PIRAEUS UNIVERSITY

DEPARTMENT OF DIGITAL SYSTEMS

M.Sc TECHNO-ECONOMICAL MANAGEMENT OF DIGITAL SYSTEMS

MASTER THESIS

TITLE

"Implementation of PMBOK practices for effective optimization of the processes of a software development house"

Author: Dimitris Politis

Supervisor: Professor Marinos Themistocleous

PIRAEUS

JULY 2013

CERTIFICATION

It is certified that the master thesis with title:

"Implementation of PMBOK practices for effective optimization of the processes of a software development house"

Written by the postgraduate student of the department of Digital Systems of Piraeus University

Dimitris Politis

MTE 1158

Has been presented to public and examined to the department of Digital Systems of Piraeus University on 2/7/2013

Supervisor	Examining Committee	
Marinos Themistocleous	Flora Malamateniou	Vera-Alexandra Stauroulaki

ACKNOWLEDGEMENTS

This thesis was done at the department of Digital Systems of Piraeus University during the ten months between September 2012 and June 2013. It is a mandatory obligation, in order to graduate from the master program of Techno-economical management of digital systems.

Primary thanks go to Softcom-Int, the organization that I cooperated with so to deliver the final applied result of this thesis. More precisely, I would like to thank the CEO of Softcom-Int, Dr. Tzoanna Ekaterinidi, for the opportunity that she provided me of aligning my master thesis with an applied industry environment. I deeply appreciate it, for the reasons that I managed to deliver a work applied master thesis and I gained valuable work environment experience and high level knowledge. At this point, I would also like to thank Panagiotis Krommidakis and all Softcom-Int's staff for their cooperation, support and priceless knowledge that they provided me whenever I needed it.

Special thanks to my professor, Marinos Themistocleous, for his support and guiding throughout this period and of course, for his decision to supervise my master thesis. Because of this opportunity to express my gratitude, I would like to adduce him and all the instructors that I had during my years as a student in Piraeus University, for the precious knowledge that I gained.

Lavish thanks to Xrisoula Mixaletou for her unconditional support and help all those months. Without her priceless advices, this thesis would not be harmonic and its form would be completely different. Thanks also go out to all of my friends and relatives whose direct and indirect support helped me finish my studies.

Last but not least, I would like to express my love and thanks to my parents and my brother for their financial and unlimited psychological support all these years.

Dimitris Politis

Piraeus, 24.6.2013

ABSTRACT

The main target of this thesis is to implement the project management processes of Softcom-Int, which is a software development house, so as to reach the capability level 3 according to CMMI-Dev v1.3. The capability level 3 requires the processes to be well-defined and controlled, using statistical and quantitative techniques, throughout the project lifecycles. The structure of this thesis is divided to the theoretical part and the practical part. The theoretical part begins with the first chapter, which contains a brief description of Softcom-Int, including its operations, organizational structure and future plans.

In order to be aligned with all the big organizations, it was decided the project management processes to be designed based on a worldwide ANSI standard for project management, the PMBOK. PMBOK extensively describes all the project management processes, the available techniques used by the best project managers in the world and can be used as a guideline throughout the lifecycle of a project.

PMBOK was not made for a specific industry, but it can be aligned in accordance with the needs and the culture of a particular organization that implements it. Therefore, it contains some “grey areas”, which need to be thoroughly researched and modified according to business needs. In the second chapter of this thesis, a detailed introduction to the concept of PMBOK takes place, including its process groups and knowledge areas. This chapter also includes an examination of the “grey areas” of PMBOK for a software development house and a few additions are proposed, in order to cover the missing knowledge.

The third chapter covers an area of PMBOK, which includes the project governance across its lifecycle. At this point, several aspects of organizational strategies that PMBOK suggests are presented along with the possible organizational structures that an organization can adapt. The adaption of such structures will provide the organization with decent governance, eliminating possible drawbacks during the implementation of a project.

Besides PMBOK, several other management techniques and methods can be implemented in order to achieve better results and deeper project management knowledge. Lean Management is one of those project management methods and it was studied in order to include to Softcom-Int's project management processes many of its suggestions. In chapter 4 there is an extensive description of Lean Management approach. From Lean Management derives a theory that was also used, especially in designing the schedule process of Softcom-Int. This theory is called Theory of Constraints and it is described in chapter 5.

In chapter 6 there is a brief description of the primary SDLCs that Softcom-Int utilizes. The main target was to align PMBOK with the SCLDs. As it is well-known, SDLCs are very important for the software development houses. Most of them contain a well structured and defined project management process. In most cases, however, this is not enough and additional action should be taken as far as the project management procedure is concerned. In the second part of this chapter, the alignment of the four most frequently used SDLCs with the PMBOK is presented.

Tailoring is another important process that takes place in almost every project for a software development house. It is described in chapter 7 along with two important examples of tailoring that the EU has published. The theoretical approach ends with a brief description of BPMN, in chapter 8, that was used in order to design the process flows of the project management processes.

The second part contains all the work that was made in order to implement the PMBOK into the business processes and the designing of all project management processes. First of all, in chapter 9, the project management process flows are analyzed and presented by the utilization of BPMN 2.0. They start by the feasibility analysis for a new income project and carry on throughout the project's lifecycle until its closure. Furthermore, in the same chapter, there is a brief description of the rest processes of Softcom-Int that need to interact with the project management process.

At the beginning of the last chapter of this thesis, the way that the projects need to be categorized, along with the possible categories, is presented. In order to achieve better handling of the projects, it was necessary to establish three project types, which depend on project needs and nature. The next step that was taken was to map the

PMBOK to these types. PMBOK produces several documents and processes, but there is always the need to define, depending on the project type, whether all these are mandatory or they can be avoided. Therefore, the documents and processes of PMBOK depending on the project type were decided and presented during this chapter. Finally, in APPENDIX I, it was important to present some pictures of the process flows more accurately, whereas in APPENDIX II some of the resulted documentation is presented.

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PART ONE

THEORETICAL BACKGROUND

1. Brief Description of Softcom-Int

Softcom-Int stands for the Software Competitiveness International Ltd. It is a Greek software development organization, which was establish in 2010 by Dr. Tzoanna Ekaterinidi, founder and until the present day CEO of the company. The organization has offices in two locations in Greece, the headquarters in Sitia, Crete and the main branch in Marousi, Athens. Softcom-Int is well known as an international ICT products, solutions and services provider. It offers to its customers, software and IT consultation, design, testing, integration, training, support and many other relevant services.

The organization's vision is to become the trusted partner of key players in the international ICT market, for Software Research and Development activities, providing high quality services. The mission of Softcom-Int is to provide the high process maturity, the professional diligence, experience and skills of the large Multinational Companies combined with the flexibility and the personal commitment of the Start Ups, the Middle European working conditions and mentality and very competitive prices. However, there is a difficulty that this target conceals for every company in this industry, because of the complexity in software development projects and high competition among the various companies. But Softcom-Int can prevail against the other rivals in the field because it has some special characteristics, which is very hard to find. That special something is the broad experience and recognition in international ICT market of the company's leading personnel, which ensures the high quality and competitiveness of the offered services on a global level.

1.1 "Doing business"

As a software development house, Softcom-Int is an expert in developing integration activities and services. With a huge portfolio of technologies in software development, Softcom-Int is able to carry out any type of software development project

and application of any enterprise. The following picture represents the technologies that Softcom-Int uses for the development of different levels of applications within an enterprise. The basic technologies for this kind of applications are .Net and J2EE.

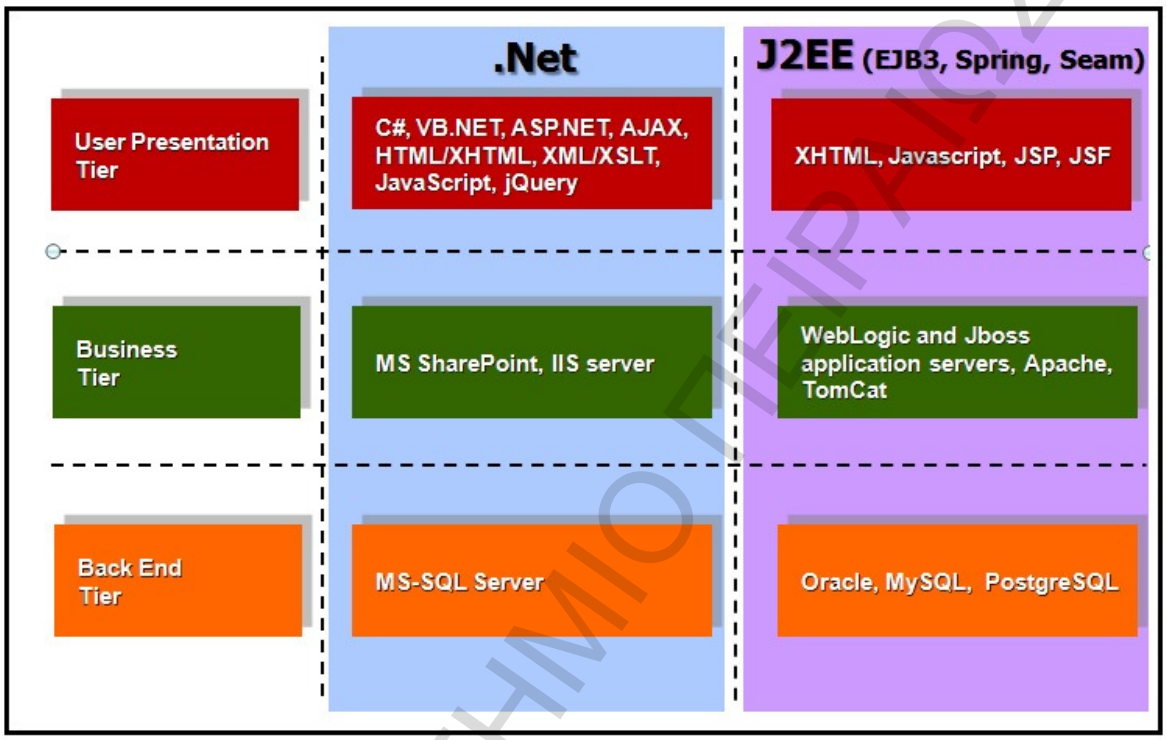


Figure 1: Basic technologies that Softcom-Int uses

One of the core competencies of Softcom-Int, apart from the numerous software development technologies, is the number of the applications that it can develop and for various target systems. By using the most important new generation programming languages and software development methods, Softcom-Int's personnel is able to create a wide range of possible applications for any type of system, fulfilling any possible need of the customer. Mobile, web, client-server applications and even embedded ones are able to implement in any type of system, including from the usual Linux, UNIX and windows to microprocessors. It is important to say that all the processes of Softcom-Int are based on CMMI, a worldwide process improvement guide for IT companies. On the following picture we can see clearly those technologies and the programming methods and processes of Softcom-Int as well.

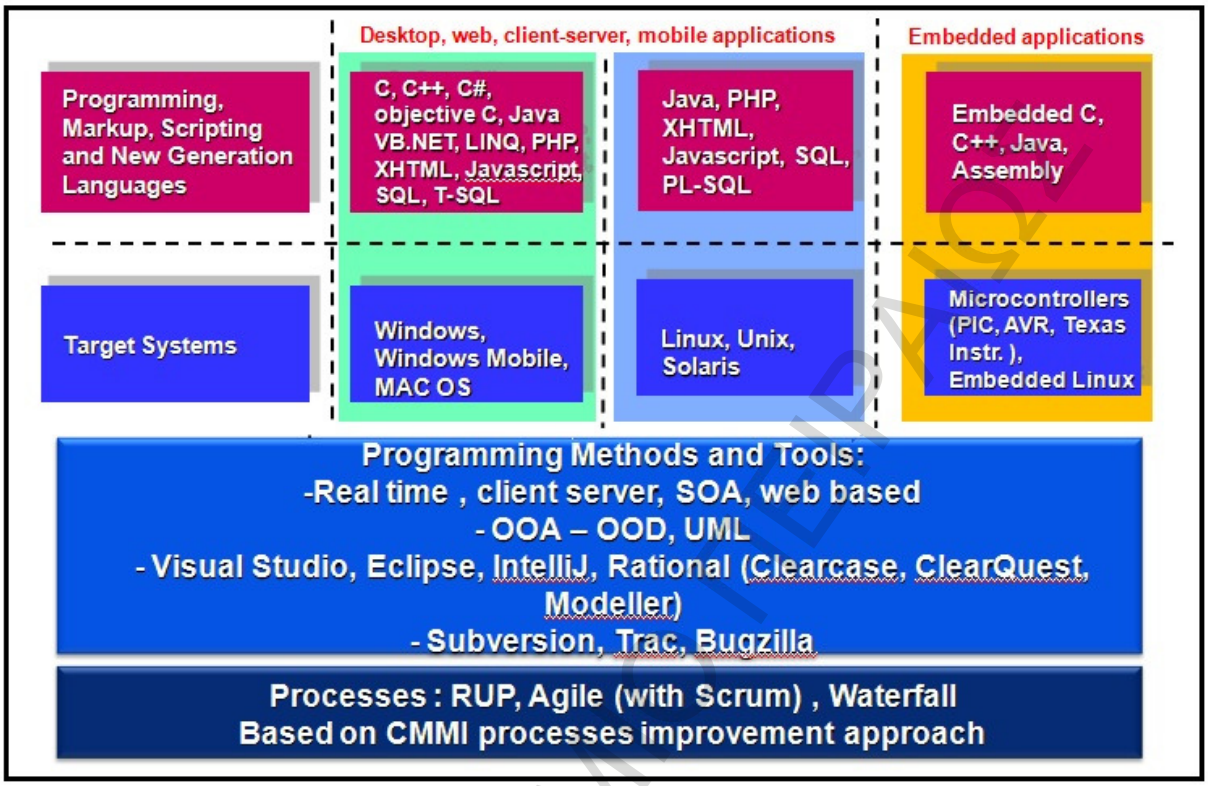


Figure 2: Technologies and programming methods of Softcom-Int

In addition to the software development applications, Softcom-Int includes in its business portfolio a wide range of many ICT solutions and services that can provide to its customers. Being familiar with the most popular information and telecommunication protocols, such as UDP, TCP, SIP, VoIP, SNMP, H 323 and other, Softcom-Int's staff can offer many innovative solutions in customers' IT departments. It can also provide high level consulting, training and project management services to customers Research and Development projects.

Special attention is being given to quality management and quality assurance. Security is an issue that has to be carefully covered and Softcom-Int has the know-how to ensure high levels of IT security. By using several IT security tools, such as SoapUI, and the BackTrack 5 penetration testing suit, and a set of processes during the entire Software Development lifecycle, Softcom-Int manages to achieve those levels.

The basic business strategy of Softcom-Int can be well explained with the following figure. It shows three cogwheels, each one representing one of the three axes of Softcom-Int's main business targets, the ICT solutions, the software R&D development and the Consulting and Training Services.

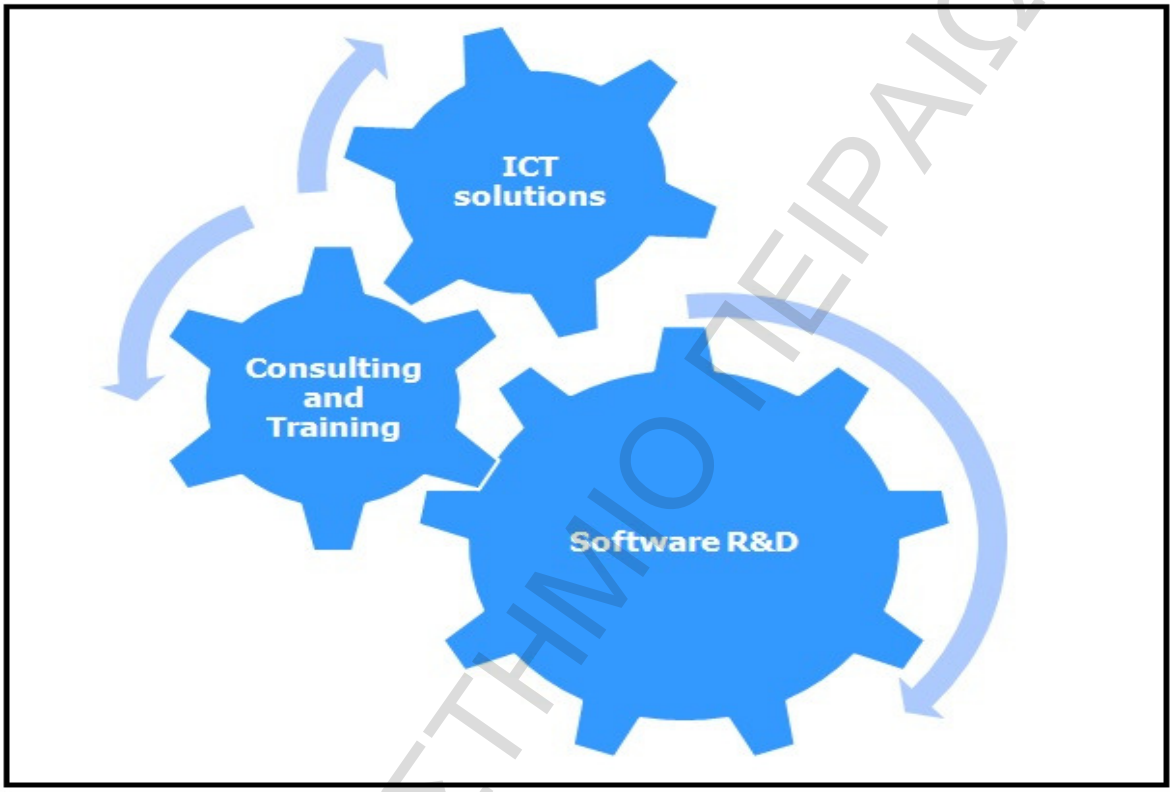


Figure 3: Business Strategy of Softcom-Int

1.2 Softcom-Int Staff

The success of the company lies behind its people. The CEO's experience counts already 20 years in international software Research and Development (R&D), with the average years of experience for software engineers of the company to be at 6,9 years. Except the experience, company's people are well-educated, motivated, responsible and excellent in team working, a very important factor in software

development's industry. Softcom-Int has 17 employees and planning to reach 40 by the end of 2012. The main functional profiles of the staff are:

- Technical Project Manager
- Senior Software Analyst Programmer
- Senior Software Developer
- Software Developer
- Junior Software Developer
- Senior Software Integration Tester
- Senior Software Tester
- Software Tester
- Junior Software Tester
- IT Security Expert
- Senior Database Administrator
- Technical Writer
- Configuration/Release/ Change Manager
- Training Manager
- IT consultant

The following two charts represent some statistical elements about Softcom-Int's employees. The first one is the average years of experience that they have in software development, testing and integration and the second one is the average age. As it obvious, Softcom-Int has a mixture of senior and junior employees in different positions, like developers, testers etc.

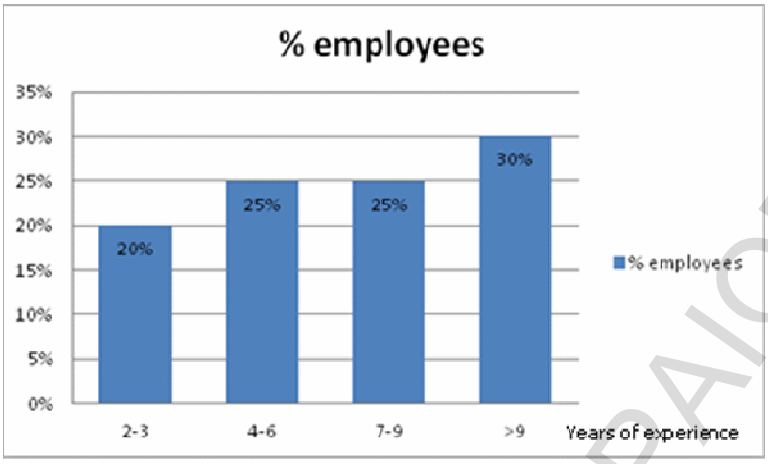


Figure 4: Softcom-Int's employees' years of experience

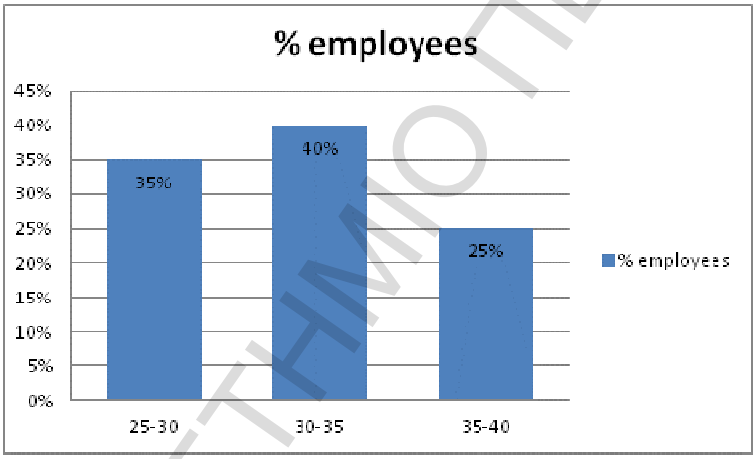


Figure 5: Ages of Softcom-Int's staff

1.3 Softcom-Int Organizational Structure

In project management organizing the company is very important. The structure of the software development organization has a direct impact either on effectively management or efficient staff. In order to have the desirable results in project management one of the prerequisites is to have a well defined organizational structure. It is really necessary for the company and the staff to have specific roles with boundaries either in authority or in responsibility. The hierarchical model is vital for any project's execution. There has to be a leader with full responsibility in project's

execution and on the team, of which each member will have a specific role and responsibility under the full authority of the project manager. Here we are going to present the organizational structure of Softcom-Int. This hierarchical tree it's not a standard one. Depending on the volume of the project or the amount of the projects that are running at the same time through the organization this might change.

Softcom-Int has five hierarchical levels in its organization structure, which is represented on the following figure. To the top level of the organization is Dr. Z. Aikaterinidi, CEO and founder. The CEO is responsible for plenty of tasks and processes. Apart from all the management processes and running the company, she is also responsible for the sales part and all the financial issues for any project that Softcom-Int is awarded. Usually in the organization there are many projects, which are being implemented at the same time. That's why the CEO has the program manager role as well. The role of the program manager, as we will see on the following chapters, is to provide an environment where projects can be run successfully without troubles and defects. Each project though has its own project manager. The CEO observes the processes that are being made by the project managers as well as the progress of each project.

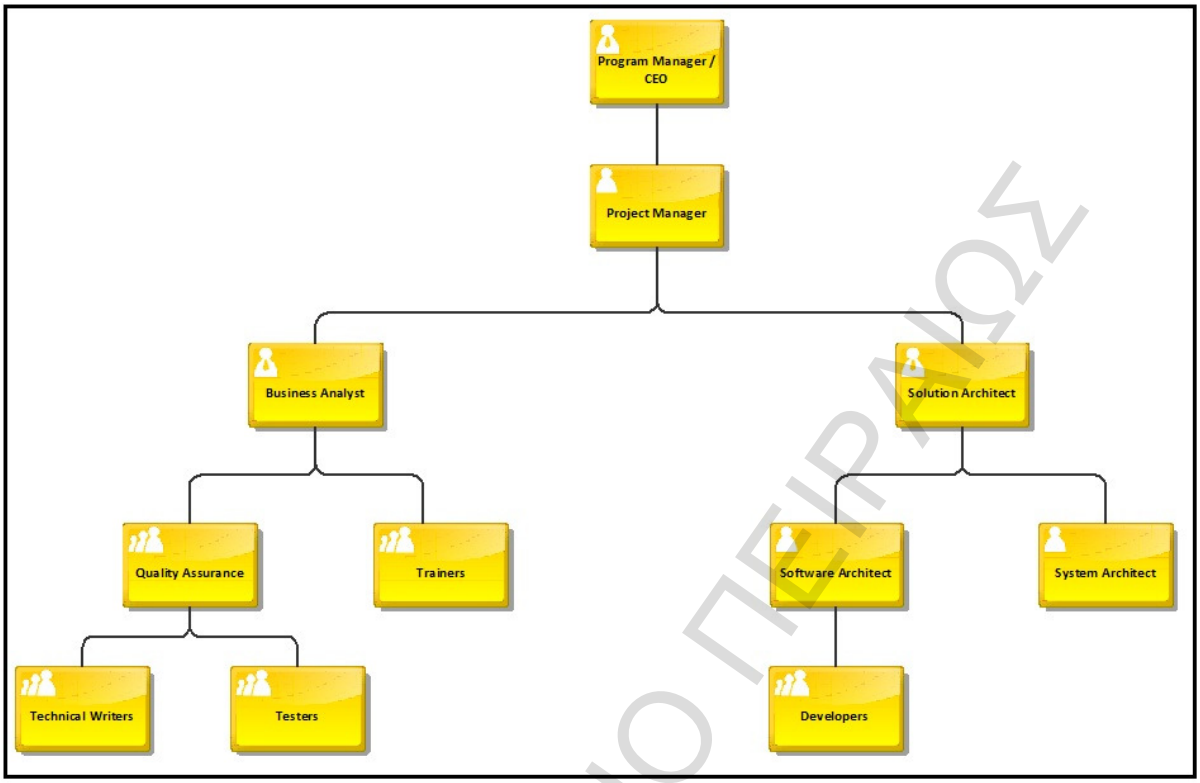


Figure 6: Softcom-Int's hierachy

At the next level in hierarchy is the project manager. The project manager is responsible for the success of every project that is being awarded to him from the CEO. He is in charge for one project at the time from the beginning of it till the end delivery. Apart from the financial part of the project, which belongs to the CEO, he is responsible for any other process that the project will need. Therefore, he is responsible for all the rest processes of project management that we will discuss later.

