Logical	6 days	Fri 15-05-15
4.2	Responsibility Structure Mapping	6 days	Fri 15-05-15
4.3	Evaluation Interview	6 days	Fri 22-05-15
5	**Evaluation**	**6 days**	**Fri 29-05-15**
5.1	Stakeholders Interview	6 days	Fri 29-05-15
5.2	Moody and Shanks Framework Evaluation	6 days	Fri 29-05-15
6	**Dissertation**	**21 days**	**Fri 05-06-15**
6.1	Produce Dissertation	21 days	Fri 05-06-15

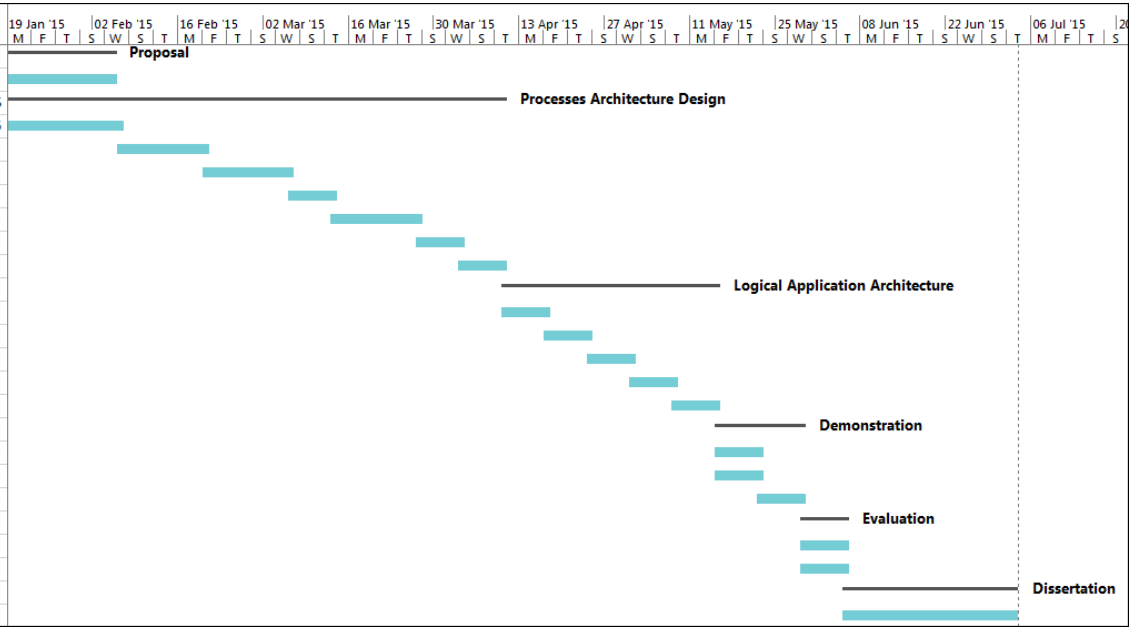

Fig. 19. Gantt Chart for the project.

Task ID	Objectives
1	**Proposal**
1.1	Prepare project presentation and discussion.
2	**Process Architecture Design**
2.1	Selection of high level processes to include in architecture; Definition of activities for each process; Definition of objectives, inputs and outputs of each activity;
2.2	Definition of artifacts related to inputs and outputs of each activity; Artifacts design and production;
2.3	Definition of a responsibility structure to support the processes; Responsibility assignment;
2.4	Interview with the main stakeholder; Necessary changes definition; Evaluation Report;
2.5	Iteration on Processes modelling, Artifact definition and responsibility structure definition tasks;
2.6	Interview with the main stakeholder; Necessary changes definition; Evaluation Report;
2.7	Iteration on Processes modelling, Artifact definition and responsibilitystructure definition tasks; Final proposal for the Process architecture;
3	**Logical Application Architecture**
3.1	Definition of PPM solution's features to include into the architecture; Definition of input activities from process architecture to PPM solution; Definition of outputs from PPM Solution;
3.2	Definition of ITSM solution's features to include into the architecture; Definition of,input activities from process architecture to ITSM solution; Definition of outputs from ITSM Solution;
3.3	Definition of ITSM and PPM solution's inputs from the processes architecture; Integration with application architectures already present in the organization; Definition of application architecture outputs; Definition of necessary infrastructure;
3.4	Interview with the main stakeholder; Necessary changes definition; Evaluation Report;
3.5	Iteration on ITSM and PPM solutions' architecture; Final proposal for the Logical Application architecture;
4	**Demonstration**
4.1	Process framework and Logical Application Architecture presentation to stakeholders; Process framework application proposal to the organization; Logical application architecture integration on organization proposal;
4.2	Mapping between responsibility structure defined and demonstration's organization structure;
4.3	Interview with the main stakeholder; Evaluation Report;
5	**Evaluation**
5.1	Interview with the main stakeholder; Evaluation Report;
5.2	Evaluation using Moody and Shanks Framework; Results analysis and reporting;
6	**Dissertation**
6.1	Write dissertation; Dissertation presentation;