At the next level in Softcom-Int's hierarchy there is separation into two branches, as we can see from the picture. On one hand we have the business analyst and on the other the solution architect. Both of them have the role of bridging the gap between the technical staff of the organization and the administration. The business analyst usually is someone with expert knowledge on a specific project's business field. He is responsible for the quality of the project and for the analysis of projects according to the strategic needs of the organization. He is leading the quality assurance team and the trainers. Depending on the classification of the project he can have multiple roles. Under

the business analyst in the hierarchy is the quality assurance team and the trainers. The quality assurance team consists of testers and the technical writers.

On the other branch of the hierarchical tree is the solution architect. He is responsible for designing the best solution, in technical terms, to every project. He might be a senior software engineer with expert knowledge. Under the solution architect, there is the software architect, who is responsible for software development solutions, and the system architect, who is mostly involved in the rest ICT services and solutions that Softcom-Int can provide. Sometimes, especially in low volume projects, the solution architect and the system architect or the software architect can be the same person.

As far as it concerns the project strategy, Softcom-Int uses the projectized organizational structure, as it is presented at the picture below. Later in this thesis, it is going to be well explained what the projectized structure means, but in general this can be briefly described into a structure, which is based on the project and in which, the project manager has a vital part in implementing and executing the project. However, this is not the only organizational structure that Softcom-Int uses. Sometimes there is a need to change in order to conform to a customer's tailoring rule. There are several types of organizational structure during projects execution as we will see on a following chapter. For Softcom-Int the most appropriate structure is the one that it usually adopts, the projectized structure, but it can work with the same results with any other organizational structure that a customer might request. Softcom-Int gives priority to the needs and demands of the customer as long as the experts of Softcom-Int decide that it is possible to have positive results or that the structure that the customer requires can work without any future flaws.

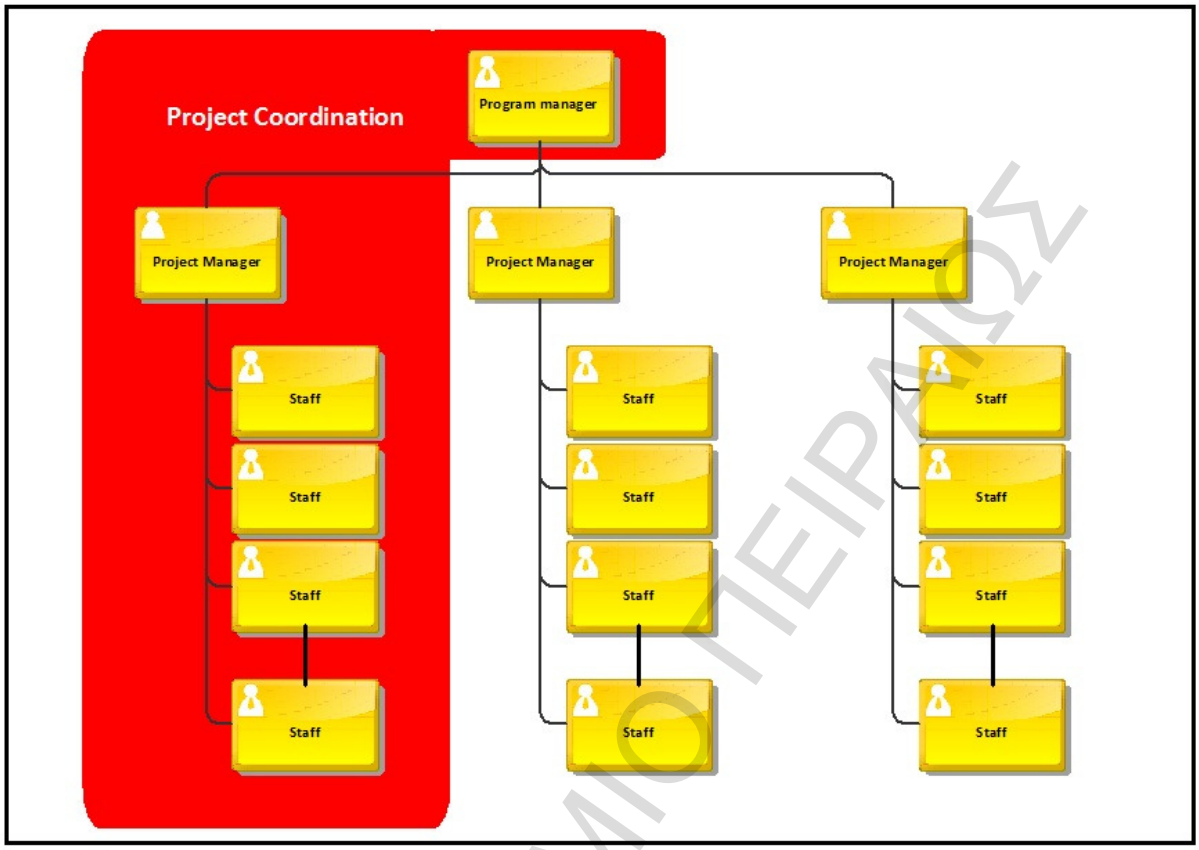


Figure 7: Softcom-Int's Project Coordination

In terms of company size and organizational structure, Softcom-Int is an SMB having adopted the so-called "Network" model. In detail, a Networked Organization is one where independent people and groups act as independent nodes, link across boundaries, to work together for a common purpose; it has multiple leaders, lots of voluntary links and interacting levels. As the business environment changes in various ways, this system senses and responds to it, and in turn creates more and more teams with volunteers to address the discrete parts of a larger change. With this Network, potential opportunities and changes are identified, urgency around tomorrow's possibilities is fostered and maintained, strategies for organization-wide changes are formed, barriers are identified and addressed, and change is achieved. Softcom-Int's benefits, from such an organizational structure, are the following:

- Being closer to the customer - there is rapid communication between those at the sharp-end and those who support them.
- Maximizing the knowledge potential of the company; network members tap into expertise wherever it may reside.
- Minimizing disruption; a network has resilience to operate even if some parts fail (e.g. in a natural disaster).
- Responsiveness and adaptiveness. A network is sensitive to stimuli and adjusts accordingly.

To that end, the majority of the Softcom-Int employees “wear many hats” and this is also reflected to our Quality Management System (QMS). However, roles and responsibilities are internally assigned with special care so as to avoid cases where conflicts of interest might occur.

1.4 Future Plans

Softcom-Int plans to become the strategic partner of both local and international key players in the future years. In order to achieve that, intensive focus to the organizational core values is required. Furthermore, the implementation and the establishment of organizational processes based on high international standards, such as EFQM, ITIL and CMMI is a must to succeed in such a mission.

Capability Maturity Model Integration (CMMI) is a process improvement certification program, marketed by Carnegie Mellon University. CMMI can be used to guide process improvement across a project or an entire organization. Under the CMMI methodology, processes are rated according to their maturity and capability levels. Currently CMMI addresses three areas of interest and one of them is the product and service development, which is covered by CMMI-DEV. Therefore, every organization which wants to be aligned with the CMMI methodology needs to tailor its processes according to the capability and maturity levels.

The maturity level of CMMI defines the internal performance of the organization. It includes five levels:

- Initial
- Managed
- Defined
- Quantitavely Managed
- Optimizing

CMMI Level	CMMI Process Area	Policies	Processes (Plans)	Applicable Standard or Best Practice
	"What"			*"How"*
		Mgmt Decision	*Practices*	
CL2	CM	Configuration Management Policy	CM Plan* (incl. Change Mgmt)	IT/IL v3 and ISO/IEC 20K
	MA	Measurement and Analysis Policy	M&A Process*	6 Sigma
	PMC	Project Management Policy	PM Process*	PMBOK
	PP			
	PPQA	Quality Policy	Quality Plan*	ISO/IEC 9001:2008
	REQM	Engineering Policy	R&D Process*	Waterfall, Agile, RUP etc.
	SAM			
CL3	IPM			
	OPD			
	RD			
	VAL			
	VER			
	SEC (pseudo PA)	Security Policy*		ISO/IEC 27K

Figure 8: CMMI, policies and processes

The capability level defines the performance of the process of the organization and it has four levels:

- (0)Incomplete
- (1)Performed
- (2)Managed
- (3)Defined

Softcom-Int has an ongoing internal project, which includes among others reaching CMMI capability level 3 (defined). A defined process is a managed process, which is aligned with the assets and the guidelines of the organization. It requires extensive description of its processes, including their purpose, their inputs and outputs, the entry and exit criteria, the activities, the roles and the measures for their effective monitoring. A quantitatively managed process is a defined (capability level 3) process that is controlled using statistical and other quantitative techniques. Quantitative objectives for quality and process performance are established and used as criteria in managing the process. Quality and process performance is understood in statistical terms and is managed throughout the life of the process.

This thesis is a part of this internal project of Softcom-Int and more precisely, its basic concept is to define the project management processes in order those processes to be aligned with CMMI capability level 3. As it is obvious from Figure 8, Softcom-Int needs to implement a project management policy and define the processes of project management in order to be aligned with the CMMI. The applicable standard that Softcom-Int decided to utilize in order to achieve this goal is the PMBOK.

PMBOK is a standard for project management and it is going to be extensively described at the forth coming chapters. For now, it is important to understand that PMBOK includes many processes for project management, but these processes are not hanging alone in the organization. They are a part of an entire organization system, the QMS, and they always interact with every other process that the organization has. A brief map of those processes and their interaction with the rest processes of Softcom-Int are presented in the picture in Appendix A.

1.4.1 The Softcom-Int Approach to Project Management

Historically, the need for standardized project management was revealed by the imperative business need to control the project performance. Standardized project management is defined as a set of project management best practices which are globally recognized and adopted. To that end, Softcom-Int made the strategic decision to build its Project Management Methodology on the "Project Management Book of Knowledge (PMBOK)" delivered by the Project Management Institute (PMI). The main reasons towards such decision are the following (in prioritized order):

1. Both our key customers and international partners (mainly located in Germany, Canada and U.S.A.) already follow PMBOK. Thus, our decision facilitates -a priory- the smooth tailoring and close coupling of our Project Management methodology with the ones followed by our end-customers;
2. It is generally recognized that PMBOK, for the last five years at least, has better momentum in comparison with the rest of project management standards (PRINCE2, IPMA etc.). Consequently, PMBOK –in terms of risk assessment – is not expected to become outdated and/or obsolete in the years to come, protecting the Softcom-Int's investment and maximizing ROI as far as the corporate resources to be spent are concerned (for the internal policy creation).

Project performance, especially in the software development business, is highly dependent of the project contract type. The following types are applicable for the offers proposed by Softcom-Int or requested by the end-customers:

a. **Fixed-Price**: These contract arrangements bind Softcom-Int to the price it has quoted. This may become a high risk situation if the customer believes that price remains the same regardless of whether or not the scope of work changes. Therefore, Softcom-Int should always define among the fixed-price contract terms a clear definition of how change requests will be handled in the context of

the specific project (allowing for modifications to be made to the price as the statement of work or project specifications change). It's all right to submit a fixed-price proposal if the following prerequisites are met:

- The scope of work is well-defined;
- The goals are achievable;
- It is clear exactly what must be done and how long it will take.

Instead, in cases things are unclear it is recommended to try hard to negotiate a time-and-materials agreement.

b. **Time and Materials (or Means)**: These contract arrangements offer more flexibility to both the customer and the contractor, especially on projects that aren't well defined at the outset. Clients sometimes worry about time-and-materials arrangements, especially when they are working with new partners. Some perceive these agreements as giving consultants carte blanche to spend their money without limit, with no assurance that they'll get any useful results for their investment. One reasonable way to minimize the risks and serve the interests of both client and Softcom-Int is agreeing to a phased project arrangement.

c. **Phased Approach**: allows Softcom-Int to do and get paid for initial work that will help define the project better and then follow that up with a more accurate, second-phase of fixed-price, or time-and-materials effort. In the paid Phase I (fixed-price, if necessary), Softcom-Int will aim to develop a good requirements and high level functional specification and a preliminary design to meet the specification. After completing Phase I, Softcom-Int will be closer to having the necessary knowledge to develop and submit a more accurate fixed-price (or time-and-materials) proposal for the rest of the project allowing the customer to

proceed with the final “GO/NO GO” decision.

2. Introduction to Project Management

The following chapters focus mainly on the theoretical part of the project management and the standard adopted by Softcom-Int. Nevertheless, specific pieces from the Softcom-Int code of practice are highlighted -for completeness purposes- where it is appropriate.

First of all, it is important to define what a project is. To begin with, the word project origins from the Latin word projectum, which has the meaning of throwing something forward. The prefix pro- denotes something that precedes in time the action of the next part of the word and comes from the Greek προ-, while the second part of the word is the Latin, iacere which means throw. Thus, project actually means something that comes before anything else happens.

A project in business is defined as an enterprise, which involves continuously involving design and research, and is also carefully planned in order to achieve a particular goal. Projects have some characteristics, which differentiate them from other categories of activities. First, they must be temporary, with the meaning of having a well-defined start and end. A project is created with the aim of delivering a specific product or service and exists only as far as those products or services are still in the phase of developing or implementing. When those products or services are delivered, then the existence of the project automatically stops. Secondly, each project must be unique and not repetitive, which means that several projects may have similarities with each other but it is never possible for them to be exactly the same. From that characteristic comes the third attribute of projects, which is the uncertainty. Since every project is unique, it should be treated differently and this differentiation brings uncertainty, which creates different risks and opportunities for every project. There are many types of projects in every industry, but the main philosophy of handling and delivering a project is the same everywhere.

Project Management can now be defined -in an abstract way- as starting a group of sequential activities to achieve some well-defined and previously stated goals. It is

always expressed by the scope, of each particular project and has three basic constraints, which are the limited amount of time, the budget and the resources. Furthermore, it also has two more sub-constraints; the quality and the risks. Thus, every project should be designed and delivered within a predefined time period, using certain amount of budget and resources, which can be both human and/or material and finally fulfill its scope. During this procedure, there is the possibility of facing up risks, due to different factors, and finally the end product or service must meet a predefined quality level. To present those constraints in a more understandable way, a triangle is used, which is depicted in the following picture. The acnes of the triangle represent the three basic constraints of project management, which are time, budget, and scope. Adjusting one of those three constraints, it will cause some kind of impact to the remaining two. This means that those three constraints are interconnected and in case of changing one of them can affect the other two by various ways.

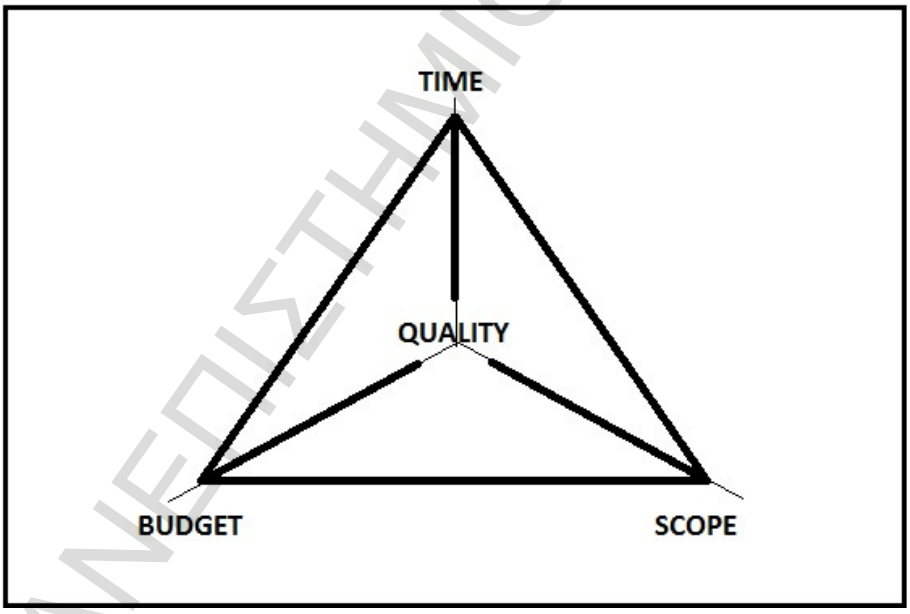


Figure 9: Project Management Triangle

For instance, if a project manager is obliged or forced to deliver a project earlier than it was originally planned and he must as well decrease the budget, due to several financial issues of the company, this will directly affect the quality of the final product or

service forcing it to be lower. On the contrary, if somehow the same project manager is able to increase the budget of the project or to extend the agreed deadlines of delivery, this would be normally translated into better quality of the final product. One of the basic targets of project management is to find the perfect combination of all those constraints in order to deliver the project when the customer needs it, on the agreed budget and at the right quality. Obviously, the project can be considered as a system or engine, which has internal processes running and interactions through external interfaces. All projects have sponsors, and stakeholders and the goal of project management discipline is to ensure that they are satisfied. The inputs of that system/engine are the allocated resources, budget and duration, while the outputs are the deliverables of the project. The processes that should take place in order to transform the given inputs to the desired outputs are being executed with the help of project management. As it is going to be extensively explained in a forthcoming chapter, in order to have a successful project one should establish a solid project plan. In detail, the project plan contains the necessary steps describing how each specific project must be initiated, planned, executed, and closed and also the way that it must be controlled and monitored throughout its lifecycle. All these elements are very crucial and essential in the quest for delivering a successful project. Due to that, several techniques and/or standards have been arisen in the recent years, including PMBOK, PRINCE2, and IPMA. PMBOK and PRINCE2 are the most widely recognized and used standards for project management. This document presents the PMBOK standard and its alignment with the software project management processes.

Nevertheless, all these industry standards cannot guarantee “a priori” the project success. On the contrary, according to the international literature, the most possible scenario for a project is to fail. Especially, as far as it concerns the IT projects, researchers came up to the conclusion that only 30% of projects are fully successful without any flaws. Nevertheless, the success of those projects is clearly based on consistent project management techniques. Otherwise, the percentage was expected to drop near to 16%.

A project is very likely to fail due to several reasons. On the other hand a project can be considered successful, only if:

- It has been delivered on time;
- It has spent the exact (neither more nor less) budget, which was planned and allocated from the beginning;
- The quality of the project deliverables was at the level that the customer initially ordered.

Consequently, if there is a delay, even for a single day, to the delivery of the project, that automatically can be translated into failure. If the project would finally cost more than what it was expected, it can also be considered as a failure. Accordingly, there is no need for a complete failure of project deliverables to meet customer requirements so as to declare a project failure. This is the reason why the percentages of project failures are that high. The objectives regarding budget, delivery time, quality and more, are described in the scope of the project. So, by staying close to the scope and designing all the respective processes for project execution with this goal in mind, it is the safest approach for the target to be achieved. In a forthcoming chapter, all the processes and procedures during the project execution are going to be presented in a detailed fashion.

2.1 The PMBOK

The Project Management Institute (PMI) is a non-profit professional organization for the project management profession having the main purpose of advancing project management. It offers a range of services such as the development of standards, research, education, publications, and networking-opportunities in local chapters, hosting conferences and training seminars, and maintaining multiple credentials in project management. One of the most common publications of that Institute is, the well-known, “A Guide to the Project Management Body of Knowledge (PMBOK Guide)” or just the PMBOK Guide with several editions released and among them, the most recent is the Fourth Edition. PMBOK is the ANSI Standard that defines accepted concepts, processes, tools, and techniques for managing projects. The information contained in

PMBOK provides a common language for Project Management used by companies around the world. PMBOK is not a Project Management methodology. However, it can be used to help the project manager or the organization (in terms of corporate policy) to formulate, or better understand, a Project Management methodology that it will work for his company and with its projects.

By using the PMBOK, every project manager can be sure that he/she provides the best possible practices in the market to the organization that he/she works in. Since it is written by the most experienced project managers and also tested across different industries, PMBOK can guarantee that this is the best way of running a project. However, PMBOK cannot stand alone and it is not enough just to follow its instructions. I can be considered as a tool or a technique, which help in organizing the projects better and understanding the steps that need to be made, in order “run” a project in the right way. It is like the backbone of each project. PMBOK is letting the world know what the correct way of running a project is, but it is completely up to each project manager, depending on the needs and the requirements of every project, to decide what it should be done next.

One of the many advantages and a crucial one as well, is that PMBOK defines 44 processes across all the phases of the project. This means that someone does not have to improvise what happens in each phase of the project since it is all written in PMBOK, in a very simple and analytical way. Furthermore, it is been widely used and well known by everyone in this profession. Therefore, when a project is being managed according to PMBOK it is very easy for someone else to take over a project, when and if it is needed. This can be done without spending any special effort trying to understand what the previous manager was doing. There would be a little need of knowledge transfer in this case, which can be translated in time and money savings for the organization.

PMBOK also has some disadvantages. One of them is that because of having so many processes it is just overwhelming if someone wants to use it in small projects. Usually in such projects all these processes included in the PMBOK are not mandatory and sometimes completely useless. Another disadvantage is that although it is carefully written to be applicable in every industry, it tends to be inefficient in projects that are

plagued by lots of change requests, especially in software development projects. Consequently, the advantages of PMBOK can also be disadvantages in some extend. To be able to overcome the risks of the software development projects while taking advantage of the PMBOK, a software development house must establish a well-defined and strict Change Management process while having setup clear rules about when the latter should be activated. For instance, change requests affecting the system design and/or architecture should not be allowed in “Fixed Price” project contracts without prior re-negotiation of the entire implementation offer and consequently of the contract itself.

2.1.1 Process Groups of PMBOK

First of all, it should be defined what a process is. A process is a set of interrelated actions and activities performed to achieve a pre-specified result. Each process is characterized by its inputs, the tools and techniques that can be applied, and the resulting outputs. Softcom-Int pays special attention on both the effectiveness and efficiency of the internal business processes. Process management, for Softcom-Int, is a management practice guided by the adopted Quality Management System (QMS), which is based on ISO/IEC 9001:2008. In parallel, Softcom-Int applies the lean management concepts on the internal business processes and especially on those referring to project management. An additional organizational goal is to reach the quantitative managed level of maturity for the core project management processes.

The project processes are performed by the project manager and the project team and generally fall into one of two major categories:

- Project Management Processes
- Product-oriented Processes

Although PMBOK describes only the project management processes, both processes overlap and interact throughout the life of a project. This is the reason why they should not be completely ignored by the project manager. Those processes apply globally and across industry groups. But this does not mean that the knowledge, skills

and processes described should always be applied uniformly to all projects. For any given project, the project manager, in collaboration with the project team, is always responsible for determining which processes are appropriate and also the appropriate degree of rigor for each process.

Project management processes are grouped into five categories known as Project Management Process Groups or just Process Groups:

- Initiating
- Planning
- Executing
- Monitoring and Controlling
- Closing

These processes are presented as discrete elements with well-defined interfaces. However, in practice they overlap and interact in several ways, which are completely detailed. Usually the application of project management processes is iterative and many processes are repeated during the project. The output of a process generally becomes an input to another.

These five Process Groups have clear dependencies and are typically performed in the same order on each project. They are independent of application areas or industry focus, as it was aforementioned. A Process Group includes the constituent project management processes that are linked by the respective inputs and outputs where the result or outcome of one process becomes and input to another. The Process Groups though are not project phases. As projects are separated into distinct phases or subprojects all of the Process Groups would normally be repeated for each phase or subprojects.

2.1.1.1 Initiating Process

The initiating process is performed to define a new project or a new phase of an existing project by obtaining authorization to start the project or the phase. The definition of the new project includes the allocation of its initial scope, requirements and financial resources. It also includes the assignment of the project manager, in case of not being assigned yet, and the identification of all the external and internal project stakeholders. All that information is being gathered in the two major outcomes of the initiating process, the project charter and the stakeholder register.

According to PMBOK, the project charter is the first document that should be created in project management process. It should include all the available initial information of the project like the high level requirements, milestones, objectives and deliverables. It should also include some basic description of the project. On the other hand, the stakeholder register includes all the identified stakeholders. As already mentioned, they have an important role to the project so it is vital to have all the available information about them in order to be easily reachable during the project execution.

Sometimes, the initiating process is being performed by the high level management of the organization. Usually projects are parts of programs or portfolios. In this case, the new project has been selected among various alternatives from portfolio or program managers. Such selection means that there is an evaluation process within the organization, which evaluates the high level requirements of the organization and decides the strategies of the organization, selecting the appropriate projects every time. So every project has a specific reason why it has been selected. This reason along with the objectives and deliverables of the project need to be documented. In such cases, the respective documentation has to be included to the project charter as well.

2.1.1.2 Planning Process

The planning process is required to establish the scope of the project, to improve the objectives and to define the required course of action to attain the objectives that the project is supposed to achieve. During this process the most vital part of the project is

being created. This is the project management plan, which coordinates all the subsidiary plans, and along with all the other documents that are being created in the planning process is carrying the project out.

During the planning process all the crucial aspects of the project are being defined and planned. Those aspects are the risks, the requirements, the scope, the communications, the human resources, the budget, the costs, the quality and the procurements. Every single one of them is being analyzed for every project and a plan about the way that each one should be treated is carried out. But this does not usually happen just once and for all. As the project is moving forward new characteristics and information are being gathered, so additional planning is required. It is quite common that changes that can occur during the project life cycle trigger a need to revise the plans of the previous aspects one or more times. This progressive revising of project management plan is called “rolling wave planning” and it shows the iterative nature of PMBOK. This is one of the advantages that PMBOK has. Updating frequently the project management plan and also the initial planning processes ensures total control over the project. Those updates can vary from simple ones to more complicated. For instance, if a change occurs during the project it is possible to affect more than one aspect. Because of the strict relationship between all those aspects, changing one it might need to change another as well. So, it is like a chain. Although it may sound too complicated, this iterative way of updating the project management plan and the project documents provides the project manager with greater accuracy in scheduling, costing and managing in general the other vital attributes of the project so as to meet the defined project scope.