Table 5. Tasks and objectives for the project.

A.2 Appendix B - COBIT 5 Processes by domain

The next Figure presents the management and governance processes from COBIT 5 process framework, presented by domain.

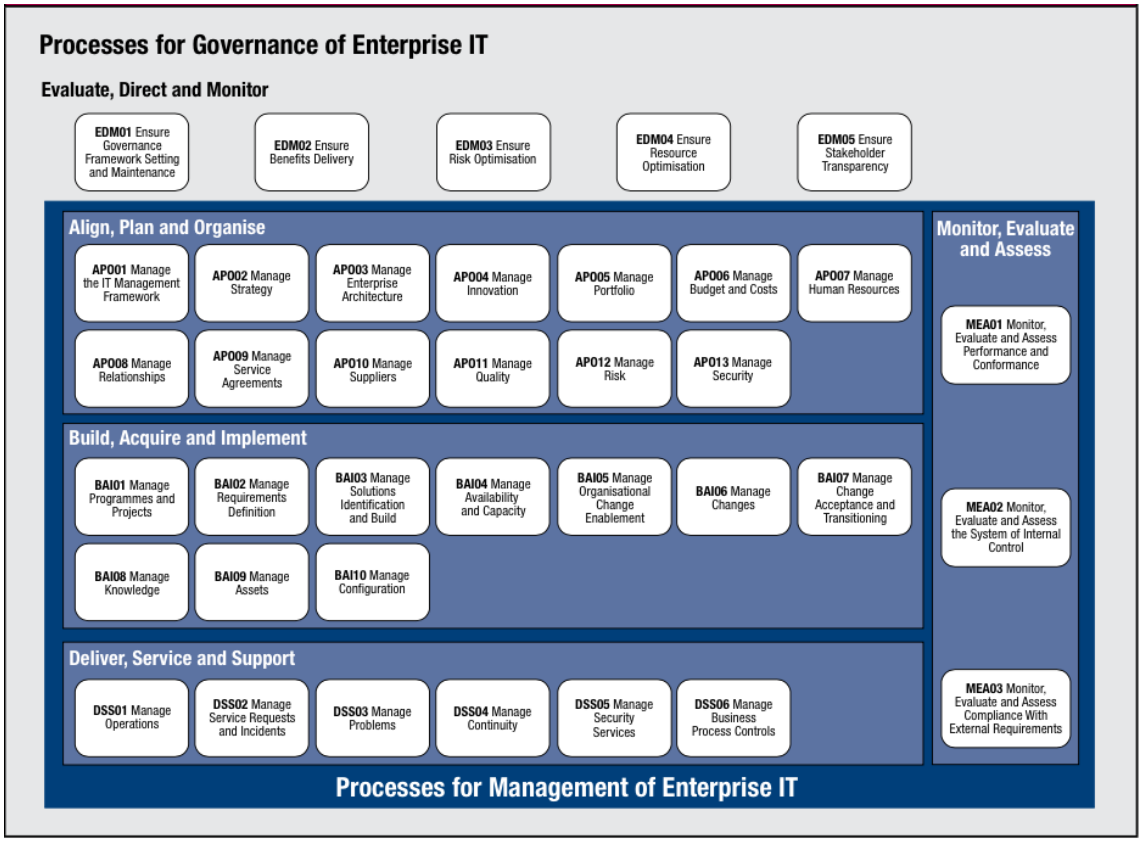

Fig. 20. COBIT 5 Processes. Extracted from [11].