Please note that Softcom-Int, as far as planning is concerned, has adopted the directives of the theory of constraints (instead of the critical path) for high complexity and/or risk projects as explained in the following chapters.

2.1.1.3 Executing Process

The executing process is performed to complete what the project management plan has defined in order to satisfy the project specifications. This group of processes

must coordinate all the available assets of the organization, like people and material resources, and also all the previously defined activities of the project.

During the execution of the project, results may be required to update the initial planning. Depending on the nature and the significance of those results, changes can be translated to a major update of the project management plan, according to the chain it was mentioned before, or to minor ones. It is obvious that when a major change request occurs, there would be the need of a complete revision of planning. However, in a minor one, such as when member of the project team stopped working for the organization, the impact to the project management plan is smaller. It will only require replacing him with someone else, which means that only the human resource plan will need updating. However, sometimes even the small changes from the initial plan can cause major impacts to the whole project planning. The iterative nature of PMBOK, though, helps in identifying those impacts at all the aspects of the project and lead to an immediate remediation action.

2.1.1.4 Monitoring and Controlling Process

The monitoring and controlling process is required to track, review and regulate the progress and performance of the project. It also identifies the areas in which changes to the plan are required and triggers the respective actions. The monitoring and controlling process is performed regularly during the whole execution of the project, from the initiating to the closing process. It measures and observes the performance of the project and it is able to identify any variances from the project plan. It can be considered as a feedback loop to every process that is performed and represents the iterative nature of the PMBOK. This continuous monitoring provides the project team with insight into the project progress and identifies the areas, which need special attention.

Another characteristic of the monitoring and controlling process is that it is responsible for controlling the possible changes and recommends preventive actions to

possible problems. It can also influence the factors that could circumvent integrated change control so only approved changes are implemented.

2.1.1.5 Closing Process

Finally, the closing process is performed to finalize all activities across all process groups to formally close the project or a phase. Since all the activities of the project are carried out and the desirable outcomes and deliverables have been accomplished, the project can be considered finished. However, it is needed to declare an official end of the project accepted by all the parties that were involved in. Consequently, several additional steps need to be made. One of them is the required acceptance of the sponsor or customer. This means that the customer needs to approve that the deliverables have been accepted and there is no need for any further action in this project.

Another important aspect of this process is to create a document of lessons learned. By conducting post-project reviews, the project team must identify all those activities or issues that came up during the whole project execution and that they can be useful as an earned experience for other future projects. The project team should also gather the important archives, among them the mail conversations between the two parties, and place them on to the organization project database in order to be used as historical data.

2.1.2 Knowledge Areas of PMBOK

PMBOK includes nine knowledge areas:

- Project Integration Management
- Project Scope Management
- Project Time Management

- Project Cost Management
- Project Quality Management
- Project Human Resource Management
- Project Communications Management
- Project Risk Management
- Project Procurement Management

Project Integration Management includes the processes and activities needed to identify, define, combine, unify and coordinate the various processes and project management activities within the Project Management Process Groups. In the project management context, integration includes characteristics of unification, consolidation, articulation and integrative actions that are crucial to project completion, successfully managing stakeholder expectations and meeting requirements. Process Integrated Management includes the following processes:

- **Develop project charter** – It's the document which authorizes a project or a phase and documents initial requirements that satisfy the stakeholders, in both needs and expectations;
- **Develop project manager plan** – it's the process which documents the actions that are necessary in order to define, prepare, integrate and coordinate all subsidiary plans;
- **Direct and manage project execution** – includes all the processes of performing the work defined in the project management plan to achieve the project's objectives;
- **Monitor and control project work** – it's the processes that track, review and regulate the progress to meet the performance objectives as they are being analyzed in the project management plan;

- **Perform integrated change control** – it's the process of reviewing all change requests, approving changes and managing changes to the deliverables, organizational process assets, project documents and project management plan;

- **Close project or phase** – it's the process of finalizing all activities across all the project management process groups to formally complete the project or a specific phase;

Project Scope Management includes the processes to ensure that the project activities include all the work required and only the work required, to deliver the project successfully. Managing the project scope is primarily up to defining and controlling what is and what is not included in the project. Project Scope management includes the following processes:

- **Collect requirements** – It's the process which defines and documents all the stakeholder's needs in order to meet the project objectives;

- **Define scope** – the process which develops a detailed description of the project;

- **Create WBS** – the process of subdividing project deliverables and work into smaller, more manageable components;

- **Verify scope** – the process of formalizing acceptance of the completed project deliverables;

- **Control scope** – the process of monitoring the status of the project and managing changes to the scope baseline.

Project Time Management includes the processes required to accomplish timely completion of the project. Project Time Management includes the following processes:

- **Define activities** – this process identifies the specific actions to be performed so as to produce the project deliverables;

- **Sequence activities** – it's the process which identifies and documents the potential relationships between project activities;

- **Estimate activity resources** – this process estimates the type and the quantities of the resources, materialistic and human, required to perform each activity;
- **Estimate activity duration** – this process approximates the number of work periods needed to complete individual activities with the estimated resources;
- **Develop schedule** – It's the process that analyzes activity sequences, resource requirements, durations and schedule constraints to create the project schedule;
- **Control schedule** – it's the process that updates project progress by monitoring the status of the project and which manages changes to the scheduled baseline.

Project Cost Management includes the processes involved in estimating, budgeting and controlling costs so that the project can be completed within the approved budget. In particular, Project Cost Management has the following processes:

- **Estimate costs** – this process develops an approximation of the resources needed to complete project activities;
- **Determine budget** – It's the process which aggregates the estimated costs of individual activities or work packages to establish an authorized cost baseline;
- **Control costs** – this process updates the project budget by monitoring the status of the project and manages changes to cost baseline;

Project Quality Management includes the processes and activities of the performing organization that determine quality policies, objectives and responsibilities so that the project will satisfy the needs for which it was developed. It implements the quality management system through policy and procedures with continuous process improvement activities conducted as appropriate. Project Quality Management includes the following processes:

- **Plan Quality** – it's the process where quality requirements and standards for the project are being identified;

- **Perform Quality assurance** – it's the process of auditing quality requirements and the results from the quality control measurements to ensure appropriate quality standards and operational definitions;

- **Perform Quality Control** – it's the process of monitoring and recording results while executing the quality activities to assess performance and recommend necessary changes.

Project Human Resource Management includes the processes that organize, manage, and lead the project team. The project team is comprised of the staff with clearly defined and assigned roles and responsibilities for completing the project. The Process Human Resource Management includes the following processes:

- **Develop Human Resource Plan** – it's the process of identifying and documenting projects roles and responsibilities, the required skills, and it also reports relationships and creates the staffing management plan;

- **Acquire Project Team** – it's the process of confirming human resource availability and obtaining the team so as to complete project assignments;

- **Develop Project Team** – it's the process of improving the competencies, team interaction, and the overall team environment to enhance project performance;

- **Manage Project Team** – it's the process of tracking team member performance, providing feedback, resolving issues and managing changes to optimize project performance.

Project Communication Management includes the processes required to assume timely and appropriate generation, collection, distribution, storage, retrieval and ultimate disposition of project information. Project Communication Management includes the following processes:

- **Identify stakeholders** – it's the process of identifying all people or organizations impacted by the project and documenting relevant information regarding their interests, involvement and impact on project success;

- **Plan Communications** – it's the process of determining the project stakeholder information available to project stakeholders as planned;
- **Distribute information** – it's the process of making relevant information available to project stakeholders as planned;
- **Manage Stakeholder Expectations** – it's the process of communicating and working with stakeholders to meet their needs and addressing issues as they occur.
- **Report performance** – it's the process of collecting and distributing performance information, including status reports, progress measurements and forecasts.

Project Risk Management includes the processes of conducting risk management planning, identification, analysis, response planning, monitoring and control on a project. The objectives of the project risk management are to increase the probability and impact of positive events and decrease the probability and impact of negative events in the project. Project Risk Management includes the following procedures:

- **Plan Risk Management** – the process of defining how to conduct risk management activities for a project;
- **Identify Risks** – The process of determining which risks may affect the project and documenting their characteristics;
- **Perform Qualitative Analysis** – It's the process of prioritizing risks for further analysis or action by assessing and combining their probability of occurrence and impact;
- **Perform Quantitative Analysis** – The process of numerically analyzing the effect of identified risks on overall project objectives;
- **Plan Risk Responses** – The process of developing options to enhance opportunities and to reduce threats to project objectives;

- **Monitor and Control Risks** – The process of implementing risk response plans, tracking identified risks, monitoring residual risks, and evaluating the risk process throughout the project.

Project Procurement Management includes the processes necessary to purchase or acquire products, services or results needed from outside the project team to perform the work. Project Procurement Management includes the contract management and change control processes required to develop and administer contracts or purchase orders issued by authorized project team members. Project Procurement Management includes the following processes:

- **Plan Procurements** – It's the process of documenting project purchasing decisions, specifying the approach and identifying potential sellers;
- **Conduct Procurements** – It's the process of obtaining seller responses, selecting a seller and awarding a contract;
- **Administer Procurements** – The process of managing procurement relationships, monitoring contract performance and making changes and corrections as needed;
- **Close Procurements** – The process of completing project procurements.

2.1.3 Documents According to PMBOK

In this section, all the documents that arise from the processes described in PMBOK are presented. The goal of the Softcom-Int PM policy is to be an applied project management methodology tailored to the organizational needs. There are many documents that are generated during the PMBOK's processes. Most of them are really important, regardless of the end target industry whereas others are not mandatory.

Choosing which documents need to be filled in by the project team is part of the project management policy. The project team and the manager have to decide which documents are necessary by examining each project, as well as the appropriate level of detail. They should also decide which subsidiary management plans should be separated documents from the project plan and which should be included as paragraphs/sections in the latter.

The PM documentation can be distinguished based on the process group each document belongs to. Almost every process generates a document according to PMBOK.

While in the **Initiating process group** the following documents should be completed:

- **Project Charter:** It is the initial document of the project, which formally authorizes the project manager with the responsibility for the project execution to
- **Stakeholders register:** It is a matrix, in which all the stakeholders of the project are listed. It also contains all the available contact information for each stakeholder.
- **Stakeholder management strategy:** It is a document, which determines the strategy of managing stakeholder expectations.

In the **Planning process group** the following documents exist:

- **Project Management Plan:** It is a formal document that defines how a project is executed, monitored and controlled. It can be composed of several subsidiary plans and the level of detail varies.
- **Requirements Documentation:** Describes how individual requirements meet the business needs for the project. Requirements must be measurable, testable, traceable, complete, consistent and acceptable by the key stakeholders. They can also be defined at a high level in the beginning of the project and progressively become more specific.

- **Requirements Management Plan:** Documents how requirements will be analyzed, documented and managed throughout the project lifespan.
- **Requirements Traceability Matrix:** Links requirements to their origin and traces them throughout the life cycle of the project.
- **Project Scope Statement:** Describes the deliverables of the project in detail and the work required to create them. It can provide common understanding of the project scope among project stakeholder expectations and it also enables the project team to provide better planning and guides the team during the execution.
- **WBS dictionary:** It is a document, which includes a more detailed description of the components of WBS, including work packages and control accounts.
- **Activity List:** It is a comprehensive list, which includes all schedule activities required in the project so as to ensure that its members understand the type of work that is needed for the project to be completed.
- **Activity Resource Requirements:** It identifies the types and quantity of the resources required for each activity in a work package and determines the estimated resources.
- **Milestone List:** A milestone is a significant point or event in a project. This list identifies all the milestones and indicates whether they are mandatory or optional.
- **Resource Breakdown Structure:** It is a hierarchical structure of the identified resources that lists them by resource category and type. It is also useful for organizing and reporting project schedule data with resource utilization information.
- **Activity Duration Estimates:** These estimates are quantitative assessments of the number of work periods that will be required for an activity to be completed. They do not include any lags.

- **Project Schedule:** It contains the schedule that the project will undergo.
- **Schedule Data:** It includes all the available data for the project schedule.
- **Activity Cost Estimates:** These estimates are quantitative assessments of the costs required to complete project work. It is applied for all the resources.
- **Basis of Estimates:** Regardless of the level of detail, the documentation should provide a clear understanding of how the cost estimates derived.
- **Cost performance Baseline:** It is an authorized time-phased budget at completion used to measure, monitor and control overall cost performance.
- **Project Funding Requirements:** It includes total and periodic funding requirements which derive from the cost baseline.
- **Quality Management Plan:** It describes how the project management will implement the performing organization quality policy.
- **Quality metrics:** They describe project attributes and the way they will be measured by the quality control process. Quality metrics are used in quality assurance and quality control processes.
- **Quality Checklists:** They are checklists, which are used during the quality control process.
- **Process Improvement Plan:** It details the steps for analyzing processes to identify which one enhances their value.
- **Human Resource Plan:** It provides guidance on how human resources should be defined, staffed, managed, controlled, and released.
- **Communication Requirements analysis:** It determines the information needs of the project stakeholders. These requirements are defined by combining the type and format of the information needed with an analysis of its value.

- **Communication Technology:** It includes the methods that are used to transfer information among project stakeholders.
- **Communication Management Plan:** Communications management is the systematic planning, implementing, monitoring, and revision of all the channels of communication within an organization, and between organizations.
- **Risk Management Plan:** It describes how risk management will be structured and performed.
- **Risk Register:** It contains the outcomes of the other risk management processes as they are conducted, resulting to an increase in the level and type of information contained in the risk register over time.
- **Procurement Management Plan:** It describes how the procurement processes will be managed from developing procurement documents through contract closure.
- **Procurement Statement of Work (SOW):** The SOW for procurement is developed by the project scope baseline and defines only the portion of the project scope that is to be included within the related contract. The procurement SOW describes the procurement item in sufficient detail to allow prospective sellers to determine whether they are capable of providing the services.
- **Make-or-buy Decisions:** It documents the conclusions reached, regarding what project services will be acquired from outside the project organization, or performed internally by the project team.
- **Procurement Documents:** They are used to solicit proposals from prospective sellers. (RFP, RFB, IFB, RFQ).
- **Source Selection Criteria**: It includes the criteria that are used to rate or score sellers' proposals which can be either objective or subjective.

- **Assumptions and constraints Log:** It is a document, in which all the constraints and the assumptions of the project are gathered.
- **Technical Documentation:** It includes all the available technical documentation of the project (i.e Requirements Spec, Functional Spec, Design Spec, Test Spec etc.).

At the **Executing process group** the following documents exist:

- **Work Performance Information:** It includes all the available information, which was routinely collected during the progress of the project. This information can be related to various performance results**.**
- **Change Requests:** When issues are found while project work is being performed, change requests are issued. All those requests are gathered in this document.
- **Quality Audits:** It is a structured independent review to determine whether project activities comply with the organizational and project policies, processes and procedures.
- **Project Staff Assignments:** It contains all the possible assignments that were made for a particular project.
- **Resource Calendars:** It documents the time period during which, each member of the project team can work on the project.
- **Team Performance Assessments:** It is very important to develop an effective project team, and, that is why various effective team development strategies and activities are expected to increase the effectiveness of the team.
- **Issue Log:** It can be used to document and monitor the resolution of issues. It can also be utilized to facilitate communication and ensure a common understanding of issues.
- **Change Log**: It is used to document the changes that occur during a project. These changes and their impact to the project in terms of time, cost, and risk must be communicated to the appropriate stakeholders.

- **Procurement Contract Award:** A procurement contract is awarded to each selected seller. The contract can be in the form of simple purchase order or a complex document.

- **Configuration Management Plan:** It is the document that includes the practices and plans according to which, changes are handled systematically, in order for the system to maintain its integrity over time.

At the **Monitoring and controlling process group** the following documents exist:

- **Accepted Deliverables:** It includes the deliverables that meet the acceptance criteria. They are formally signed off and approved by the customer.

- **Work Performance measurements:** It describes the measurement of different processes, activities and deliverables based on the work performance information, including the overall project progress.

- **Variance analysis:** This includes the project performance measurements that are used to assess the magnitude of variation from the original scope baseline.

- **Forecasts:** As the project progresses, the project team can develop a forecast for the Estimate at Completion (EAC) that may differ from the Budget At Completion (BAC) based on the project performance.

- **Quality Control Measurements:** It includes all the results of quality control activities in a format specified during quality planning.

- **Validated Changes:** It documents any changed or repaired items that are inspected and will either be accepted or rejected before notification of the decision is provided. Rejected items may require rework.

- **Validated Deliverables:** A goal of quality control is to determine correctness of deliverables. The results of the execution quality control processes are validated deliverables and are documented in this document.

- **Performance reports:** It organizes and summarizes the information gathered and presents the results of any analysis as compared to the performance measurement baseline.

- **Risk Audit:** It examines and documents the effectiveness of risk responses in dealing with identified risks and their root causes, as well as the effectiveness of the risk management process.

- **Procurement documentation:** It contains all the available documentation about the procurements of the project.

- **Root Cause Analysis:** It provides a discussion of the approach taken to identify and document the root cause of a particular problem.

- **Issue Management Plan:** It documents the plans of managing the possible issues in a project.

Finally at the **Closing process group** the following documents exist:

- **Lessons Learned:** Some troubles during the execution of the project that are documented as a list in order to be avoided in a future project.

- **Close Project:** It is the authorized result of the project.

- **Procurement Audits:** It is a structured review of the procurement process. The objective of procurement audits is to identify successes and failures that warrant recognition in the preparation of other procurement contracts.

- **Closed Procurements:** It is a formal written notice, which informs that the procurements have been completed.

These are the 63 documents that can be generated by the processes described in PMBOK. However, it is not necessary for each one of them to be exhaustively detailed. It should be decided which ones are important for every project. Additionally, there are some documents that PMBOK doesn't exactly suggest, but they add value to the projects' execution. Some of these additional documents are referenced below:

- **Project Scorecard:** It is a document that contains the justification that led project manager and the project team to categorize the project in one of the three available types of projects.
- **Minutes of Meetings:** Include the agenda of the meetings, all the agreements and possible assignments that were made during the meetings.
- **Quality Gates:** Document the quality gates' decisions for the project with a brief description of what is achieved by them.
- **Release Notes:** They are technical documents, shared with customers of the organization, which detail the enhancements made to the features of the end-product, which was previously agreed to be delivered.
- **Reports:** They can either be internal or external (released to the customer as part of the communication plan). Reports basically document the progress of the project, as well as any additional information that needs extra attention.
- **Offers:** They can either be financial or technical. Offers include the point of view of Softcom-Int on the project execution.

2.1.4 Processes Not Covered Explicitly by PMBOK

PMBOK is a guide which covers the most important aspects of project management. It can be used in any industry and includes the basic processes that each organization should use, in order to run successful projects. However, because of its own nature, PMBOK cannot cover exclusively and in detail all the processes that might be important in every specific industry. It's easy to understand, that every industry has its own way of running projects because of the nature of the requirements that are different in every case. The main structure and work flow might be similar, but it's

almost sure that in different industries several issues will arise that might not be met in another industry's projects. In our case, where PMBOK is applied to software development's projects, there are some important processes, which are mandatory to perform in this industry, but they are not analyzed in PMBOK extensively or in the desirable degree. On the following sub-chapters such software development related processes of that can be characterized like "grey areas" of PMBOK will be presented shortly.

2.1.4.1 Configuration Management

Configuration Management is the practice of handling changes systematically so that a system maintains its integrity over time. Configuration Management is usually responsible for the log of changes. It often manages and evaluates proposed changes, monitors the status of them and maintains the inventory of the system and the documents of the support processes during the implementation of the change. In order to do all that, it needs to implement well-defined policies and procedures as well as various techniques and helpful tools. Configuration Management programs and plans provide technical and administrative directions in developing and implementing all those critical procedures, the appropriate tools and the resources, which a complex system is required to have in order to be successfully developed and supported. During system development, Configuration Management allows program management to track requirements throughout the life cycle through acceptance, maintenance and the various operations. The traditional software configuration management (SCM) process is frequently used by practitioners as one of the best solutions to handle possible changes during software development projects. It is able to identify all the functional and physical attributes of software at randomly chose points in time, and it typically performs a systematic control of changes to the identified attributes for reasons like the purpose of maintaining software integrity and traceability throughout the software development life cycle.

The SCM process further defines the need to easily allocate changes and the capability of the verification of the final delivered software, which must have all of the

planned enhancements, which are supposed to be included in the deliverable release. It usually includes four procedures that must be defined for each software project to ensure that a sound SCM process is implemented. Those procedures are:

- Configuration identification;
- Configuration control;
- Configuration status accounting;
- Configuration audits.

In PMBOK, configuration management is partly addressed during the Project integration Management process group and more specifically in the “perform integrated change control” knowledge area, as part of the change control process. At a glance, configuration management is being described in PMBOK guide mostly like an enterprise environmental factor.

2.1.4.2 Issue Management

During the life cycle of any type of project it is almost sure that there would be unexpected problems and questions that would crop up. When these issues arise, the project management team has to be ready to deal with them for the reason that they can potentially affect the project's outcome.

Since most issues are, by their nature, unexpected, the most viable question is how a project manager or a project management team is going to deal with them. Ideally, they need an issue resolution process in place before they start the project – to make sure that they stay on schedule, and meet the project’s objectives.

Issue management is the process of identifying and resolving issues, which are potential threats in producing major damages. These issues are possibly could be problems with the staff or the suppliers, some technical failures or material shortages, and all of them could possibly have a negative impact on any project. If the issue goes unresolved, risks are creating unnecessary conflicts, delays, or even failure to produce the desired deliverables.

Sometimes the difference between an issue and a risk it is not quite obvious. Issues and risks definitely are something different. However, they have same characteristics like the exact nature of both is largely unknown before the beginning. With risks, we usually have a general idea in advance that there is a cause for a concern. An issue is much less predictable and it can arise with no warning at any given time. For example, a risk could be the incapability of finding qualified staff for the organization. However, if u already have got qualified staff but suddenly one of them had a car accident, and his/her condition was that bad that needed to be hospitalized for a month that is surely an issue.

The only area, where someone can find something being implied in PMBOK about issue management is only in the stakeholder management plan. It's being referred there mostly like an organizational process asset. There has to be also an issue log document, which is going to provide the project management team with all the possible issues that might be revealed in any phase of a project.

2.1.4.3 Root Cause Analysis

Causal analysis is one of the most vital parts of Software Continuous Process Improvement. Without being able to trace all the possible defects that may appear and to spot their root cause, there is no possibility of reducing or eliminating them. A mandatory and important process of Causal Analysis is a process called Quality Assurance. This process is the one that establishes all the process descriptions and the existing standards along with the procedures that best practices offer and then checks for noncompliance issues against those documented standards. Identification of those defects provides initial input to Casual analysis and so does an ongoing Software Metrics (measurements) program. There is no doubt that root cause analysis process is very important for every software development process. Although, it is not that important for other industries projects that's why PMBOK doesn't refer to it extensively. PMBOK only refers to root cause analysis during the project risk management's process group and name it as a tool and technique in identifying potential risks in the identify risks knowledge area.

2.2 Software Development Project Management

As we said before, project management can be applied in every kind of industry as long as there is a project to be executed. The same stands for PMBOK practices, since it is applicable to any type of project, no matter in what industry the project lies. In this thesis we are going to describe the processes of applying PMBOK in software development projects. Software development is being used and it's a part of many industries, but we consider it mostly as a part of IT. So, before starting with software development projects, it is important to understand IT projects. In general, when we refer to IT systems, we actually mean a combination of computer hardware parts and software systems in an integrated system, which is capable of doing some specific work depending on the needs of the organization or the company. For example, in order to do some financial transactions we can use a business software application, which is a complete system consisting of an installed software system in a computer hardware system and it is ready to be used by end users. Therefore, an IT project could be setting up such software systems along with the hardware so to get business intelligence capability and make business processes and procedures more sufficient and effective. There are several tasks involved in such projects, from building or developing the software system and buying the relevant computer hardware to run it, to installing and configuring it.

As we can understand, a software development project can be a part of an IT project or an IT project on itself. The main task of a software development project is to design software based on customer needs and requirements and to implement it into source code. There are some additional tasks like testing the code for defects or adding new functionalities or even making the software product available to many operating systems, etc. Those tasks can be also part of a software maintenance project. Combining software development and software maintenance we have what it refers like software project and software project management.

Software project management is to develop and maintain a software product by implementing project management principles and processes as well as software engineering principles so that the software project will be delivered within the minimum time, at minimum cost and with good quality.

2.2.1 Types of Software Development Projects

There are many types of software projects with many different characteristics and various sizes, which mean that they are not homogenous at all. The general types are:

- Software Development Life Cycle (SDLC) projects
    - Full life cycle projects
    - Partial life cycle projects
- Approach-driven software development projects
    - Development from the beginning projects
    - Commercial off-the-shell (COTS) projects
    - Porting
    - Migration
- Maintenance Projects
    - Software modification
    - Functional expansion
    - Operational Support
    - Defect Repair
- Web application projects

First of all, there are the SDLC projects, which can be either full life cycle or partial life cycle projects. We will see in a following chapter what exactly a SDLC is, but for now we need to know that there are projects that are following the entire methodology of a SDLC and others that they just follow specific parts of the SDLC models.

Also we have the approach-driven software development projects. Most often in this case we have “fresh” projects. Those projects are new, by the means that there is nothing completely identical to it and its development must begin from scratch. In this category there are also the COTS projects. In the marketplace someone can find numerous COTS products like ERPs or CRMs etc. Customization or implementation of such products, in order to fit them with the organizations needs, can be a part of approach-driven software development. Furthermore, in this category there are porting projects, which deal with making software available among various hardware platforms, and migration projects, which mostly are projects that their source code is being upgraded in order to gain advantages from a specific new software release.

Another category is the maintenance projects. This category consists of software modification, defect repair, functional expansion or operational support of projects. However, in order to call software maintenance a project, it needs to have a well defined beginning and ending, for the reason that maintenance of software can be a continuous work. A software modification maintenance project occurs when an organization, which owns a specific software product, wants to modify some attributes of it for several reasons, including changes in business processing logic or changes in requirements. A functional expansion of a software project is often occurs when an organization requires additional functionality to an existing software product. There are also maintenance projects for repairing defects, which are based on SLA agreements. Defects can occur months or even years after the final delivery of a software product.

Finally, we have the web application projects, which defer from other software development projects for the reason that they have more than two tiers, such as the presentation tier, database server tier, application server tier, web server tier and the security server tier. Also, another main variation from other project is that backend programming and middleware programming may be in different programming languages

and may require persons with different skill sets, even for the same project. Environmental changes that have nothing to do with the organization, for example a new security threat, the release of a new browser, or the upgrade of an existing browser, etc., can also trigger software maintenance in a web application, even though the functionality remains unaltered.

3. Project Governance across Lifecycle

Implementing a project is a demanding endeavor, therefore lays the need of an effective method, which will control and monitor its progress throughout life cycle -of this particular project- in order to ensure its success. That method is being provided by the project governance and it should be described in the project management plan. Project governance must fit within the organization that sponsors it. Depending on these constraints and the additional limitations, it is up to the project manager and the project management team to determine the most appropriate method of carrying out the project. There are several important decisions that must be made during that process, such as the allocation of the necessary resources, the individuals that would be involved in and also whether the project should consist one or more phases and, in case of multiple phases, the specific phase structure for the project.

The phase structure provides a formal basis for control. Each phase is formally initiated to specify what is allowed and expected for that phase. A management review is often held to reach a decision to start the activities of a phase. A project phase is generally concluded and formally closed with the review of deliverables to determine completeness and acceptance.

When projects are multi-phased, the phases are part of a generally sequential process designed to ensure proper control of the project and attain the desired result. However, there are situations when a project might benefit from overlapping or concurrent phases. There are three basic types of phase-to-phase relationships:

- A **sequential relationship**, where a phase can only start once the previous phase is completed. The step-by-step nature of this approach reduces uncertainty, but may eliminate flexibility for reducing the schedule and integrate change requests.

- An **overlapping relationship**, where the phase starts prior to the completion of the previous one. Overlapping phases may increase the risk and can result in

rework if a subsequent phase progress before accurate information is available from the previous phase.

- An **iterative relationship**, where only one phase is planned at any given time and the planning for the next is carried out as work progresses with regard to the current phase deliverables. This approach is useful in largely undefined, uncertain and rapidly changing environments, but it can reduce the ability to provide long term planning.

For multi-phase projects, more than one phase-to-phase relationship could occur during the project life cycle. Considerations such as level of control required, effectiveness and degree of uncertainty determine the relationship to be applied between phases. Based on those considerations, all three relationships could occur between the various phases of a single project.

3.1 Organizational Strategies

In large project management organizations, which usually have plenty of projects running at the same time, project management is a part of a more complex context, which is governed by portfolio or program management. Depending on the strategic plan of that kind of organizations, several combinations of the organizational strategy can coexist, by the means of project prioritization, which can be mostly based on funding and risk. Usually, many projects can be a part of a program, which is governed by program management, and many programs are a part of a portfolio, which is governed by portfolio management. Projects under the same program are dependent on each other, by the means that all of them are implementing in order to achieve a higher level goal, which is controlled and managed by the program. Moreover, a group of programs are a part of an even higher level goal for the organization, which is controlled and managed by the portfolio. There are cases, where projects or programs are independent on each other, but they belong under the same portfolio. There are also situations, where a group of projects belong to a portfolio, which may include a group of

other programs as well. No matter what, there is no defined structure that every organization must have in order to categorize projects, programs or portfolios. Every organization can have its own, depending on the situation or in general its business culture. However, each one of them has different characteristics and requirements. On the following picture the hierarchy between those three from the well-known PMI pyramid, which by the way is depicted on the cover of PMBOK book, are depicted.

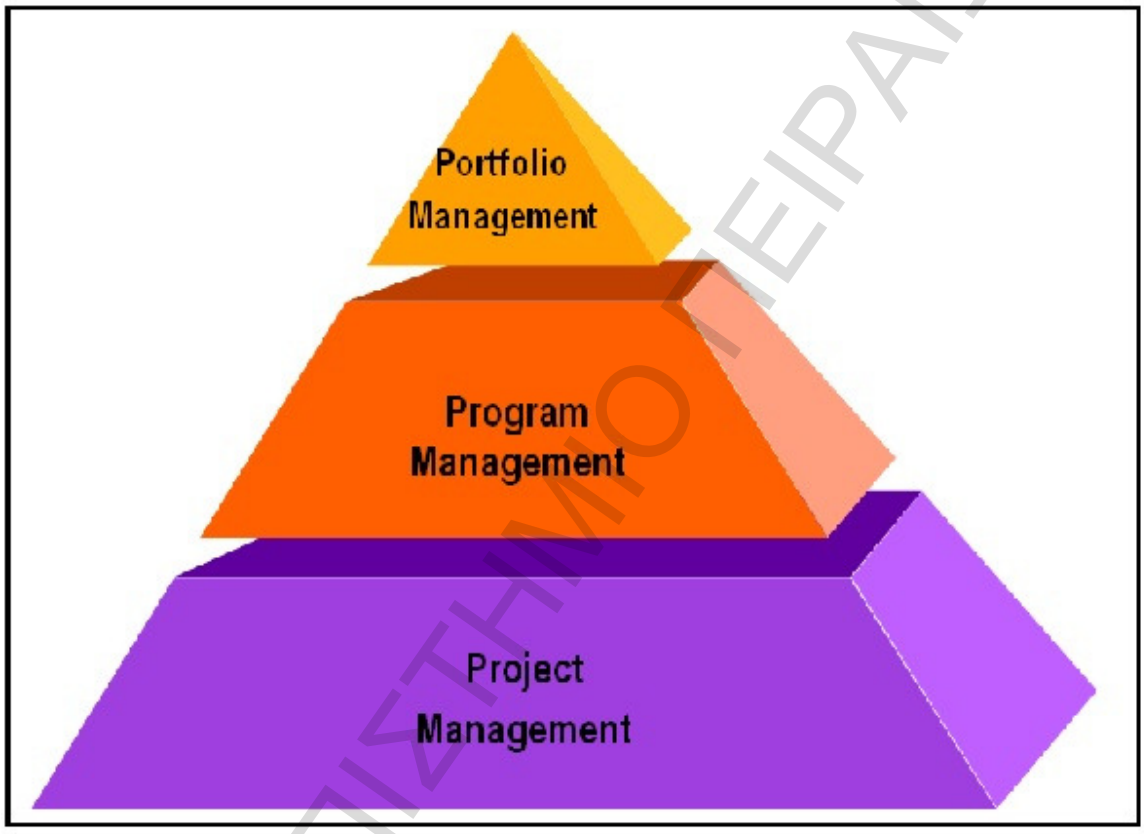


Figure 10: PMI Pyramid

3.1.1 Portfolio Management

Portfolio is a collection of programs, mostly, or projects which are grouped together in order the management of the efforts to meet a strategic business goal of the organization. As stated before, programs or projects under the same portfolio are not necessarily related directly with each other. Portfolio management is a centralized management, which includes identification, prioritization and authorization of the group of programs or projects or even portfolios.

Among the basic characteristics of portfolio management is that their business scope must follow the corporation strategy and the success is measured by the overall performance of its components. Furthermore, portfolio managers must continually monitor the macro- and the micro-environment of the organization for possible changes and also they are responsible for the management and coordination of the portfolio staff. One basic goal of portfolio management is to maximize the value of the portfolio by evaluating its components and projects.

3.1.2 Program Management

A program is a group of related projects, which are being managed together so as to obtain specific benefits. Usually, in case of managing them individually it is more unlikely to achieve the desirable level of completion. Program management focuses on achieving the strategic goals of the integrated program, unlike to project management, which main target is to meet specific objectives of a project. Program management, in general, may provide a layer above the management of projects and focuses, mostly, on selecting the best group of projects, defining them in terms of their objectives and providing an environment, where projects can be run successfully without faults and defects.

A very good example of a program is the implementation of an ERP (Enterprise Resource Planning) system. ERP systems usually contain several individual projects, such as Finance, Purchasing, etc. Each one of these specific projects should be run by a project manager. However, the overall grouping of these related projects must be run by a program manager, who will be responsible for making them all work together as a system and moreover, to achieve the initial objective of the organization, which was to make a system meeting the business objectives. On the other hand, each project manager should make sure that his project should be able to be easily integrated with the other projects of the overall program. Success in a program is being measured by ROI, new functionalities and benefits realization.

3.1.3 Project Management Office (PMO)

A Project Management Office (PMO) is an organizational entity, to which numerous responsibilities have been assigned related the centralization and coordination management of all the projects under its domain. Those responsibilities can vary from supporting project management in different levels to direct management of the projects, depending on the authority level that has been assigned to it from the organizational higher level of governance.

The projects that the PMO supports or manages do not have to be independent from each other. The specific form, structure and responsibilities of PMO are not standard since it depends on the business needs and the organizational structure. Most of the times, though, it happens to have an independent role within the organization and

it is being able to supervise or to act, in general, as an integral stakeholder to ongoing projects.

Most of the major functions of the PMO are to support project managers in different ways, which may include:

- Managing shared resources across all projects.
- Coordinating communications across projects.
- Monitoring compliance with organization's standards about project management.
- Developing project policies.
- Developing project management methodologies and standards.

On the other hand, when it acts like a supervisor, its primary actions are:

- To make recommendations.
- To terminate projects.
- To keep business objectives consistent.

Most of the times, project managers and PMO are seeking different objectives, but for both the efforts should be aligned with the organization's strategic needs. The basic difference between the two of them is that the project manager's role is to handle a specific project by managing its constraints, resources and objectives, while the PMO is in a high level of abstraction, having the role of coordinating all the projects in the organization. PMO optimizes the use of shared organization resources across all projects and manages methodologies, standards and interdependencies among projects at the enterprise level.

Please note that no PMO has been officially established yet at Softcom-Int as the number and volumes of the awarded contracts does not lead to such a strategic decision. Nevertheless, Softcom-Int recognizes the value of a PMO in a project-hunting organization and this function is actually driven by the CEO.

3.1.4 Roles of Stakeholders

Stakeholders are either persons or organizations, who are actively involved in a project and also have different levels of interests, which are being affected either positively or negatively, by the successful completion or not of a project. Depending on the role or the characteristics that each stakeholder can have on a project, they can influence the whole process in different ways. The identification of every possible stakeholder of a specific project is a very important process that the project team should do, in order to be able to determine all the project expectations and requirements.

The level of a stakeholder's responsibility and authority to a certain project can vary from a very simple role, such as a single team member, to a very important role, such as the sponsor of the project, which can have a political, economic and financial impact on the project. Stakeholders may be either internal (project team of Softcom-Int) or external (customer side or subcontractors). Stakeholders can have either positive or negative results from a project completion. Some of them, mostly the majority, benefit from a successful project, while others may not. For example, if a new ERP system is going to replace an old one in a company, the users possibly are not going to accept it, because they don't want to change their behavior. In this case, the top management of the company would like the project of implementing the new ERP to be successful, but the users would rather prefer to fail, so as to retain the present status quo. Thus, when they will ask them to participate in acceptance tests, they will have a negative attitude against the new system, so it is more possible for the new ERP system not to pass those tests. By not passing the user acceptance tests (UAT) automatically means that the project has failed. Thus it is clear, the crucial role that the negative stakeholders have to a project and that by overlooking their influence the likelihood of a project failure is being increased. That's why managing the stakeholder expectations is a vital part of project manager's responsibilities. The following are some more detailed examples of the potential stakeholders in a software project.

- **Customers/users:** They are the ones that are going to use the final product of the project and they can be internal or external;

- **Sponsor:** Responsible for the project funding;
- **Portfolio managers/ Program managers:** They are responsible for the governance of a group of projects or programs, which may or not be independent.
- **Project managers:** They are assigned from an organization in order to achieve the project goals and also to lead the project team.
- **Project team:** This team, usually consisted by several individuals from different groups and knowledge background, is the one, which carries out the work of the project. They are not getting involved in the management of the project, but mostly in the execution phase(s);.
- **Vendors/ business partners:** Vendors, suppliers and (sub-)contractors are usually external organizations or persons, who are contracted to perform a specific work or their services on a project. Business partners provide specialized expertise on several issues to the organization.

Softcom-Int not only is keen but also systematically seeks the active involvement of the stakeholders from the customer side into the project activities by setting up a joined project management team.

A project team with well-defined structure, communication interfaces and escalation paths is necessary for the successful execution of every project. The main features and characteristics of the joined project team should be:

- Distinguished Roles;
- Distinguished Responsibilities;
- Participation of the key stakeholders;
- Full coverage of the project needs in terms of resources availability;
- Full coverage of the project needs in terms of business know-how;
- Full coverage of the project needs in terms of technical know-how;
- Flexibility.

Project management team after taking over the responsibility of the project execution, in the kick-off meeting, will be responsible for:

- Achieving the project objectives;
- Ensuring that the execution plan meets the target implementation date, remains within the agreed budget and that deliverables meet the desired quality standards as specified in the contract between the two partners;
- Coordinating and handling of internal and external issues, through the appropriate departments and agencies;
- Organizing periodic and on demand, as necessary, meetings to monitor the progress of the project;
- Delivering periodic progress reports.

3.1.5 The Software Development Project Manager

Software engineering and software project management in extend have been in existence only for last 60 years or so, starting from the 1950s. As a result from this lack of engineering practices, software project management is a difficult process. Requirements and software design specifications are still immature in the software industry. Tools, technologies, and models for software projects are still evolving. Education and training required to work on software projects are also still evolving, resulting to people working on software projects with less than desired skills. A person responsible for managing a software project thus truly feels inadequate due to less than perfect circumstances under which he is supposed to perform.

A successful software project manager should be able to understand not only how a project should be planned and executed but also the processes beyond the project itself. He should learn the environment in which he should be planning and executing the projects. No doubt, software projects are extremely challenging. Nevertheless a good framework to plan and execute a project definitely helps. Software project tasks require a lot of creativity and that is why they are very human-intensive

activities. At the same time, compliance to good framework ensures that human mistakes are avoided or at least minimized. Frameworks also ensure that there is a good way of working on assigned tasks and outputs are measurable. Software project managers should understand these practical aspects and should plan and execute their projects accordingly to be successful.

Furthermore, there are some basic characteristics that software project managers should have. One of those is that they should be people oriented. They must enjoy the interaction with other people and being able to recognize emotions in others. This is very important because they will have to handle a team so being able to interact with others is an advantage that they should have. Another special characteristic of a successful project manager is to be centered. Project managers are centered when they are aware of their own liabilities, confident and calm. Finally, creativity and detail orientation are also some special characteristics for project managers.

A good project manager is a good planner as well and he can add value to the organizational project planning processes through several actions and behaviors, such as:

- Diligently planning the project and preparing plan documents so that they adhere to organizational processes, standards, and guidelines.
- Recognizing the importance of project planning. It is not just preparing documents, it is planning the project. The documents are an offshoot of the planning process that are to be used for the purposes of review, improvement, and reference by all concerned groups in the organization.
- Assisting the organization in developing, establishing, implementing, and continuously improving the project planning process.
- Adhering to organizational processes, standards, and guidelines.
- Giving feedback to concerned parties.
- Participating in process improvement activities.

- Carrying out the project planning activity to the best of one's ability as diligently as possible.

As a conclusion, we could say that assigning a project manager is very important for the success in project execution, that's why the one who is responsible of assigning the project manager should be very careful. A wrong choice in this part of the project it might affect the whole execution later and it also might cost more in effort, in time and in budget for an organization.

3.2 Internal Project Organizational Structure

The internal structure of an organization has a particular role in conducting a project. It is an important environmental factor, which can affect many aspects of a project, such as the authorization level and the availability of resources. The way that each organization is structured can also influence, either positively or negatively, all the processes of a project. The following table shows all the possible structures that each organization can have. The structures of the hierarchy vary from functional to projectized, with a variety of matrix structures available between them. Each hierarchy offers different authority levels in a project, which automatically means different approach and work breakdown in every project. However, in order to precede with successful management the structure of each company and the authority levels, as well, must be well defined and strict.

ORGANIZATION STRUCTURE / PROJECT CHARACTERISTICS	FUCTIONAL	MATRIX			PROJECTIZED
		WEAK MATRIX	BALANCED MATRIX	STRONG MATRIX	
Project Manager's Authority	Little or None	Limited	Low to Moderate	Moderate to High	High to Almost Total

Resource Availability	Little or None	Limited	Low to Moderate	Moderate to High	High to Almost Total
Who Controls the Project Budget	Functional Manager	Functional Manager	Mixed	Project Manager	Project Manager
Project Manager's Role	Part-Time	Part-Time	Full-Time	Full-Time	Full-Time
Project Management Administrative Staff	Part-Time	Part-Time	Part-Time	Full-Time	Full-Time

Table 1: Organization Structures and project characteristics

The most traditional structure for an organization is the functional, where there is only one superior for each employee. Staff members are grouped depending on their specialties, which can be further subdivided. Usually, each department in a functional organization will perform its project work on its own and independent from the other departments. In this structure the project management duties are being shared among the functional managers, which means that organizations like that don't let themselves to the needs of project management. Advantages of this structure are that there is only one higher authorization level to deal with and after the completion of the project the organizational reporting structure remains intact. On the other hand, its main weakness is the difficulty of focusing resources on the project, because they are not always available. The functional structure is represented on the following figure.

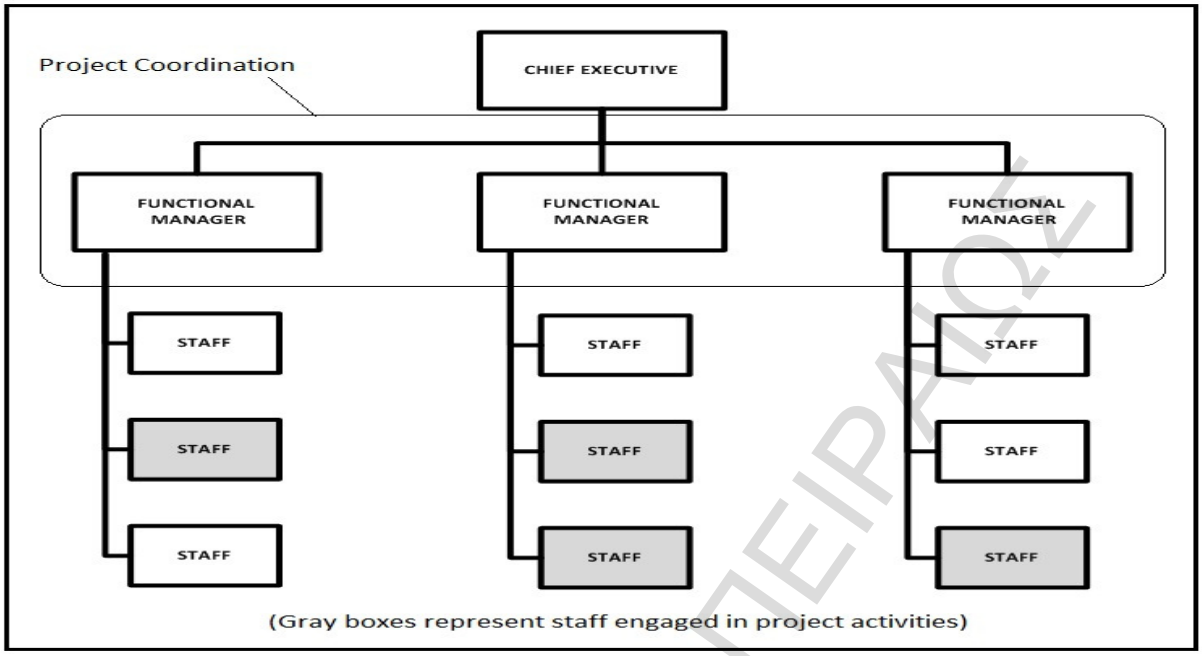


Figure 11: Functional structure

The matrix structured organizations are including characteristics of both functional and projectized structures, where the team leadership is being shared between the project manager and the functional managers. The weak matrices maintain most of the functional structure characteristics and the role of the project manager is more like a coordinator in projects. As it is obvious from the figure below, in weak matrices structure resources from different departments are available to be used in any kind of projects. The main advantage of this structure is that the reporting structure of the organization remains intact even after the completion of the project, while the disadvantage is that the project manager has minimal amount of authority.

Strong matrices, on the other hand, have many of the characteristics of the projectized structured organizations. They can have full-time project managers with high level of authority and different levels of administrative staff. Here as well, resources can be used from different departments as the picture depicts. The strengths of a strong matrix structure are that focusing on a project is the most important activity and that the reporting structure of the organization remains intact, here as well, after the completion of any project. The weakness is that this structure requires extensive communication with the team and the functional managers.

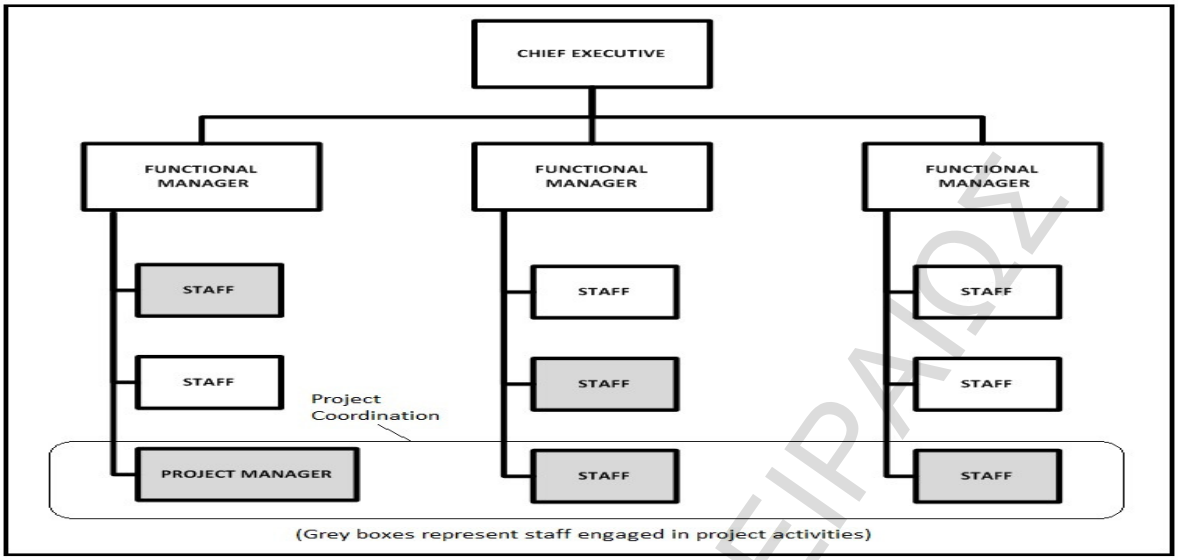


Figure 12: Weak Matrix Structure

Finally, even if the balanced matrix organizations recognize the need of having a project manager, they do not provide the project manager with high-level authority over the project and with the project funding. The main problem with balanced matrices is that there are actually two higher authorization levels, which can be rather confusing as contradictions could easily occur. That's why in order for this structure to be successful the roles need to be clearly laid out.