A.3 Appendix C - ISO 19011 Audit Programme Management process

The next figure presents the process flow purposed by ISO 19011 International standard for Audit programmes management.

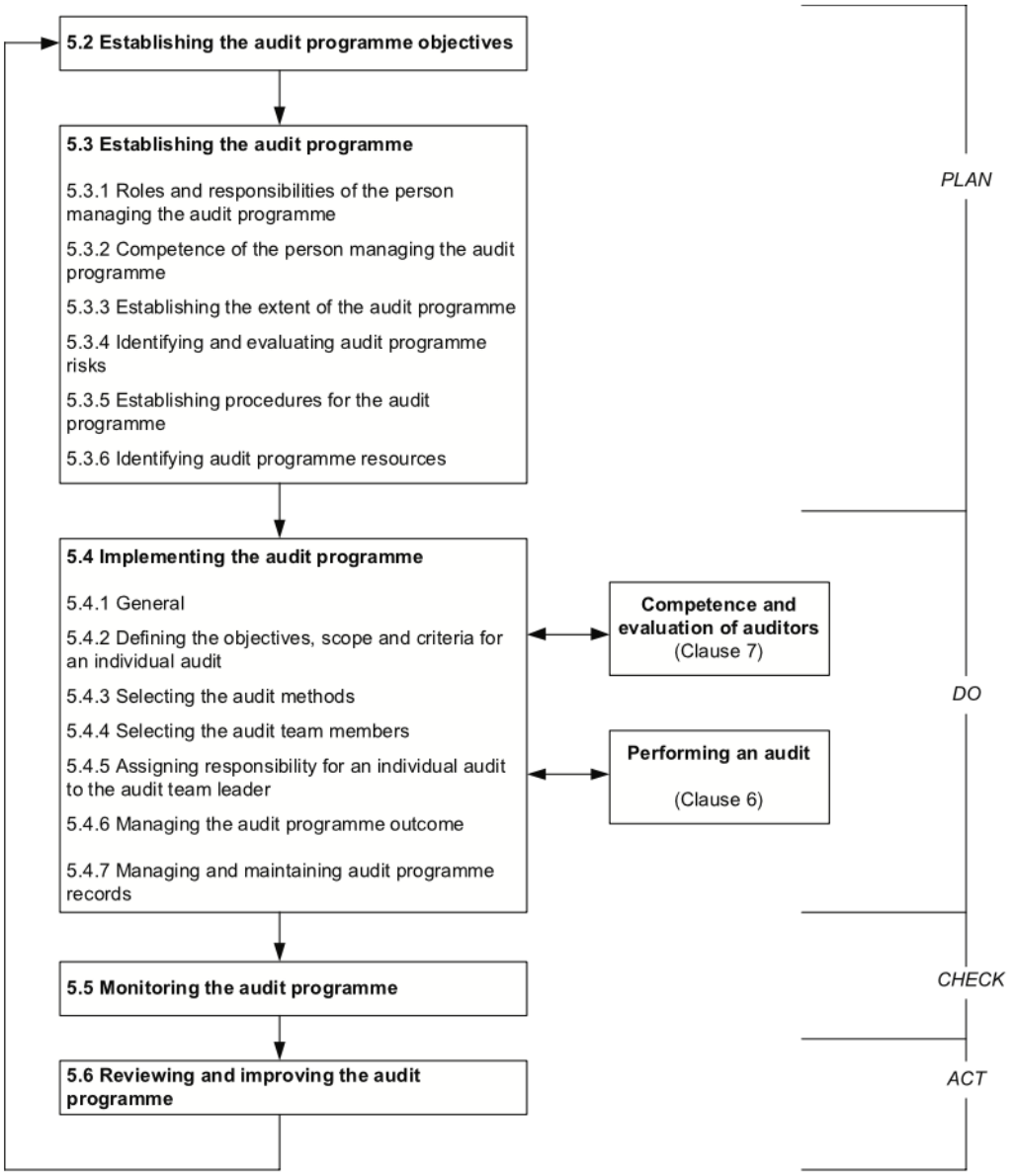

Fig. 21. ISO 19011 Audit Programme Management process. Extracted from [14].

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