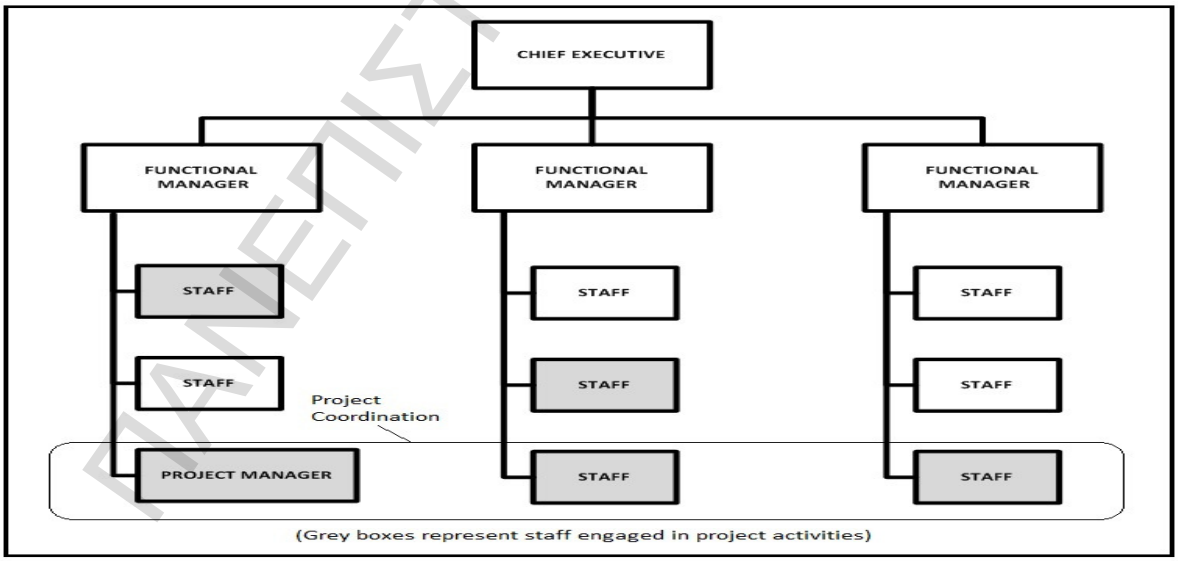


Figure 13: Strong Matrix Structure

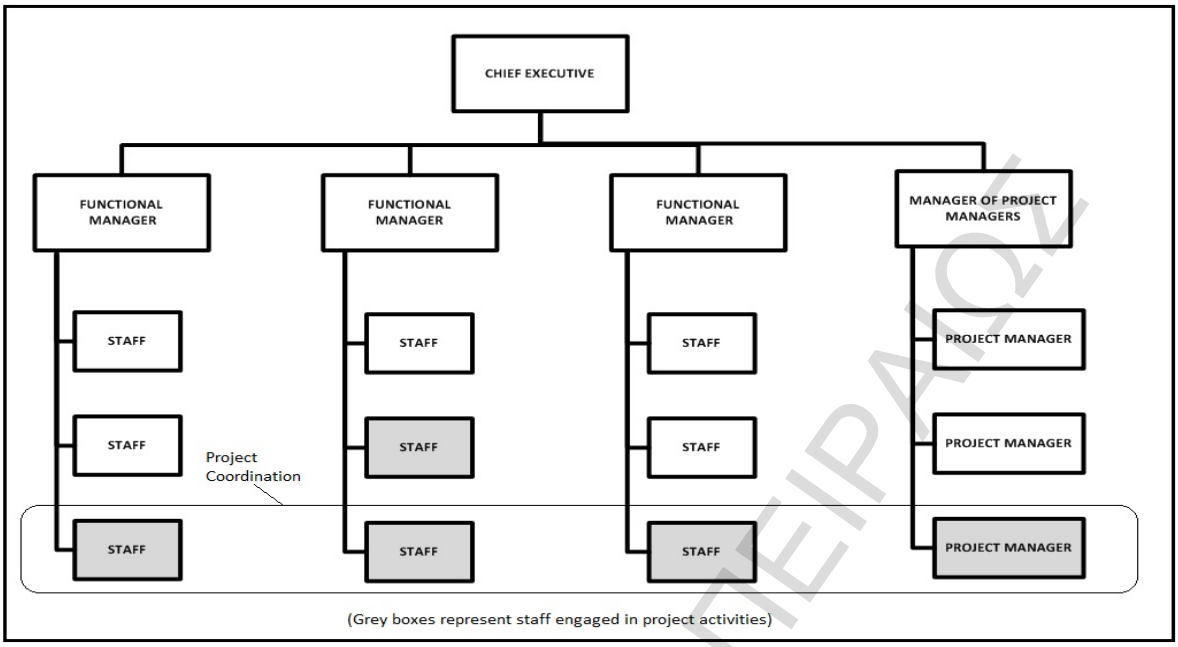


Figure 14: Balanced Matrix Structure

As far as the projectized structured organizations are concerned, they are quite the opposite side of the functional ones. In this kind of structure, team members are usually in the same location, most of the resources can be directly involved in every project of the organization and the project managers are independent having a high level of authority on the projects. The strength of this structure is of course the existence of a dedicated project manager to each specific project, which automatically means quick decisions and readily available supervising resources for the project. On the other hand, it has the disadvantage that at the end of the project team members usually don't have certain positions to return to and they might become idle for a while.

Although, none of the best practices suggest such thing, it is quite common for organization to have more than one structure. Even for the most functional structured organization, it is normal sometimes to create a special project team to implement a crucial project. In this case, such team may have the characteristics of a projectized structure, although this is not the main strategy of the organization. Sometimes, though, there are such strategies in place and those types of organizations that use them are called composite organizations.

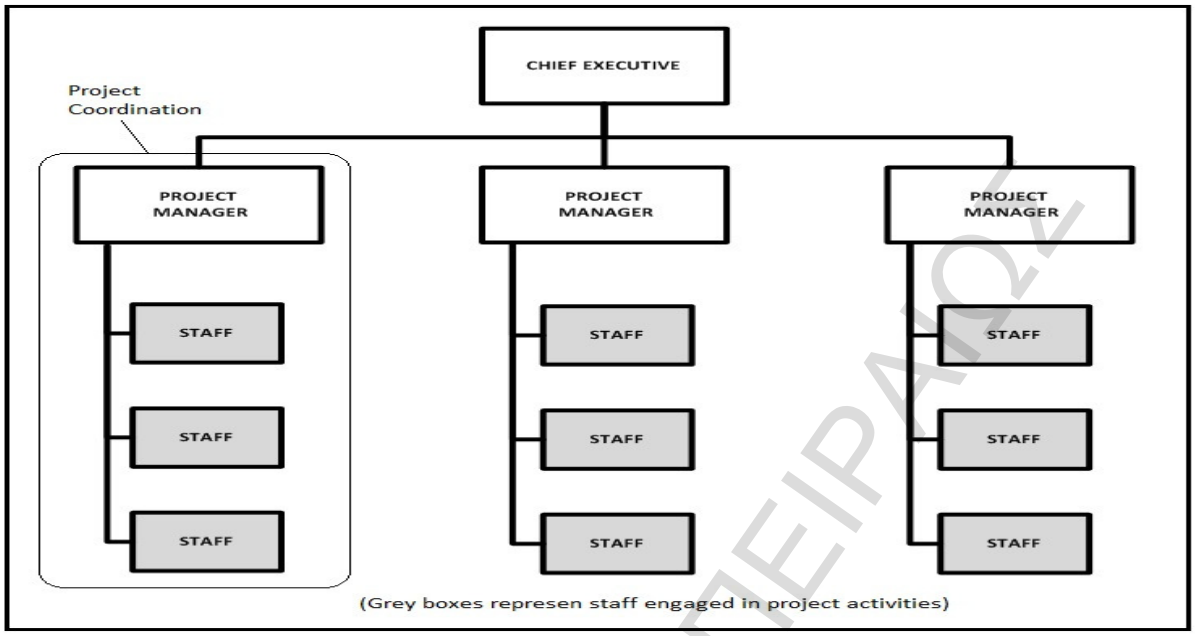


Figure 15: Projectized Structure

Softcom-Int has adopted the projectized organizational structure due to the following reasons:

- it is considered the more effective so as to deliver successful projects and
- it fits better to the network business model that has been already setup internally in the company.

4. Lean Management

Right after the World War II, the economy of Japan was in a very bad shape. With the mutual target of rebuilding and upgrading their economy, the Japanese started deploying new plans and methods. One of those methods was the Lean Manufacturing, which was developed by Toyota, a well-known Japanese automotive industry. They utilized the Toyota Production System (TPS), which had the main scope of "the absolute elimination of waste", according to one of the inspirers of this system, Taiichi Ohno. As it is going to be explained later on this chapter, by waste, it is meant anything that can prevent adding value during the whole process of transforming a raw material into a finish good for sale. However, the only responsible to judge whether a firm has created value or not, is its customers.

The concept of Lean thinking was not that familiar to the Western world until 1991, when Womack, Jones and Roos published the book "The Machine That Changed the World". In this book they extensively analyzed the Lean philosophy, introducing it to the organizations across the world. The Lean philosophy is nothing more than trying to eliminate any, or if it is possible, all the waste (Muda in Japanese), that an organization can produce during all of its activities, including human relations, technology, management etc. In order to do so, it seeks fast and flexible process flows and it considers an 'end to end' value stream that produce one or more competitive advantages to the organization that applies the Lean Thinking.

4.1 Lean Principles and Waste

The Lean approach has 5 basic principles:

- **Value**
- **The value stream**

- **Flow**
- **Pull**
- **Perfection**

The **value** principle specifies what creates value from the customer's point of view. Usually any kind of a process (i.e. a well-defined project management or software development process) that a customer would pay for it adds value to the product. An activity which adds value transforms the end product closer to what the customer wants. For that reason any activity that does not add any kind of value to the end product is considered to be a waste.

The **value stream** principle identifies all the steps, which forming the process chain. It is the sequence of processes that transform the raw material to the end product and it creates value.

The **flow** principle makes the value process flow. This principle is responsible to combine with the most efficient way all the activities and the processes of the organization so to maximize the value added and to minimize the waste. For example, by eliminating the waiting time between processes ensures the flow will go more quickly, which is a policy that adds value.

The **pull** principle makes only what is needed by the customer. By this, it is assumed that the organization is aware of the exact needs of its customers and is in position to produce exactly what is needed so to eliminate unnecessary procedures and waste and add value.

The last principle of Lean Thinking **is perfection**. By this it is meant, that there has to be a continuous improvement by adding value to the customer and by producing exactly what the customer needs, when the customer needs it, in the amount that the customer needs it and at the previously agreed price.

As far as it concerns, the wastes that Lean Thinking insists a lot, the first step it has to be taken in order to eliminate them is to identify them. There are 7 elements of waste (muda) according to Lean:

- **Muda of Correction**: The waste of Correction includes the way of handling and fixing mistakes (i.e. software defects). Correcting and repairing a defect adds unnecessary costs.

- **Muda of Overproduction**: The waste of Overproduction is when something is produced in more amounts or more detailed than what it was supposed to (i.e. functionality or features that the customer has not requested). It is possibly the worst form of waste for the reason that it contributes to all the other wastes.

- **Muda of Processing**: The waste of Processing relates to over-processing anything that doesn't add value (i.e. unnecessary complicated bureaucratic processes) and with this precious time can be lost.

- **Muda of Conveyance**: The waste of Conveyance is the unnecessary movement of materials and goods (i.e. promoting a software package for UAT although the code quality is not good enough and it is expected that the customer will reject it).

- **Muda of Inventory**: The waste of Inventory is material or resources that are bought, invested but not immediately used or sold (i.e. over allocated staff).

- **Muda of Motion**: The waste of Motion is the unnecessary movement of people and equipment, which doesn't add value (i.e. unnecessary on customer premises meetings while a phone conference would be efficient enough to extract the needed outcome).

- **Muda of Waiting**: The waste of Waiting is related to a nonproductive time due to lack of material or human resources (i.e. delays caused by a wrong planning of the procurement orders).

Lean also offers a simple but effective method to organize the workplace in a better way with the 5S methodology. However, it goes beyond this simple concept, by maintaining standardized conditions and instills the discipline required in order each person to maintain a top class work environment. The 5S method took its name from

the 5 Japanese words for the five implied practices, which are leading to the offering accomplishments. Those 5 words are:

a. **Seiri (sort)** means to separate needed tools or parts from unneeded materials and to remove the latter, to separate what it is needed and what not and disregard the useless stuff.
b. **Seiton (straighten)** is the second step, in which when seiri has been carried out then it is implement to classify and arrange the needed items. By doing that, the search time and effort are minimized and so does the inventory.
c. **Seiso (shine)** means cleaning the working environment. By keeping it clear and in a good shape the risks of catching fire or having injuries are minimized.
d. **Seiketsu (systemize)** means to keep one person clean, by the means of wearing appropriate clothes and gear.
e. **Shitsuke (sustain)** means to maintain self-discipline.

As aforementioned, Lean started from and it is associated with the manufacturing industry. Although, this doesn't mean that it cannot be applicable to any other industries. As a matter of fact, the last years more and more industries are trying to adopt the Lean approach in their processes. The result is that nowadays, many industries managed to integrate the Lean philosophy to their industry needs and their different processes. One major process that Lean found plenty of room to develop and to be successful in is the Project Management processes and Softcom-Int is willing to invest on this direction.

4.2 Lean Approach and Project Management

As one said, the resource managers and in general, the project managers do not need the Lean approach to tell them how it is to work in a Lean world. Their job's nature is to work in a lean environment, which demands lean on time, lean in resources and lean in funding. Thus adopting the Lean approach was not that difficult for them. However, there were some issues that came up during the integration between Lean approach and the project environments. One of those issues was that some project environments are made up of a system of different systems, for example the supply

chain environments. The difficulty here was to prioritize and decide in which area to focus, more or less, for potential wastes and adding value. In addition to that and because of the initial development of Lean for manufacturing environments there is no readily significant translation for it to be applied in the project environment immediately. As a result, when applying techniques for improving some areas of a project-based system, like productivity, value, waste, it is appeared to have some disconnections. Another drawback is that the PMBOK (and the current 4th edition) doesn't integrate Lean to its practices, which by the way is very important and as it is expected, the PMI is going to include Lean approach in the next edition of PMBOK.

There are a couple of definitions, which are generally used to connect the Lean approach to the project management processes. The Lean System emphasizes the prevention of Mura (Waste), which is the amount of time, resources and effort that are being spent without any of them adding value to a specific product or service. Then is the Lean Enterprise definition, which fosters the company culture and employees seek to improve their skills, knowledge and production. The main target of the enterprise should be to deliver to its customers what they asked for in the first place, which it might be a service or a product, in the right amounts, at the right time, to the right location and also in the right condition. From now on, the phrase "Lean Project Management" is going to be used for the project management processes, which are being influenced by the Lean approach. The main reason is to build Lean Behaviors in Softcom-Int.

The previous Lean Principles can now be adjusted in order to integrate them with the project management logic. So the LPM (Lean Project Management) Principles could be:

- Eliminate Waste;
- Empowerment, Respect, Integrity;
- Decide later, Deliver Faster;
- Amplify Learning;
- See the Whole;

- Risk Management.

Let's analyze further the main characteristics of those principles. The first new LPM principle is the Eliminate Waste principle. There are several kinds of waste that should be eliminated as much as possible. This is a very difficult task and in order to achieve a significant elimination of those wastes, there should be a well-defined flow of the various processes during the execution of each project. The four basic steps that one needs to take care off are to prepare a plan, build good team work, practice for perfection and of course avoid rework. For example, it is very vital for LPM to have a strong Work-Breakdown Structure (WBS). By having a well-designed and analyzed WBS, with the exact responsibilities, deliverables and milestones, the elimination of possible time, resources and effort waste for the organization is maximized. So, the possibility of delivering the service to the customer in time, on budget and in the right quality, is as well, maximized.

The second principle is the empowerment, the respect and the integrity. This has to do mostly with the Project Team. By empowerment, it is implied to give authority to the team members, which is something that can result into greater commitment and greater motivation to team members. However, it requires discipline, respect and integrity, characteristics that anyone in the team must have. There are, however, some requirements that need to be completed for a person to be part of such team, to have the right qualifications, to be well trained, in addition to the personal characteristics.

The next principle deals with the management of many projects and the way to organize the available resources, time and budget so to achieve the ultimate target of being successful in all of them. It includes methods like the theory of constraints, which is going to be examined in one of the following chapters. These kinds of methods are offering ways of handling the schedule and the resources in a successful and lean way. A very important method, that Softcom-Int will also adopt, is the Critical Chain Project Management (CCPM). Here it gives emphasis as well to the planning and development processes and is trying to eliminate the wastes of Inventory, Waiting and Defects.

The Amplify learning principle focuses on the training and education of the team, while the last principle suggests of watching the project's life cycle constantly so as to overcome mistakes and prevent others.

4.3 Benefits of Implementing Lean

There are three categories in which the benefits of implementing Lean approach could be broken down:

- Administrative Improvements;
- Operational Improvements;
- Strategic Improvements.

Most of the organizations that implement Lean are doing it because of the operational benefits.

The operational improvements can be found in reducing Lead Time, increase productivity, reduce Work-in-Process Inventory, improve quality and reduce space utilization. The administrative improvements can be things like reducing processing errors, paperwork and staff demands, and also by streamlining the customer service. As far as it concerns the strategic improvements, the organizations that implement Lean do not adequately take advantage of the possible improvements. It might take some more time to achieve something, but it is a matter of time to learn how it can benefit and produce tangible improvements.

Apart from that type of improvements, there is another area where the implementation of Lean approach has a positive impact. This area is Project Management and the sub-processes that can be improved by following the Lean approach. As it was previously stated, project management systems have many roles each one of them with an own perception of what needs to be improved. As long as those systems are not aligned to work together, it is almost impossible to achieve real improvement. For that reason it is almost mandatory and vital as well, to understand the relationships between these systems. Only when the capacity of the organization (resources time and budget) is well defined one can proceed in making individual

project commitments. The key improvement that Lean has to offer is the alignment of these systems of systems.

Furthermore, traditional Project Management needs some refinements to become Lean. There are numerous improvements that have been developed through the TOC (Theory of Constraints) methodologies, like the Critical Chain that is going to be examined later. The alignment of the system of systems is already established because of that. Also the portfolio work should be pipelined in accordance with the capacity of the organization. There have also been shorter and more realistic schedules and the assignment and execution of tasks are now better organized.

4.4 Categories of Waste in Project Environment

This chapter tries to map the general wastes of Lean to the similar wastes of project environment and to analyze the situations where a waste occurs. Having clarified this, it would be easy to locate those wastes and try to eliminate them. The first category is Overproduction. This waste can be translated in project waste into assigning resources to a task just because the resources are available and not because that task needs that quantity of resources. Overproduction can also be appeared when doing a task, which is not a part of the delivering value task. With those, the organization ends up spending time and resources without adding value and this is something that must be eliminated.

The next category of waste is waiting. In project environments this waste occurs usually when a resource is multi-tasked. There are times when a resource needs to work on different tasks and so there is an interruption in one task. At this time the task experiences a waste of time as it remains idle for the time being waiting for the necessary resources to assume execution. This also happens when a predecessor task has been completed but does not pass on the work to the successor task. The successor task also experiences waste by waiting for this hand-off.

The third category of waste is Transportation. It is quite usual for the relationships between predecessor and successor tasks not to be well defined. This

leads to the possibility of a successor task to wait for the completion of a predecessor task, in order to take an input that it doesn't really needs. This might cause Waiting waste as well. Obviously, it is very important to identify and make the relationships between tasks very clear.

The next category of waste is Inventory. Excess Inventory waste, in a project environment, is represented when resources accomplish more tasks than the organization can process. This means that it has been made wrong evaluation of the resources needed for the execution for a task or process. It also happens, when a resource is being assigned in a task and is more skilled than what it is required to be for the execution of that task.

The fifth waste is Motion. Excess motion occurs when the amount of the work that it is needed for the completion of a task is misjudged and it has been assigned more time than it requires. This time is non-productive and therefore a waste.

The sixth category is Non-Value Added Processing. This waste occurs frequently in software development projects, where sometimes a change needs to be made in a part of the developed application/program. This change, however, is supplementary and does not create any kind of added value.

The seventh category is Defects. Defects can appear with numerous variations. From wrong information to incomplete ones and so the task is handed over without meeting the predefined exit criteria.

The last waste is Underutilized resources. This waste happens in many project environments and has an impact on scheduling and executing ideally a project.

5. Theory of Constraints

The Theory of Constraints (TOC) is another management philosophy introduced in 1984 by Eliyahu Goldraat in his book titled “The Goal”. It basically shows how to identify and direct focus on some critical issues that matter to the overall performance. The theory’s main target is to help organizations achieve their goals by focusing on systems improvement. A system is a series of independent processes and can be considered like a chain. There is a common idiom saying “the chain is no stronger than its weakest link” and the TOC adopts it. This means that no matter how strong is the relationships between some systems or processes, if there is a simple weak link in this chain it can always damage or at least affect the final outcome. So, by improving that weakest part, the whole system is becoming less vulnerable. But there would be always something less powerful than something else on the system. There are always constraints that slow the processes down. So that’s exactly what TOC is trying to do. Identify the possible constraints and restructure the rest of the organization around them, in order to eliminate them or reduce the risk of making some kind of damage (always depending on the importance they have).

There are three rates, which can be considered as measurements and by supervising their variation constraints’ control can be achieved in a certain extend. Those three are throughput, operational expense and inventory. Throughput is the rate threshold at which the system generates income through sales. Inventory is all the amount of money that the system invested in purchasing things that is going to sell. Operational expenses are the amount of money that the system used to create throughput from the inventory. The theory of constraints suggests five focusing steps:

- Identify the constraint;
- Exploit the constraint;
- Subordinate other processes to the constraint;

- Elevate the constraint;
- Repeat cycle.

The first and the most important step is to identify the constraint using the respective methodology. The constraint is typically something that prevents the organization from obtaining more from a specific goal. Secondly, once the constraint is identified then it is exploited in order to support the process and gain its utmost capacity without major changes. The next step is to subordinate the constrained process with the other processes so all the systems pace would be the same. Then if the systems overall output is not satisfying it needs further improvement. This step called “elevate” and includes actions to improve the constrained process including major changes, reorganization or other major expenditures of time and money in order to make the system work properly. Finally, once the constraint is broken there would be some new constraints in another part of the system, so the same procedure will go over and over again. The performance of the overall system is re-evaluated.

The theory of constraints is a method that can be applied and aligned to several situations. One of the most common applications of TOC is an approach that can be used to develop numerous techniques in the Project Management field. Because of the multi-disciplinary nature of project management many different applications can be easily developed and implement to its procedures. The most interesting and the first application of TOC to project management is at the area of project scheduling, with the development of critical chain technique. The main target of this application was to reduce project duration and simplify project control. However, it is quite common and many insist that TOC can be applied to other similar areas of project management, like in risk management and in cost management. At the next chapter, these TOC applications to project management are going to be presented and its influence degree to the overall processes is going be further analyzed.

5.1 Critical Chain Project Management

Critical Chain Project Management (CCPM) is a method of planning and managing projects, mostly during the scheduling and planning processes. It is based on the resources required to execute all the important project tasks. It has been introduced from Eliyahu Goldratt (as well as the Theory of Constraints). Firstly, it was represented as a contrast to critical path method, which by that time was frequently used by the project managers for scheduling planning.

The critical path method (CPM) is an algorithm for scheduling the project activities. It was developed in the late '50s and it is applicable to numerous forms of projects. This technique is using three basic values:

- List of activities needed for the project completion
- Duration for each activity
- Dependencies between activities

By using those three characteristics, CPM can calculate the longest path of planned activities to the end of the project and also the earliest and latest that each activity can start or finish without causing the project to last longer. Thus it is crystal which activities are "critical" and also which ones can be delayed without affecting the project duration. A critical path is a sequence of project activities that by adding them up, the longest overall duration of the project can be defined. By this, it is possible to determine the shortest time that is needed to finish the project. However, any possible delay in any activity in the critical path can impact the project completion date. This is the most important drawback of the CPM method, because the possibility of a delay occurring in an activity is very high and this method does not clearly defines the actions that need to be undertaken in order to avoid the side effects. Additional drawbacks of this method exist as well; like that it doesn't consider resource dependencies and that it is based only on the deterministic task duration. For all those reasons, a new method was necessary to be introduced and this method was the Critical Chain Method (CCM).

The Critical Chain Method is based, as it was mentioned, on the Theory of Constraints, because it removes bottlenecks with a view to resolve constraints and to Lean Thinking because it eliminates wastes. It can also be considered as a part of the

Planning and Control processes of PMBOK. The main strategy that it uses is to evaluate resources and predict possible constraints that occur because of the resources. It also uses Buffers, which are actually time that is being added/allocated in order to prevent slippage of schedule. This is one of the obvious differences of CCM with CPM. In detail, there are three types of such buffers:

- Project Buffers (PB): it's the amount of buffer time at the end of the project;
- Feeding Buffers (FB): it's the amount of buffer time at the end of sequence tasks;
- Resource Buffers (RB): it's an alert buffer, which is used to indicate that a specific resource is needed to perform a task.

The Critical Chain Project Management (CCPM) application includes three basic steps. Firstly, the safety time, which was added between the tasks, must be removed and the expected duration of them must be reduced by 50%. Then the schedule on Late Finish dates must be created and remove the resource constraints. After this step the critical chain is easily identified. Finally, it is necessary to add project buffer of 50% on the tasks duration and also a Feeder buffer to the non-critical chain. There are many discussions about whether or not the 50% reduction of the tasks duration and the 50% project buffer are effective. As it is mentioned many times in this thesis, all these practices can be aligned in accordance to the organization needs. Therefore, each organization can reduce or increase the number according to their experience and needs. These are numbers that the bibliography suggests.

6. Software Development Lifecycles (SDLCs)

The Software Development Life Cycle (SDLC), or Software development process in systems engineering, information systems and software engineering, is a process of creating or altering information systems, and the models and methodologies that people use to develop these systems. In software engineering, the SDLC concept underpins many kinds of software development methodologies. These methodologies form the framework for planning and controlling the creation of an information system and the software development process.

The SDLC framework provides a sequence of activities for system designers and developers to follow. It consists of a set of steps or phases in which each phase of the SDLC uses the results of the previous one. A Software Development Life Cycle (SDLC) adheres to important phases that are essential for developers, such as planning, analysis, design, and implementation.

There is a number of different models of SDLCs that have been created in the market for quite some time now. In the operational context of Softcom-Int we will deal only with four of them, a) Agile, b) RUP, c) Waterfall and d) V-Model XT (eXTreme). In the following sections we are going to explain the basic characteristics of each one of them, starting with the oldest, widely used and best known which the Waterfall model is.

6.1 Waterfall Model

Waterfall is a sequential model used in software development. It's one of the simplest models, and it is mainly used for development projects of low complexity. In waterfall model, the progress of the project is flowing steadily downwards (just like a waterfall) through the subsequent phases. These phases are Conception, Initiation, Analysis, Design, Construction, Testing, Production/Implementation, and Maintenance.

The first formal description of the waterfall model is often cited as a 1970 article by Winston W. Royce, although Royce did not use the term "waterfall" in this article.

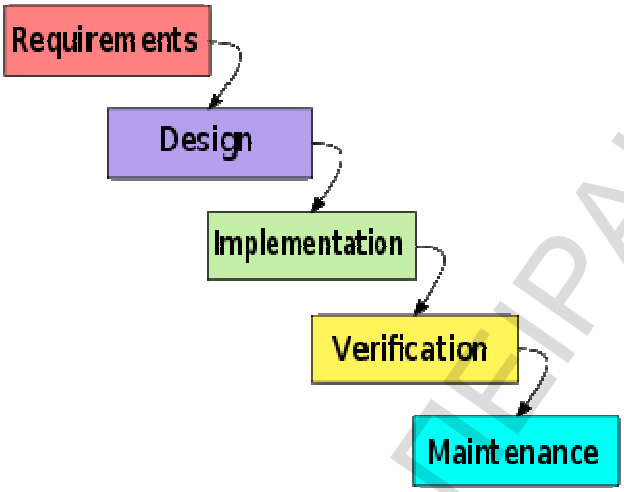


Figure 16: Waterfall Model

In Royce's original waterfall model, the following phases are followed in order:

- Requirements specification;
- Design;
- Construction (implementation or coding);
- Integration;
- Testing and debugging (validation);
- Installation;
- Maintenance.

According to the waterfall model, a phase must be 100% completed before moving on to the next one. Additionally, in line with bibliography, it is possible for someone using the waterfall model, to move back from one phase only to the previous one. It is not allowed, however, to return to any other phase. For instance, assuming there is a project running, which uses the waterfall model, and in a particular moment it

yields at the verification phase of the respective timeline. In case of a major change in the requirements of the project, by the customer, it is necessary going back to the requirements phase so that the appropriate adjustments would be made. Unlike, in the iterative SDLC models, where this would be a feasible task, in the waterfall model this transition is not allowed. The only way that it is possible for an organization to act in such cases is only by making a change request. However, the action that should be taken each time depends on the volume of the project, the complexity and the availability of resources so as to implement the change request. This is one of the most important disadvantages of the waterfall model and the reason why it led to the creation of the other SDLCs, like RUP and Agile. The new SDLCs are iterative, which makes easier to handle a software development project.

6.2 Rational Unified Process (RUP)

Rational Unified Process (RUP) is an iterative software development process framework created by the Rational Software Corporation, a division of IBM since 2003. RUP is not a single concrete prescriptive process, but rather an adaptable process framework. In particular, RUP is intended to be tailored by the development organizations and software project teams. The latter shall select the elements of the process that are appropriate for their needs. RUP is a proprietary implementation of the Unified Process, which is a proprietary incremental and iterative software development process framework.

RUP is based on a set of building blocks, or content elements, describing what is to be produced, the necessary skills required and the step-by-step explanation describing how specific development goals are to be achieved. The main building blocks, or content elements, are the following:

- **Roles** (**who**) – A Role defines a set of related skills, competencies and responsibilities.

- **Work Products (what)** – A Work Product represents something resulting from a task, including all the documents and models produced while working through the process.
- **Tasks (how)** – A Task describes a unit of work assigned to a Role that provides a meaningful result.

For each iteration, the tasks are categorized into nine disciplines:

- Six "engineering disciplines"
- Business Modeling;
- Requirements;
- Analysis and Design;
- Implementation;
- Test;
- Deployment;

Three supporting disciplines

- Configuration and Change Management;
- Project Management;
- Environment;

In RUP, the project life cycle consists of four phases. Each one of these phases may contain a number of iterations. These iterations are the only additional attribute, which distinguishes the iteration based models from the waterfall styled ones. Moreover, each phase has a specific milestone that denotes the objective which needs to be accomplished. Those four phases are:

- Inception Phase;

- Elaboration Phase;
- Construction Phase;
- Transition Phase;

The following image depicts the disciplines and the expected work load in each phase and iteration during the progress of a RUP project.

6.3 Agile

Agile is a group of software development methods based on iterative and incremental steps, where requirements and solutions evolve through collaboration between self-organizing and cross-functional teams. It promotes adaptive planning, evolutionary development and delivery, a time-boxed iterative approach, and encourages rapid as well as flexible response to change.

In 2001 there was a meeting between world-class software developers to discuss upon the necessity of lightweight development methods. From this meeting, the “Manifesto for Agile Software Development” was published. Agile software development manifesto objective was to “uncover better ways of developing software by doing it and helping others do it”. The main principles, in which it is based, are the following:

- Individuals and interactions over processes and tools;
- Working software over comprehensive documentation;
- Customer collaboration over contract negotiation;
- Responding to change over following a plan.

There are three basic software development methods in agile:

- eXtreme Programming (XP);
- SCRUM;
- Feature-Driven Development (FDD).

The most popular among them is the Scrum method, which is also followed by the teams working on product development, for international key players, in Softcom-Int.

6.3.1 SCRUM

Scrum is an iterative and incremental agile software development method for managing software projects and product or application development. Every project has four constraints, time, budget, quality and scope. However, in a scrum project the scope is not fixed.

There are also three core roles in scrum. These roles are assigned to individuals who are committed to execute the project and produce its final deliverable. These individuals, who basically constitute the scrum team, are:

- **The product owner** who represents the stakeholders and actually is the voice of the customer. The product owner is accountable for ensuring that the team delivers value to the customer business.
- **The development team,** which is responsible for delivering potentially shippable product increments at the end of each sprint.
- **The scrum master** who is accountable for removing impediments to the ability of the team to deliver the sprint deliverables. He or she is also the enforcer of the rules and acts as a buffer between the team and any distracting influences.

The following image represents the Scrum methodology.

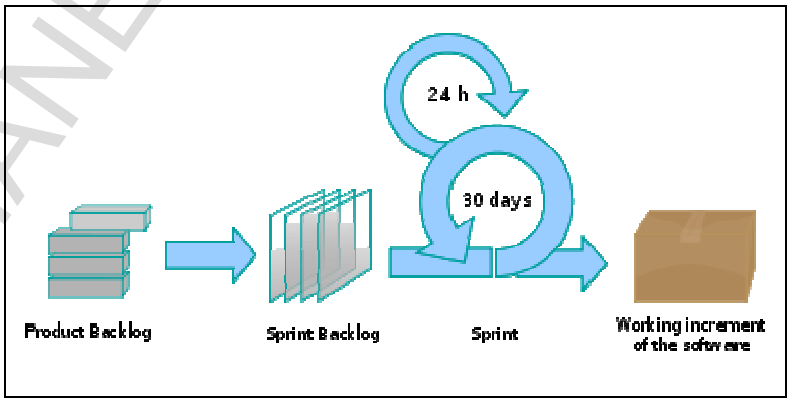


Figure 17: SCRUM Methodology

An essential part of the SCRUM model is the sprint. Sprint is an iteration, the duration of which varies and can last up to a month. The sprint usually has specific length, which remains stable throughout the development of the project. Each sprint is designed in the beginning of the project by the Scrum team. By the end of every sprint, a particular task should have been completed. When this task is finished, there is a small increment to the progress of the project. As a result, when all sprints are finalized, the end-product has been developed. Each Scrum team meets daily for a 15-minute status meeting, which is called the daily Scrum. The daily Scrum takes place at the same time and place throughout the lifecycle of the particular project.

The requirements for the product that need to be developed by the Scrum team are listed in the product backlog. It is basically a prioritized feature list, which is allowed by Scrum not to be completed upfront, but it evolves dynamically as long as more information is gathered about the end-product. Product backlog can break down into smaller, more manageable pieces, which are called sprint backlogs. Sprints backlogs consist of the tasks, which are performed by the team in order for product backlog items to turn into “Done” increments. A “Done” increment includes the analysis, design, refactoring, programming, documentation and testing.

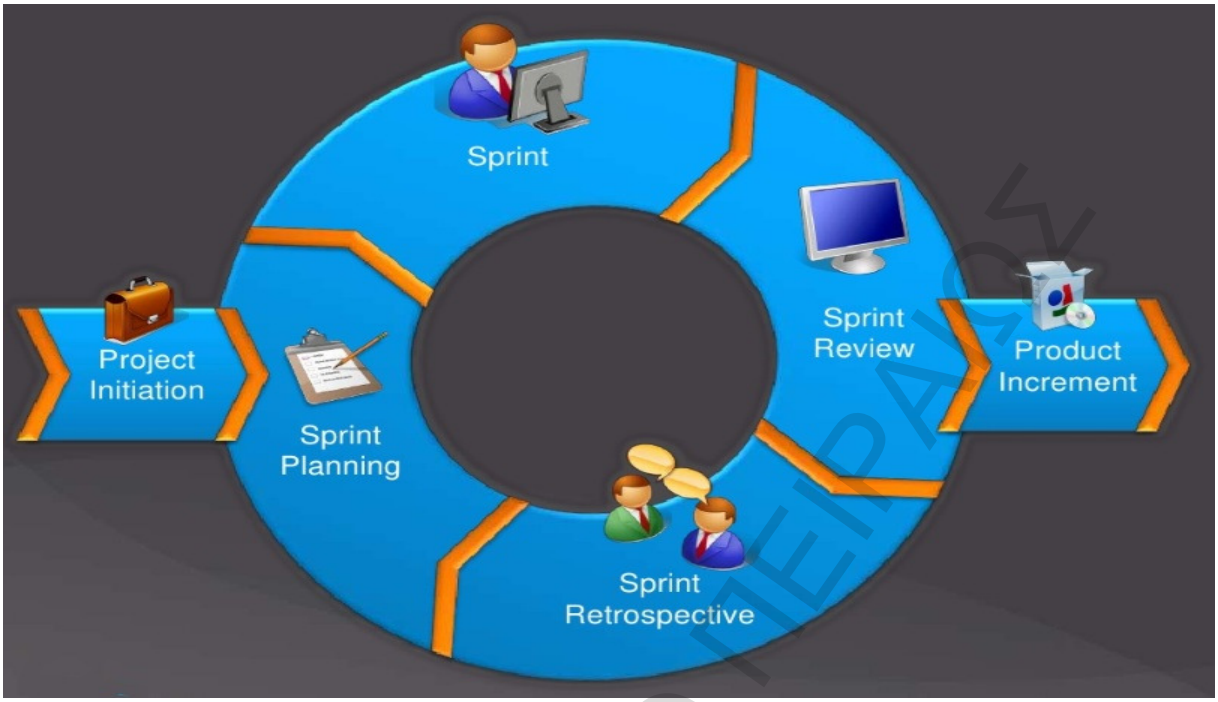


Figure 18: SCRUM

Among the enabling processes of the Scrum methodology are the sprint review, the sprint burn down and the sprint retrospective. A sprint review is a meeting, which takes place when a sprint comes to an end. During this meeting, the Scrum team and the stakeholders collaborate about what was just done and about the next thing that should be done. A sprint burn down is a graph of the amount of sprint backlog work remaining in a sprint across time. It is useful to keep track of these sums by day and use them to create a graph that shows the work remaining over time. Finally, the sprint retrospective is also a meeting which takes place after the sprint review and prior to the next sprint planning. The purpose of this meeting is to evaluate and inspect how the last sprint went in regards to people, relationships, process and tools. This inspection should identify and prioritize the major items that went well, and those items that, if done differently, could make things even better.

6.4 V-MODEL XT

V-Model XT (VM XT) is the last SDLC model that is going to be presented in this chapter. It is a further development of the V-Model 97 and it is widely used in the automotive industry (especially in Germany). The automotive industry should follow a very strict set of rules with regard to the applied code of practice, which led to adopting this unique SDLC.

XT stands for eXtreme Tailoring due to the flexible customizing ability of the process model regarding application needs, project types, and project complexity. In comparison to previous releases, new features in VM XT cover regulations for hardware development, logistics, project management, and process improvement. Furthermore, VM XT assists three different project types: (i) software development from customer's point of view, (ii) software development from contractor's point of view, and (iii) implementation and maintenance of the organization-specific software process.

In addition to these three different project types, VM XT describes a set of 99 products, 18 Process Modules, 18 decision points (DPs) and seven project operation strategies:

- Products are the results of activities performed by defined roles that apply a set of methods and techniques. Some of these products are supported by document templates for project implementation.

- Process Modules (PMs) include a set of products, corresponding activities, and basic method suggestions. Project operation strategies enable customizing and tailoring of PMs to achieve appropriate process course. Some basic PMs are mandatory for all project types and others are optional depending on the application domain and the type of application.

- Decision Points (DPs) are related to a subset of products and represent the state of treatment and the state of consistency.

- Project Operation Strategy (POS) is defined as a sequence of DPs for project course. According to individual requirements of the organization, project

operation strategies may be customized, e.g. regarding incremental, agile, component-based development as well as migration and maintenance purposes.

This set of concepts is the basic process model, which can be adjusted to the business domain and project types.

The following picture represents the structure of the V-Model XT and the processes in the execution of the project. It is obvious that its name refers to the V structure of the model.

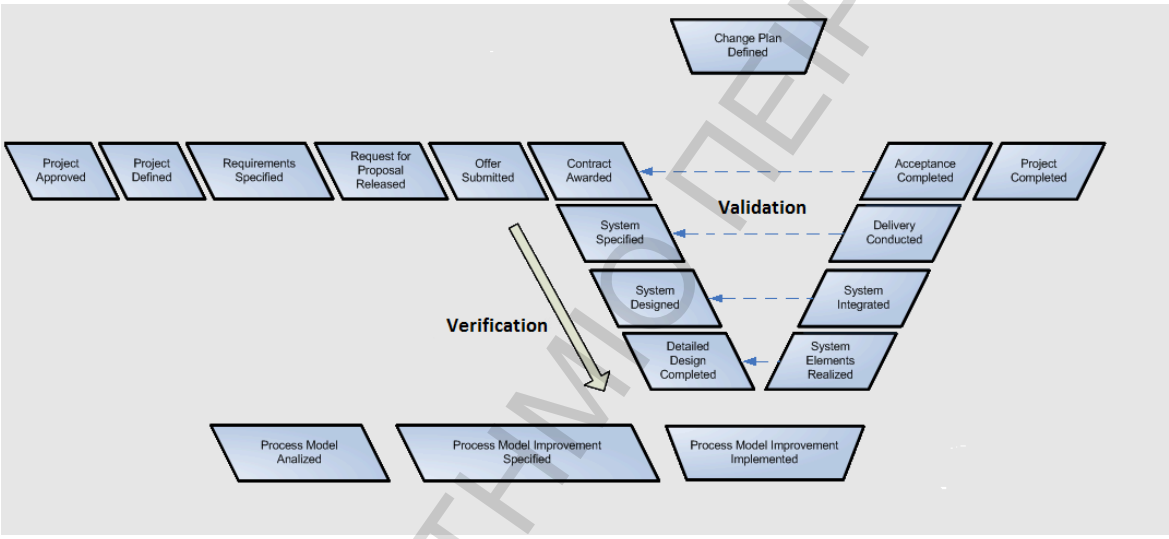


Figure 19: V-MODEL XT

In general, VM XT intends to achieve the following objectives:

- **Minimization of project risks**: It improves the transparency and control of the project throughout its execution. In addition, it permits an early recognition of planning deviations and risks.
- **Improvement and guarantee of Quality**: Being a standardized process model, VM XT is able to ensure that the results that are to be provided will be complete and have the desired quality.
- **Reduction of total cost over the entire project life cycle**: VM XT has the ability to control, estimate and calculate the development, maintenance and operation of a software product in a transparent manner. As a result, it manages to reduce the total cost of the final product.

6.5 Connection between SDLCs and the PMBOK

Software development consists of two components, software engineering and software management. Software engineering includes all the technical activities that are performed in order to build the project deliverable. It mostly deals with techniques of building the components, integrating, verifying, validating them and finally putting all of them together in order to construct the final product. SDLCs, mostly, are being used in software engineering processes. On the other hand, software management facilitates software engineering so that each project will be completed on time, without critical or major defects and in high quality. Some SDLCs include in their processes management procedures but sometimes those procedures are not sufficient enough, especially for high volume projects. Therefore, there is an emerging need to implement more effective project management practices, like PMBOK, aligned with the target SDLCs.

Depending on several project characteristics, the project manager determines what processes are appropriate and to what degree applicable to any project. This is the main reason why any SDLC model can be mapped to PMBOK. If we could consider a sub-phase of a traditional project to be a complete cycle of design, development and test, which results in a working software then we could understand that this mapping is reasonable. It is also possible to consider requirements, design, development, testing and deployment to be activities and not phases and where each phase encompasses all these activities, always resulting in working software.. Also, a phase in PMBOK is similar to a scrum release and the sub-phases of a project can be mapped to individual iterations or sprints.

There are two general types of mapping software engineering models and management methodologies, the tightly coupled and loosely coupled respectively. The tightly coupled approach suggests that both methodologies are tightly coupled together and that management is completely dependent on the software engineering models adopted for building the project final deliverables. That's the reason why, project

management needs to be tightly interlaced with software engineering. On the other hand, loosely coupled approach suggests that the two aspects, software engineering and management, should not be tightly coupled together but loosely, by means of just influencing each other. Therefore, each aspect needs tailoring in order to suit the other. Additionally, project management is considered to have multiple objectives, with the primary objective being to build the final deliverable. Other objectives include management of the schedule, quality, material and human resources, stakeholders, communications and profit.

This alignment between the project management methodology and the software development models is driven by various factors, such as the organizational structure, size and the type of software engineering used on a particular project. For example, in a small organization where the owner is a technical person who is actively involved in project activities, the management methodology can be completely aligned with the software engineering models. A completely aligned project management methodology fits better to smaller, more homogenous organizations (like Softcom-Int), while less homogenous organizations should have a project management methodology that is decoupled from the software engineering methodology of the project.

On the following sub-chapters, the four basic methodologies of SDLC, Waterfall, RUP, V-Model XT and Agile's Scrum will be mapped to PMBOK.

6.5.1 PMBOK and Waterfall

The mapping between PMBOK and waterfall is the easiest mapping among all SDLC methodologies. The reason is that waterfall model is not iterative, unlike the rest of SDLCs. The waterfall model describes five phases, where a new phase starts when and only the previous one has been ended. There are two ways to map PMBOK with the waterfall method. The decision about which way is appropriate depends on the project volume. The first way, which is for low and medium volume projects, is when PMBOK is being implemented once in every project. The other way, applied only in high volume projects, is when for each waterfall model phase there is a full PMBOK running

in parallel. Consequently, each phase can be considered like a stand-alone project. This concept is depicted it the next figure.

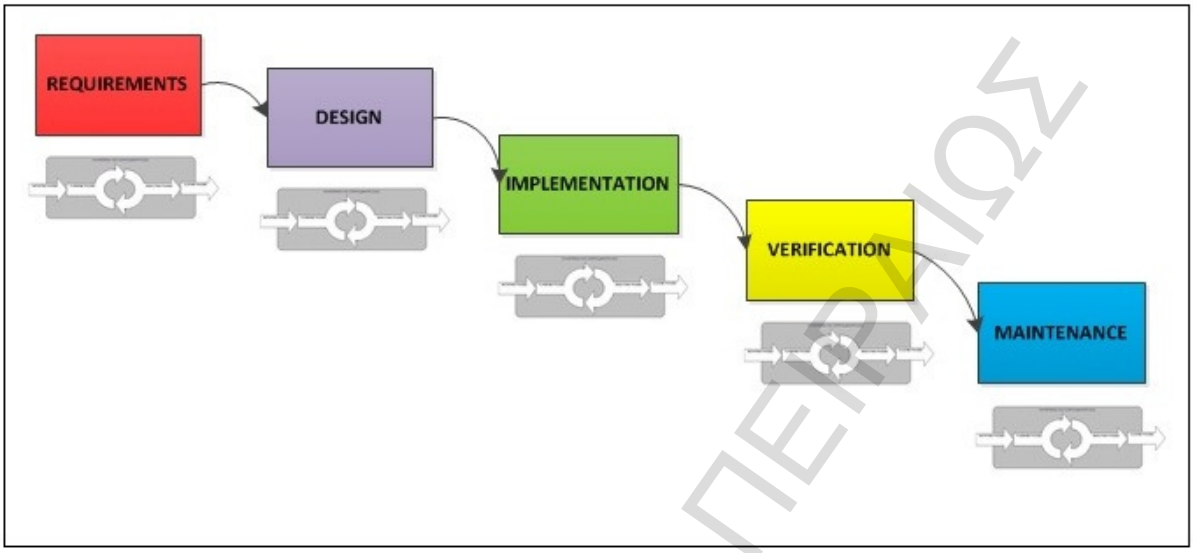


Figure 20: Waterfall and PMBOK

This strategy is being used in high volume projects, because in this kind of projects the complexity is rather high and strong management controls should be applied. By applying such policy, the risks closely monitored and moderated. On the other hand, in cases of medium or low volume projects the execution of PMBOK has only one cycle, due to the low complexity levels.

6.5.2 PMBOK and RUP

During the analysis of the RUP model at a previous chapter, it was stated that it includes a project management discipline. The basic purpose of this discipline, in the context of RUP, is to provide a framework for managing software projects along with practical guidelines for planning, executing and controlling them. Accordingly, it would be very useful to examine whether or not this discipline can provide, unassisted, efficient project management guidance. For this purpose it is critical to go through the artifacts that it creates and afterwards compare them with those of the PMBOK.

There is a wide variety of artifacts that are created during the PM discipline. The major artifacts are the following:

- Software development plan (Quality assurance, Risk management plan, Measurement plan, Product resolution plan and Product acceptance plan);
- Business Case;
- Iteration Plan;
- Iteration Assessments;
- Status Assessment;
- Risk List;
- Work Order;
- Issues List;
- Project Measurements.

Obviously, these artifacts can be mapped to the PMBOK's process groups. The relationships could be depicted as follows:

- Initiation => Business Case
- Planning => Iteration plan, Quality assurance plan, Software Development plan
- Executing => Work order
- Controlling => Project measurements, Status Assessment
- Closing => Iteration Assessments

The artifacts that RUP produces during the project management discipline can be mapped almost immediately to some of the PMBOK deliverables. For instance, the project measurements artifact can be mapped to the Perform Quality Control Knowledge area of PMBOK and its deliverable document "Quality control

measurements". The quality assurance plan is the same to PMBOK as well. From the following figure one can notice that project management discipline includes PMBOK in an abstract way. Moreover, the timeline of the PMBOK process groups' execution during the phases and iterations of RUP model is depicted as well.

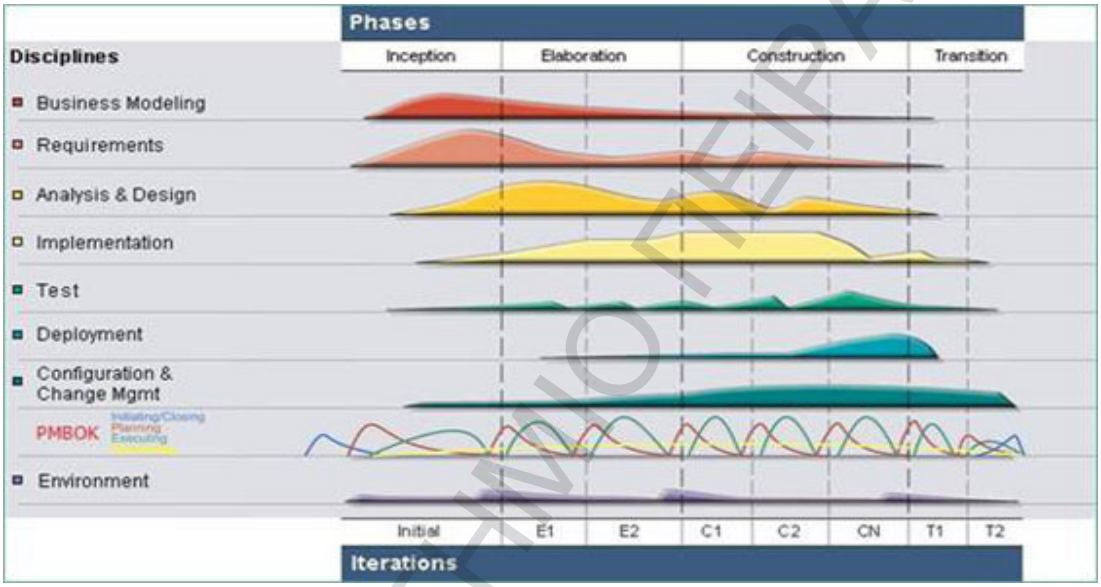


Figure 21: RUP and PMBOK

Apart from the project management discipline of RUP there are additional artifacts produced by different disciplines that can be mapped to PMBOK. For example the requirements discipline can include all the steps of the requirements analysis of PMBOK, which are a) requirements documentation, b) requirements management plan and c) requirements traceability matrix. Also RUP includes within its disciplines the assigning tasks and responsibilities, which is obviously a PMBOK task as well, during the Human Resource Knowledge area and the documents that are produced, like "Human Resource Plan" and "Project staff assignments".

To recapitulate, RUP project management discipline elaborates on selected Project Management aspects that are relevant to planning its activities and executing its tasks, specifically with regard to iteration planning. Unlike PMBOK, RUP does not address project management as an end-to-end process. RUP also completely ignores

important project management-related activities, including people management, resource planning and estimation, escalation, and contact management. These are the reasons why RUP cannot perform the Project Management procedure by itself. Thus, it is recommended to take advantage of PMBOK along with RUP for the end-to-end project management of a software development project. In the following table, the possible matching between PMBOK's knowledge areas with their processes and RUP's major activities are listed.

PMBOK	RUP
PROJECT INTEGRATION MANAGEMENT	
• Develop project charter • Develop project manager plan • Direct and manage project execution • Monitor and control project work • Close project or phase • Perform integrated change control	• Plan phases and iterations • Develop iteration plan • Develop product acceptance plan • Compile software development plan • Develop business case • Develop vision • Develop deployment plan • Monitor project status • Schedule and assign work • Report status • Handle exceptions and problems • Submit change requests • Update change requests • Review change request • Confirm duplicate or rejected change request • Project plan development • Report status • Assess iteration
PROJECT SCOPE MANAGEMENT	
• Control scope • Define scope • Create WBS • Verify scope • Collect requirements	• Initiate project • Initiate iteration • Develop business case • Develop vision • Develop problem resolution plan • Develop requirements management plan • Write change management plan • Find actors and use cases • Detail a use case • Detail of software requirements • Capture common vocabulary • Plan phases and iteration • Develop iteration plan

	• Lifecycle milestone review • Review requirements • Report status • Assess iteration
PROJECT TIME MANAGEMENT	
• Define activities • Sequence activities • Estimate activity resources • Estimate activity duration • Control schedule • Develop schedule	• Plan phases and iterations • Develop iteration plan • Report status • Assess iteration
PROJECT COST MANAGEMENT	
• Estimate costs • Control costs • Determine budget	• Acquire staff • Plan phases and iterations
PROJECT QUALITY MANAGEMENT	
• Plan Quality • Perform Quality Control • Perform Quality assurance	• Develop quality assurance plan • Define monitoring and control processes • Submit change requests • Update change requests
PROJECT HUMAN RESOURCE MANAGEMENT	
• Develop Human Resource Plan • Manage Project Team • Develop Project Team • Acquire Project Team	• Define project organization and staffing • Acquire staff
PROJECT COMMUNICATIONS MANAGEMENT	
• Report performance • Plan Communications • Distribute information • Manage Stakeholder Expectations • Identify stakeholders	• Compile project development • Report status • Assess iteration • Define monitoring and control processes • Prepare for phase close out

PROJECT RISK MANAGEMENT	
• Plan Risk Management • Identify Risks • Perform Qualitative Analysis • Perform Quantitative Analysis • Monitor and Control Risks • Plan Risk Responses	• Develop risk management plan • Identify and assess risks • Submit change requests • Update change requests
PROJECT PROCUREMENT MANAGEMENT	
• Plan Procurements • Conduct Procurements • Close Procurements • Administer Procurements	• No mapping to RUP

Table 2: Matching between PMBOK and RUP

There is also another less detailed approach but with the similar logic. In this approach it is assumed that PMBOK and RUP processes are running in a parallel way. What happens here is that processes of PMBOK are running along with the same level RUP processes. For example, the initiating process of PMBOK can be mapped, because of the relevant activities, with the pre-project, inception and part or the first iteration of the elaboration phases of RUP. Furthermore, the planning process of PMBOK includes similar activities with the inception and the elaboration phases of RUP; therefore they can also be mapped. Additionally, each iteration of RUP's phases can perform the planning, executing and monitoring and controlling processes of PMBOK. In order to ensure that no changes are required to the business case, no new stakeholders have emerged and no contracts are ready to close out, it is performed at a cursory level, the initiating and closing phase in each iteration.

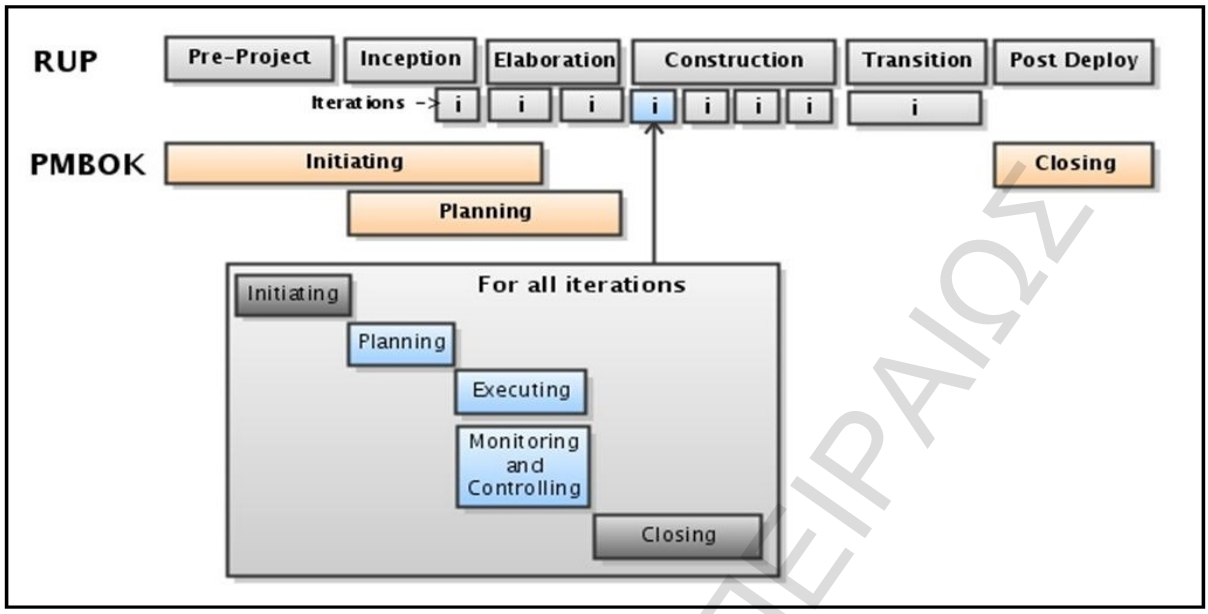


Figure 22: PMBOK and RUP's iterations

Evidently, performing PMBOK so extensively in every project requires great amount of effort and time. In high volume projects it is suggested to follow that exact method. Even though with this procedure the best control over a software development project can be ensured, sometimes it is simply overwhelming and without adding value to the project. For this reason, in low or medium volume projects performing the PMBOK just once for each iteration would be secure enough.

6.5.3 PMBOK and SCRUM

Nowadays, the most frequently used SDLC in software development projects is SCRUM, which is part of the agile method. Like the previously described iterative SDLC method of RUP, SCRUM as well includes to its core processes basic project management processes like scheduling, team management and quality assurance. However, these processes are not enough for effective and successful project management. For this reason, PMBOK should be integrated with SCRUM's processes. On the following table one can notice the knowledge areas and processes of PMBOK and how they could be mapped to the related processes of SCRUM. For example, the "Develop project charter" process of project integration knowledge area in PMBOK is

similar to the “Product roadmap, vision and backlogs” of SCRUM’s process. By doing that, it would be easy to find which ones of the crucial processes of PMBOK are not included in SCRUM methodology and since they are revealed, to determine the additional tasks that have to be done.

PMBOK	SCRUM
PROJECT INTEGRATION MANAGEMENT	
• Develop project charter • Develop project manager plan • Direct and manage project execution • Monitor and control project work • Perform integrated change control • Close project or phase	• Product roadmap, Vision and Backlog • High-level release plan and more detailed plan for the next sprint • Scrum principles • Continuous improvement • Change control via the product backlog • Sprint reviews / project retrospectives
PROJECT SCOPE MANAGEMENT	
• Control scope • Define scope • Create WBS • Verify scope • Collect requirements	• Develop and prioritize Product Backlog items • Select Product Backlog items for the release or sprints • Create a Feature Breakdown Structure for the release • Via feature acceptance use product backlog and traceability matrix • Protect the iteration
PROJECT TIME MANAGEMENT	
• Define activities • Sequence activities • Estimate activity resources • Estimate activity duration • Control schedule • Develop schedule	• Features are selected for a sprint by team and tasks are identified to accomplish the features • Estimation of tasks to complete story • Overall release schedule is developed= just-in-time planning • Team manages the features are developed in which sprint
PROJECT COST MANAGEMENT	
• Estimate costs • Control costs • Determine budget	• Perform top-down estimation of the releases and sprints , Perform bottom-up estimations and refine estimates • Create cost baseline • Product burn-down charts
PROJECT QUALITY MANAGEMENT	
• Plan Quality • Perform Quality Control • Perform Quality assurance	• Quality is implicit through scrum practices • Use sprint reviews and release/ project retrospectives

	• Use burn-down charts to monitor trends of feature development and add acceptance test as part of product backlog
PROJECT HUMAN RESOURCE MANAGEMENT	
• Develop Human Resource Plan • Manage Project Team • Develop Project Team • Acquire Project Team	• Plan for the team size based upon the project needs for the entire project duration, split the project into multiple teams if the scope is large • Develop a dedicated cross-functional team at the start of the project and keep it intact for the duration of the project • Use agile and scrum values to develop and build team • Facilitate and coach self-managing scrum team by providing real time feedback to the team
PROJECT COMMUNICATION MANAGEMENT	
• Report performance • Plan Communications • Distribute information • Manage Stakeholder Expectations • Identify stakeholders	• Identify the stakeholders and embed a business representative in the scrum team itself • Release/Sprint backlogs and Burn-down charts are visual indicators of project status • Visual indicators of project status are information radiators • Stakeholder management is done is done by product owners
PROJECT RISK MANAGEMENT	
• Plan Risk Management • Identify Risks • Perform Qualitative Analysis • Perform Quantitative Analysis • Monitor and Control Risks • Plan Risk Responses	• Informal risk planning as part of sprint/release planning and review meetings • Identify risks in daily scrums • Avoidance/ Mitigation/ transfer acceptance
PROJECT PROCUREMENT MANAGEMENT	
• Plan Procurements • Conduct Procurements • Close Procurements • Administer Procurements	• Team provides input for describing need for procurement using early iterations or proof of concepts • Team conducts evaluations and provides input into contract documentation • Additional information about potential contracts

Table 3: Matching PMBOK and SCRUM

SCRUM pays major importance to scheduling, as one of the most vital parts of a project. The SCRUM team estimates and adjusts the sprint scope to guarantee schedule, while the SCRUM master with the daily reviews monitors and controls the right pace of the project. Those daily meetings, which should not last more than 15 minutes per day, are actually the method of controlling the project team and the project work. Additionally, the roles of project manager and SCRUM master are not identical and many people in the business believe that those two roles should be completely separated. As an agile expert has stated “The reasoning behind this is understandable: the Scrum Master is not the manager of the team, and people don't report to her/him. If, however, the role of Scrum Master is assumed by the current project manager, people will still see her/him as the boss, and no magic wand will make them suddenly change their perception”. The project manager should be higher in organization’s/project’s hierarchy tree than the Scrum Master and that’s the common approach.

However, there are some issues that a project manager can handle better than the Scrum Master like interfacing with other organizational departments such as IT, Accounting or HR. The role of the project manager should be more focused on supervising and monitoring the entire process of the project than getting actively involved with the execution tasks. Thus, it is achieved In high volume or complexity projects the process of mapping PMBOK to SCRUM methodology can be quite complicated. PMBOK processes are going to be executed in each phase of the SCRUM method. In medium and low volume projects it is possible to map PMBOK to those phases as it is presented in the following picture.

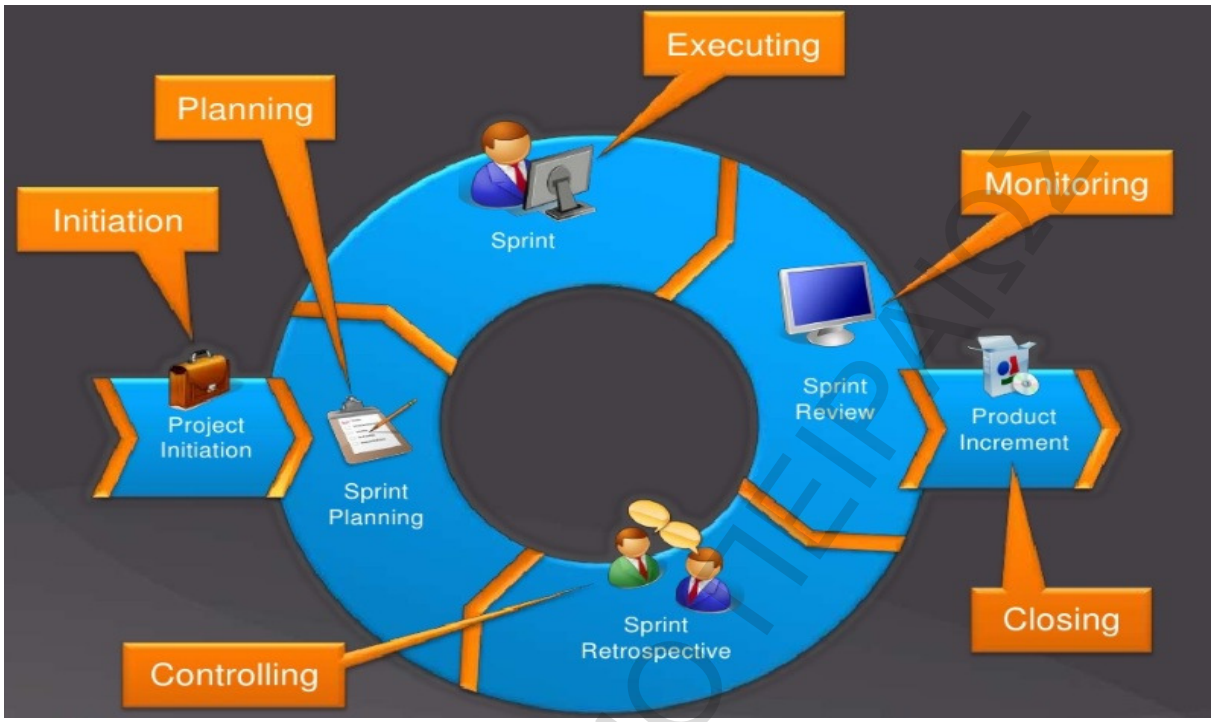


Figure 23: PMBOK and SCRUM

Thus, in SCRUM's project initiation phase the initiation process of PMBOK can be aligned. During the sprint planning phase, which explores the vision and provides the prioritized backlog, the planning process of PMBOK can help in management. Also, the executing process can be aligned to the sprint of SCRUM. Furthermore, the sprint review and sprint retrospective of SCRUM can be aligned with monitoring and controlling processes of PMBOK. Finally, the product increment has the same meaning/content as the closing process of PMBOK.

As a conclusion, the aforementioned transformation is difficult due to the core philosophic differences and requires more discipline:

- Understand the mapping between traditional and agile project management;
- Identify the similarities and differences, learn the balance between agility and control;
- Develop individual and organizational skills, culture and environment for the transition;
- Stick to the basic agile principles and look for ways to produce value for the

customers rather than focus on following an agile or traditional process or practice.

6.5.4 PMBOK and V-MODEL XT

V-model XT, in comparison to the rest of the SDLCs, incorporates more management mechanisms in its phases, as depicted in the figure below:

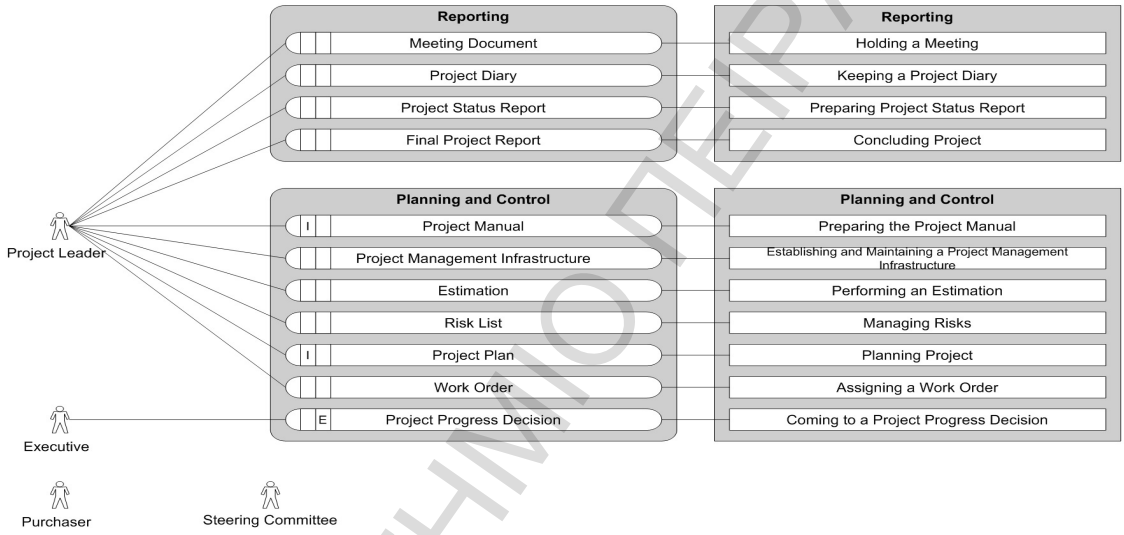


Figure 24: Managing mechanisms of V-MODEL XT

The project management module describes initialization, planning, execution and conclusion of a project. Important products include the project manual, which specifies the organizational framework conditions, the project plan, the risk list and the reporting products, which are intended to document all project events and results and ensure the internal and external distribution. According to this module, the project leader prepares the project manual, an initial project plan and a risk list in cooperation with the acquirer. In the course of the project, these documents will be updated. At regular intervals, at least before pending project progress decisions are made, a project status report shall be prepared for the acquirer and the in-house management. At the end of the project, a final project report will be prepared and distributed.

Consequently, it almost follows the PMBOK guidance. That's the reason why in low and in medium volume projects it does not have to be aligned with PMBOK.

However, in high volume projects it would be an advantage – in the attempt to secure the success of the project-if it would be possible to run PMBOK in every phase of the V-model XT, as shown below.

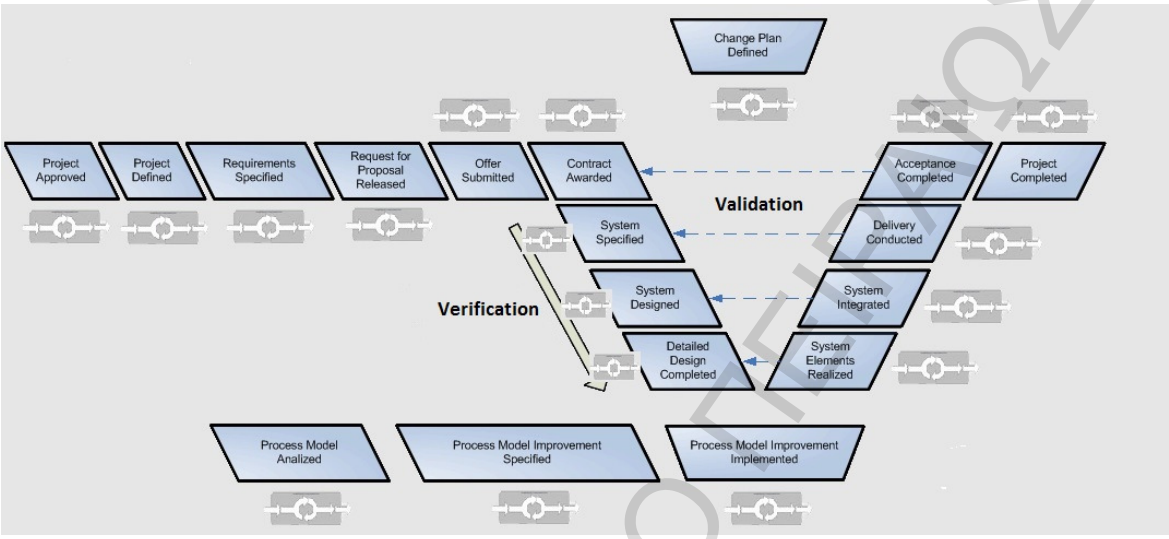


Figure 25: PMBOK and V-MODEL XT

Depending of the nature and the requirements of that high volume project running PMBOK in some of its phases can be avoided. This is something that the project team should investigate, when they are about to plan transition from one phase to another.

7. Tailoring

Software development industry is one of those industries that their products are fully specified upon the needs of their customers. The most usual case is that a customer will order a specific product or service from a software development house and this product will need to have unique specifications and requirements, depending on the need of the customer. As we can understand, the relationship between the organization and the customer must be very strict and well described so for both of them to be successful and each one to achieve its own target, which for the customer would be to receive the desirable result and for the software organization to deliver it. There are also times, when a software development organization is developing a product for internal use or as a product to sell. In this case, there are no external customers.

Every software development organization has its own set of processes and procedures in order to execute every new income project. Sometimes though and mostly because of that unique relationship between the two parts, the software development organization is required to use the method of tailoring. Tailoring is the process when some of the established processes and procedures of the software development organization are needed to be extracted from a specific project in order to best suit with the customer's processes. The main target of tailoring is to raise the possibility of effectiveness of a project and sometimes this can occur only by the matching of the processes between those two parts. The tailoring method usually is being required from the customer side and the software development organization needs to conform to that.

Apart from that type of tailoring, which is when the software development organization tailors its processes to those that a customer has, there is also the type of tailoring when an organization tailors its processes according to best practices and/ or to other proposed directives issued from different standardized official organizations. Such official organizations can be the European Union or the AQAP 150 (Allied Quality

Assurance Publication), which is a NATO quality assurance requirement for software development, such as Software Engineering Process Group (SEPG) or any other Software Process improvement (SPI) contributors. Later on this chapter we will examine such cases of tailoring.

There are several areas within each project where the tailoring can take place. The most usual cases, where the tailoring occurs, are at the processes, like project management, testing etc., at the milestones, by the means of both parts having the same milestones in a project and at the reports. Usually is the customer, who sets up the form of the reports and also the way and the time, when reporting should occur.

7.1 TEMPO and RUP@EC

The European Commission (EC) is politically independent and its basic aim is to represent the interests of EU as a whole. The main role of EC is to implement EU policies and enforce EU laws. To achieve those primary goals, EC works together with other institution and bodies of the European Union, such as European Parliament (EP), Court of Justice (CoJ), European Central Bank (ECB) and many more. In order to coordinate all the IT organization in the EU, EC created DIGIT (Directorate-General for Informatics). The mission of DIGIT is to enable the EC to make efficient and effective use of ICT so to achieve its political objectives. For this reason DIGIT is responsible for various issues, such as:

- To define IT strategy of EC
- To provide EC and other European Institutions and bodies whenever it is appropriate with high quality IT services and solutions
- To deliver the appropriate information systems required for the support of EC business processes
- To promote and facilitate the deployment of various important services for European citizens and enterprises.

TAXUD Electronic Management of Project Online, better known as TEMPO has been established in the DG TAXUD IT Unit environment and it is a Quality Management System (QMS), which supports the business objectives of DG TAXUD. DG TAXUD belongs to European Commission as well and stands for Taxation and Customs Union, which has the main aim to develop and operate Customs and Taxation trans-European Systems (TES) and also to provide office automations, end-user support and internal systems support.

TEMPO guarantees quality driven trans-European systems by providing strategic and operational management as well as several reference manuals, knowledge base, procedures and tools. The goal of TEMPO is to provide support, by making available a set of core guidance, policies and procedures, to all the relevant stakeholders during the complete lifecycle of the projects and services surrounding the TES systems. The stakeholders include internal stakeholders from within DG TAXUD IT Unit and external, such as the contractors of DG TAXUD IT Unit, business representatives and member states.

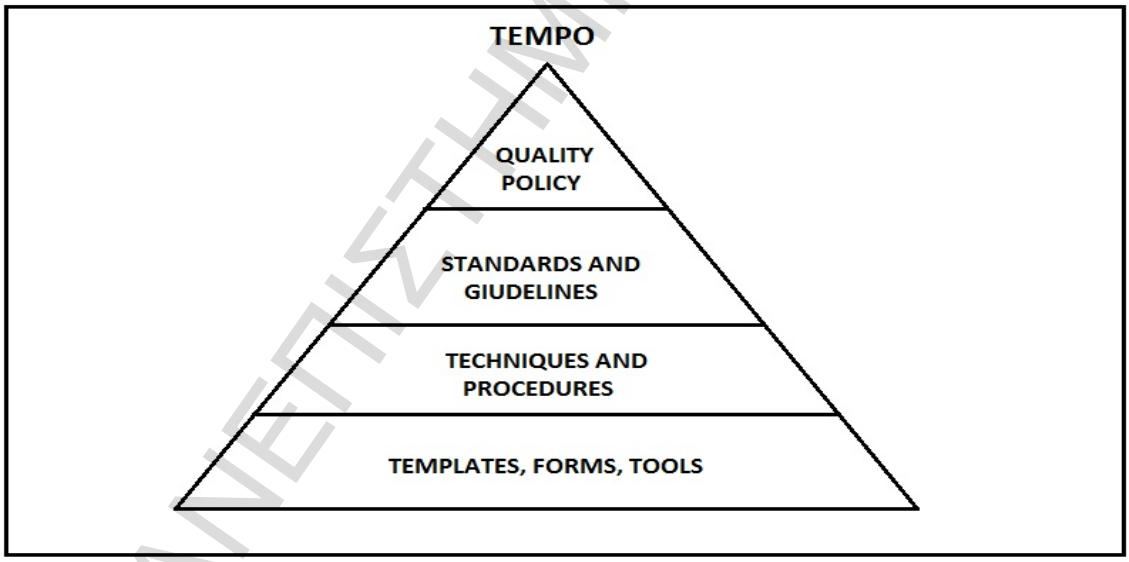


Figure 26: TEMPO's set of policies

As we can see from the figure above the TEMPO QMS can be defined as a set of policies, core guidance, processes and procedures for planning and execution in certain areas of the DG TAXUD organization. The TEMPO QMS system enables the DG TAXUD IT Unit to identify measure, control and improve the various DG TAXUD

core business processes that will ultimately lead to improve the DG TAXUD business performance. The TEMPO QMS includes techniques such as Quality Assurance, Quality Planning and Quality Control.

As far as it concerns the Project Management process, it is also on TEMPO, and helps in tailoring industry wide Project Management processes and practices to the specific needs of DG TAXUD thereby resulting in a customized DG TAXUD IT Unit Project Management process. As the Project Management practices mature within the unit, more and more innovative practices specific to DG TAXUD IT Unit will be published in this document. As a result of this expanding knowledge this document will continue to evolve. The following picture represents the last release of TEMPO knowledge base, which is comprised of a set of core guidance and supporting material for many different aspects of projects.

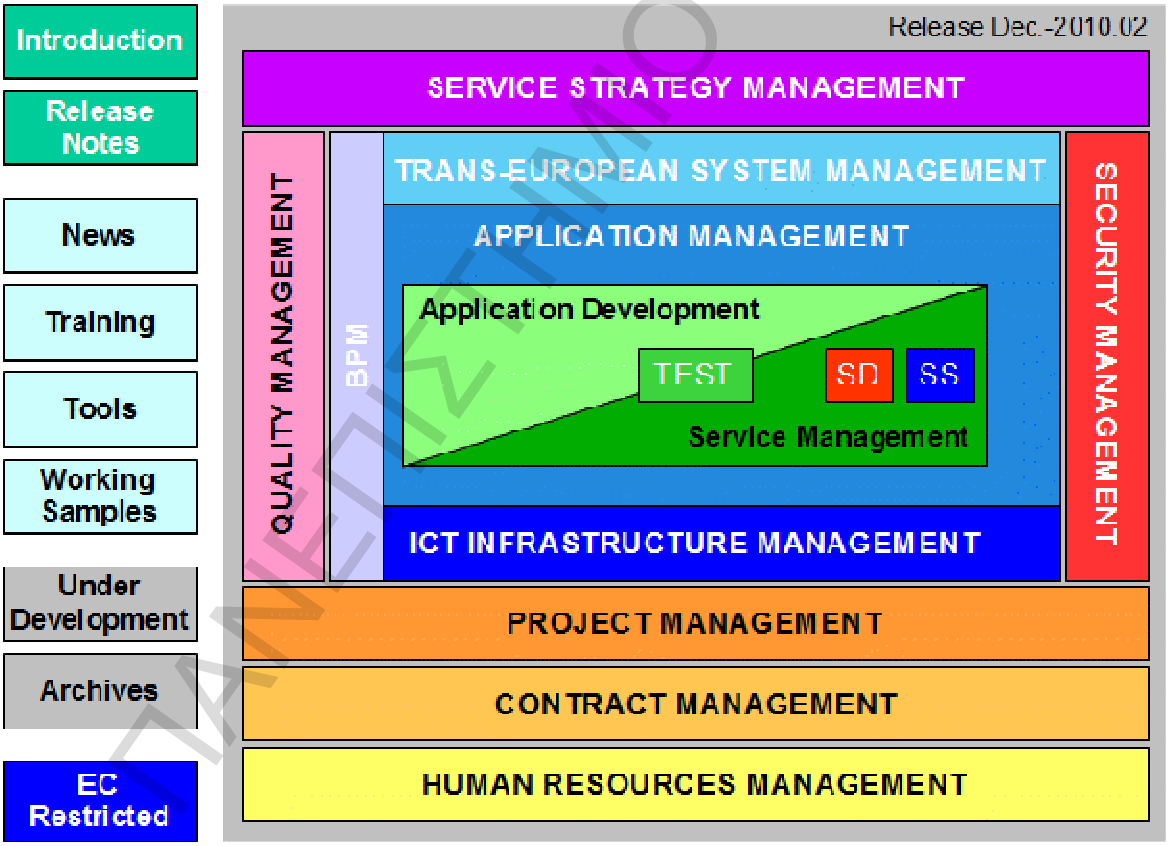


Figure 27: TEMPO

Topics covered in Project Management include Risk Management, Project Management Techniques, and Project Management Templates. From this list, only the Risk management topic will be further elaborated. The other Topics are just comprised of a set of Techniques and Templates to be used for effective and efficient Project Management practices.

As part of this policy of EC and more extensively of TEMPO, the RUP@EC was created by DIGIT. RUP@EC is a standard (or guide) methodology for developing software products. It can be adapted to projects by project managers or process engineers and by that it becomes part of the project documentation.

RUP@EC helps the project manager in planning a project, by suggesting a minimum set of artifacts to be produced and the timing, of when those artifacts should be produced during the project's lifecycle. It does not suggest, though, how much iteration each phase of the project should have.

Because of the various customers that Softcom-Int has in different countries in the European Union, many times in the past had to tailor many of its processes to TEMPO and RUP@EC. Some of the techniques that those methodologies include have been accepted and adopted by Softcom-Int, as a result of interfering with them. Such tailoring processes are very likely to occur again in the future.

8. Business Process Modeling

Business process modeling is going to be used so as to depict the various process flows of the Softcom-Int's project management methodology. Business Modeling is an activity with the aim to represent the business processes and procedures of an organization, in order to analyze them better and improve them. Usually, it is used by business analysts, who are seeking for a solution to improve the efficiency of a process, as well as its quality.

Several modeling, simulation tools and techniques exist, which provide their users the ability to model their processes and virtually execute them, making their job more effective. The most widely used methodology is BPMN (Business Process Model and Notation).

In this reference manual, the graphical tool that is going to be used is Aris Express (community edition). Aris Express is a very useful modeling tool for business processes and management, which includes many notations, like BPMN2, general diagrams, IT infrastructure and many others. In the remaining paragraphs of this chapter the BPMN notation is described, as well as its graphical objects and how they work together as part of a business process diagram.

8.1 Business Process Modeling Notation

BPMN (Business Process Modeling Notation) was released by the BPMI (Business Process Management Initiative) in 2004. The primary goal of the initiative was to provide a notation, which would be easily understood by all users; from business analysts, who are the ones that create the initial drafts of the processes, to technical developers, who are responsible to make those processes a reality, and finally to business people who will manage and monitor these processes. BPMN defines a Business Process Diagram (BPD), which is based on a technique that uses flowcharts i

for creating and tailoring graphical models of business process operations. A Business process model is a network of graphical objects, which is basically the sum of numerous activities including the flow control that defines the activities' order of execution.

8.2 BPMN Basics

The Business Process Diagram (BPD) consists of a set of different graphical elements, which make the development procedure easier with simple diagrams, like flowchart diagrams, in order to look familiar to most business analysts. Those elements are well-distinguishable from each other and have well-known shapes with special recognizable meaning, such as rectangles for activities and diamonds for decision taking. There are five basic categories that the graphical aspects of notation are organized:

- Flow Objects;
- Data;
- Connecting Objects;
- Swim-lanes;
- Artifacts

Next, these categories are analyzed further as well as the graphical elements that can be found in every one of them.

8.2.1 Flow Objects

There are three types of Flow Objects that BPMN uses and their main target is to define the behavior of any Business Process. Those types are the Events, the Activities and the Gateways.

8.2.1.1 Events

An event is something that occurs during the course of a process. It often has a cause that triggers it, it creates impacts and most of the time it affects the flow of the process. Events are possibly the heart of the processes and there are three main types of events:

- Start events, which indicate the start of a process
- End events, which indicate the end of a process
- Intermediate events, which indicate something that happened during the Process

An event can be either “a catch a trigger event”, mostly the start and some intermediate events or “a throw a result event”, which can be an end or some intermediate events. With the phrase “a catch a trigger event”, it is meant an event that occurs because something has changed or something has happened during the process flow, for example a catching mail. The other type of event, the “a throw a result event” can be a sending e-mail.

There are several Start, Intermediate and End event types depending on what it triggers them:

- **None**; none event does not have a specific defined trigger.
- **Message**; the message event triggers the start or the end of a process by a receiving email.
- **Timer**; the timer event triggers the start or the end of a process by a predefined specific time or date.
- **Conditional**; the conditional event triggers the start or the end of a process when a well-defined condition occurs.
- **Signal**; the signal event triggers the start on the end of a process when a specific signal arrives.

The events that are used during the design of the process flows in Aris Express are being represented on the following table.

	Message start event. A process starts when a message or an email is being received.
	Timer start event. In this case a process flow start after a particular time.
	Timer intermediate event. A process flow continues after a particular time.
	Message throwing intermediate event.
	Message catching intermediate event.
	Multiple throwing intermediate event.
	Multiple catching intermediate event.
	Terminate end event.
	End event.

Table 4: BPMN events

8.2.1.2 Activities

Activities are the work that is performed within a process. They can be performed by only one user or by a group of users. There are three main types of activities:

- Task is usually a single user activity during the flow of the processes. A task can be used when the work cannot break down into more detail. The most common task types are represented on the following table.

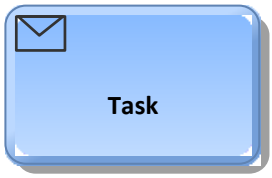
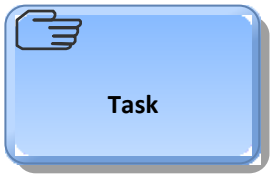
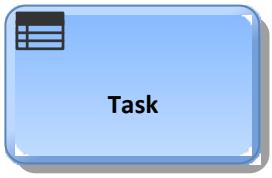
	Send Task is a simple task that is designed to send a message to someone.
	Receive Task is a task designed to wait for a message to arrive from an external source.
	Manual Task is a task that can be performed without the strict business processes.
	Business Rule Task is a task that is expected to be performed within the business strict rule processes.

Table 5: BPMN tasks

- Sub-Process is a lower-level process. It is designed by using activities, events, sequence flows and gateways and is used in order to simplify the process flow. There are numerous types of sub-processes but the most widely used are those that are represented on the following table.

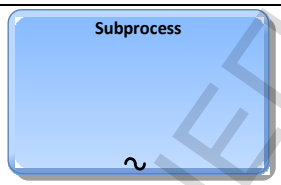
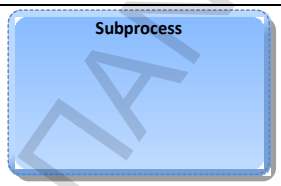
	Ad-Hoc Sub-Process is a process that includes several groups of activities that have no required sequence relationships
	Event Sub-Process is an event triggered process within a higher level process.

Table 6: BPMN subprocesses

- Call Activity is an activity that identifies a specific point during the flow of the process when a specific Global Task or Process has occurred.

8.2.1.3 Gateways

Gateways are like gating mechanisms that control the flow of the process by allowing or blocking the passage from a specific point of the flow. The flow can also be controlled by implying that the process managed to reach a result that was previously decided. This notation is frequently used in order to pass from one process to another depending on the results that appeared after the on-going process. They surely need to have an internal indicator to show the type of the result that is reached during the process. Gateways can be used like decision makers, for branching, merging and joining. This means that they can have multiple input and output flows.

There are several types of gateways and the most important appear on the following table:

	Exclusive Gateway, which is used during a process flow to create alternative paths and depending on the given instance of the flow, there is only one path that can be taken each time. It is often used as a decision maker given a specific path, depending on the answer to the question that was placed or some specific conditions.
	Inclusive Gateway, which is used to create either alternative or parallel paths within the process flow. The main difference with the exclusive gateway is that it evaluates the conditions.
	Complex Gateway, which is used to model complex synchronization behavior within process flows.
	Event-based Gateway is used to represent a branching point during the process flow, where the different paths that are after the gateway are based on events that have occurred. Most of the time those events are messages or timers.

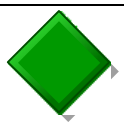
	Parallel Gateway, which is used to create and combine parallel flows without checking for any kind of conditions.
	This is a gateway that Softcom-Int has used as a milestone. It could be either an internal or a project milestone.

Table 7: BPMN gateways

8.2.2 Data

Data Objects often provide information about the requirements and activities that need to be performed, as well as the outputs that are produced. The nature data that are used here are documents that are produced as well as the type of storage used. Data objects in Aris Express are either inputs or outputs to a process, a task or an activity. Furthermore, there might be a data collection, which can represent a group of documents.

On the following table, the types of data objects and data stores that were used in Softcom-Int's process flows are represented.

	This is a data object, most likely a document that is produced by a process or a task. It can either be an output or an input.
	This is a data store object, which usually represents a server where the produced documents are being saved or stored.

Table 8: BPMN Data objects

8.2.3 Connecting Objects

BPMN uses four notations to connect the flow objects with other kind of information or each other. Those types are:

- Sequence Flows;
- Message Flows;
- Associations.

A sequence Flow is represented by a solid line with a solid arrowhead and is used to depict the order or sequence in which the activities should be performed in a process. A message flow is represented by a dashed line with an open arrowhead and is used to show the flow of messages between two separate process participants or roles that send and receive them. Finally, an association is represented by a dotted line and is used to associate data, text, and other artifacts with flow objects. Associations are also used to show the inputs and outputs of the activities.

8.2.3.1 Swimlanes

Swimlanes represent a partner entity and/or a partner role that participates in collaboration. The swimlanes are often considered as mechanisms to organize activities into separate visual categories in order to illustrate different functional capabilities or responsibilities. Swim-lanes can be either a pool or a lane. A pool represents a participant in a process. It also acts as a graphical container for partitioning a set of activities from other pools, usually in the context of B2B situations. A lane is a sub-partition within a pool and can extend the entire length of the pool, either vertically or horizontally. Lanes are used to organize and categorize activities.

Pools are used when the diagram involves two business entities or participants who are physically separated. The activities within separate pools are considered self-contained processes, whereas, lanes are often used to separate the activities associated with a specific company function or role. On the following picture an example of a pool, which includes two lanes, is represented.

Figure 28: Typical example of a pool

8.2.3.2 Artifacts

Artifacts are used to depict additional information in a BPMN process or collaboration diagram that is not directly related to the sequence or message flow. BPMN provides two standard artifacts, the group and the text annotation. A group is represented by a rounded corner rectangle drawn with a dashed line. The grouping can be used for documentation or analysis purposes, but it does not affect the sequence flow. However, text annotation is a mechanism for a modeler to provide additional text information for the reader of a BPMN Diagram.

PART TWO

PROJECT MANAGEMENT PROCCESS

9. The Project Management Process of Softcom-Int

The chapters below describe extensively the project management process of Softcom-Int. First of all, there is an extensive description of the process flows that Softcom-Int is going to implement for effective project management. There are nine process flows starting from the project feasibility analysis and ending with the project closure process. These process flows were made based on the organization's culture and needs as well as on the PMBOK. They can be used like a map, so the project management process of Softcom-Int would be clear to everyone. However, the main target of designing these flows was to connect the different processes of Softcom-Int that they are interacting with each other and so to become obvious in which exact period of the project management process each one of all the other sub-processes are taking place.

Afterwards, the categorization of the new income projects is performed. During that phase, the new project is assigned with a particular Project Type. Depending on the Type of the project, is going to be defined not only the exact treatment of the project but also which documents are going to be used so for the project to be successfully completed with the exact amount of work that it requires. This categorization is based on several project aspects like its complexity, difficulty and many more.

Then, the documents of the project management process are listed on the exact type of project. This means that depending on the type, what are the documents that are going to be used.

Finally, few of the documents that were created for this purpose are presented in the Appendix, as well as the four processes of Schedule Development, Cost Control, Schedule Control and Effort Estimation.

9.1 Integration with the rest of Softcom-Int processes

In the appendix figure 1, the interaction of the - PMBOK based - Project Management processes of Softcom-Int with the various enabling processes and sub-processes of the company is depicted. Moreover, the processes where KPIs should be established and monitored are revealed. At a glance, the enabling sub-processes of Softcom-Int (the majority of which are part of the Softcom-Int Quality Management System) provide input to the Project Management Process.

As it is going to be presented later on, Softcom-Int's projects can be distinguished between three basic types; the type I, II and III projects. Depending on several characteristics, such as the volume of the project and the complexity, it is being categorized of the project team in one of these categories. But first, it is important to briefly describe the sub-processes so to understand how they are connected with the project management processes.

9.1.1 Effort Estimation

The process has the objective to improve the estimation procedure so that the effort and travel needs estimates are:

- Comprehensible, well-documented and ready for use in the negotiations with the sales / customers
- With comparable quality (i.e. usage of identical criteria)
- On a reliable basis (check / review of the estimations)
- Precise and realistic even for unfamiliar software development or testing areas and projects
- Independent of the experience and expertise of the software developer, tester, project manager, etc.
- Used for accurate resource and project planning
- Used for statistics

The best people to undertake estimation is the staff who is going to do the work. The staff chosen to produce an estimate is typically drawn from the Softcom-Int resources and/or external partners who have relevant experience of similar previous projects or tasks in the business area.

Our estimation process is based on three components:

1. **Expert judgment**, i.e. consultation with qualified experts from within Softcom-Int and our business and service partners. This is supplemented, where required, by expert input from software suppliers and consultants.
2. **Experience*,*** i.e. comparison of the proposed project or task with previously completed work.
3. **Task Decomposition**, i.e. decomposing the project into components, i.e. a Work Breakdown Structure, and estimating each component individually to produce an overall estimate.

The estimates are validated through peer review and are backed up by an experienced Project Manager who takes overall responsibility for the total. Estimates are reviewed and updated throughout the project lifecycle. Estimates, and the processes followed to produce them, are transparent and consistent across all projects.

9.1.2 Requirements Engineering

The processes used for Requirements Engineering can vary widely depending on several factors, such as the application, the people involved and even the organization that develops the requirements. Usually requirements engineering has two areas to cover; the requirements development and the requirements management. The requirements development area includes the elicitation, analysis, specification and validation of the requirements, while the requirements management includes the requirements traceability and change management.

The elicitation process is the process of discovering the requirements for a system by communicating with the stakeholders. The requirements analysis is the process, with which user requirements are broke down into their components and then trying to study those so to develop a set of system requirements. The requirements specification is a complete description of the system that has to be developed. The requirements validation process is used to ensure that the set of requirements is

correct, complete and consistent and also that they are sufficient in order to create what the customer wants. Those processes are being performed by the solution architect during a software development project.

The requirements management process is being performed by the project manager and its basic activities are to understand the relationships among the key stakeholders, to identify change in requirements, to identify and track the attributes of the requirements and to trace requirements. Requirements traceability is the ability to describe and follow the life of a requirement throughout the project lifecycle, from its origin to its subsequent deployment and use. The requirements change management is the process that manages possible changes in requirements over the entire project lifecycle.

Main strategy of Softcom-Int, as far as it concerns the requirements, is to define them as soon as possible, especially in type I and II projects. It is vital for the organization to have them defined early during the project, for the reason of decreasing the impact, which gets enormous in case of new, unidentified requirement in the late stages of the project.

9.1.3 Procurement

Suppliers are evaluated and selected based on their ability to meet contract requirements. We use a three-tier classification approach for identifying our suppliers, “acceptable,” “approved,” and “disapproved.”

- **“Acceptable” Suppliers** - Acceptable suppliers include all suppliers available for general use. These suppliers have been determined to have minimal or no potential impact on our ability to run our business or meet customer requirements. It is the responsibility of the Procurement Manager to determine and use acceptable suppliers. There are no approval requirements or records needed for acceptable suppliers. A list may be maintained if determined of value but is not required.

- **"Approved" Suppliers –** Any supplier that is determined to have a potential impact on our ability to run our business or meet customer requirements must be selected based on criteria that effectively demonstrate their ability to meet our requirements. Each supplier is reviewed and approved by criteria based on their determined risk. A "Supplier Approval Worksheet" is initiated to determine approval criteria and completed as evidence of this approval process. Any evidence of fulfillment of selected criteria must be referenced and/or included with the completed worksheet. Once approved, the supplier will be added to the "Approved Supplier List".
- **"Disapproved" Suppliers** – The ongoing performance of all approved suppliers is regularly assessed during the management review process. Any supplier that has consistently not met contract requirements will be removed from the Approved Supplier List.

9.1.4 Training Process

The objectives of the training process are:

- Identification of training needs
- To coordinate training in order to increase capability in the group competence areas, knowledge and skills.
- To ensure that each staff member receives appropriate training related to the organizational and the project specific needs.
- To evaluate the training courses effectiveness via a feedback form.
- To define the appropriate training institutes.

9.1.5 Costs Monitoring and Controlling

The costs monitoring and controlling is a crucial process for every organization. The policy of Softcom-Int implies that efficient cost management must be occurred

throughout the life cycle of every project. The reason that led to that decision was the primary Softcom-Int's intension of eliminating or decreasing all the possible wastes that can be appeared due to ineffective cost control. Additionally, Softcom-Int would be able to predict, at any given point, the future performance of every activity of the project. This can be translated into taking corrective actions, whenever is needed, so as to decrease the impact that can occur due to some possible overruns. Apart from the obvious advantages, by encompassing the costs monitoring and controlling to the general process work load, Softcom-Int manages to be aligned with lean management as well.

The basic technique that was adopted by Softcom-Int, so to perform the costs monitoring and control process, is the Earned Value Management (EVM) technique. EVM is able to show the past and the current performance of the project and also predict its future performance by the utilization of statistical techniques. It integrates the scope, schedule and cost of a project. Combining good planning with effective use of EVM will reduce a large amount of issues, which can be arose out of cost and schedule overruns. In general, EVM is a project management technique that objectively tracks physical accomplishment of work. Furthermore, EVM requires a number of tasks to be performed before its utilization. Those tasks are the WBS and the creation of a detailed schedule/plan of the project activities.

9.1.6 Lessons Learned

Lessons Learned are considered to be either worst or best practices, experience of which, can be used again from the organizational members.
Lessons Learned action can be triggered at:

- Pre-defined important project milestones. The case studies are documented and reported
- Internal audit sessions
- Any time that an organizational wide demonstrated case comes out.

All case studies considered as lessons learned cases are stored in the Lessons Learned database and then, presented, discussed and evaluated on regular basis during Softcom-Int Coordination meetings. Passed lessons earned cases are publicized in the Intranet Site. Feedback is also provided to the best practice authors.

9.1.7 Secure SDLC

Information systems and the information processed therein should be protected against threats to the confidentiality, integrity and availability of these systems and information.

Moreover, building and deploying these information systems in a secure manner has become more critical today than ever before. Enterprises deploy several applications at very short notice. Business demands increased automation and more Internet enabled applications. Security is often considered after the application has been developed and is about to go live or in some cases even after the systems have gone live.

Building security into systems during their development is more cost-effective and secure than applying it afterwards. It requires a coherent approach to systems development as a whole, and sound disciplines to be observed throughout the development cycle. Ensuring that information security is addressed at each stage of the cycle is of key importance.

A common misconception is that applications should be secured after they are developed but before deployment to the production environment. Performing a security audit after they are completed typically results in a significant amount of security flaws. Some of these flaws can involve serious architectural issues. In a best case scenario, developers can expect to invest an immense amount of time and effort to fix these flaws. Worst case, the application may require re-coding and an overhaul of its architecture. Performing application security in this manner is expensive and time consuming. Integrating security into the early phases of the software development life cycle minimizes this cost and produces more secure applications in far less time.

This is why Security needs to be incorporated within every stage of a development cycle.

9.1.8 Quality Assurance

Quality Assurance is integrated in the SDLC process of Softcom-Int. The existence of proper procedures to safeguard the project offers the customer the ability to control the quality of the project deliverables.The assurance processes verify the plans, estimates and assumptions throughout the project lifecycle while acting as a communication tool between the vendor/supplier and the project acceptance committee of the Customer. Quality assurance refers to:

- The sustainability of the project overall cost;
- Meeting the requirements of the key stakeholders;
- Providing a suitable technical solution.

It is necessary to apply the techniques of quality control as well as the designated quality assurance procedures to guarantee the technical excellence of deliverables and services for the project. Primary objective of the project managers will be:

- to ensure that participants have established clear standards for deliverables before beginning the creation,
- that they adhere to best practices and standards as defined by the international literature, and
- that for each deliverable a systematic review process has been established.

Softcom-Int is committed to the satisfaction of customer needs, and seeks to develop products and services of high quality standards.

The implementation of the Quality Assurance System for every software project is achieved through a number of complementary actions which in many cases may coincide. These actions will be undertaken by Softcom-Int and will include:

- The design and implementation of quality assurance processes for the precise definition of what is required, by whom and following which standards;
- Develop a team approach to review and improve the work of the project;
- Periodic quality control for measuring the effectiveness of internal processes to achieve the agreed performance targets.

9.1.9 Risk Management Process

With the commissioning of the project, it is necessary to perform an initial risk assessment with the contribution of all stakeholders. The initial risk assessment aims to identify and prioritize the possible risks at the very start of the project and to establish the appropriate mitigation strategy for each registered risk.

The risk management matrix will be continuously monitored by the project management team, and it will be updated throughout the duration of the project with monthly estimates, which will be included in the project status report.

9.1.10 Review Process

The step-wise approach for the project execution aims to control the quality and completeness of the deliverables before reaching the training period. Thus, the project risks will be significantly decreased as the project stakeholders will be able to inspect the produced application documentation of each phase in a timely fashion. Accordingly, the supplier will have the capability to apply changes and corrections if necessary, the

customer will be able to supervise the outcome of the supplier activities during the project lifecycle and most importantly, both partners will be confident about the mapping of the project activities to the actual needs of the key stakeholders. To achieve that a formal review process of the project documentation should be established with the participation of both parties.

Review process is introduced to the project, through the implementation of six key sub-processes:

- A formal process for the distribution of the document/deliverable to be reviewed to the designated stakeholders of the customer. The key stakeholders should provide their review comment within three days from the reception of the document (via e-mail).
- A formal process for the collection and logging of the review comments. A formal process for the supplier to respond to the summary of collected review comments. Supplier should reply to all the review comments within three days, in the basis of whether the comment is accepted or not (and why).
- A formal process for dealing with unresolved review comments in order to take the appropriate actions.
- A formal process for the sign-off of the finalized document by both parties (including the key stakeholders of the customer). It is noted that final versions of the documents will be considered approved by the customer five days after the expiration of the sign-off deadline.
- A formal process for modifying the contents of an already approved document/deliverable through either the issue management or change management process.

9.2 Overview

Every project is unique by its nature and has a specific start and end, but in most cases, especially in software development, the way of implementing and managing projects permits a more or less standardized approach. The project manager and the project team need to go through several processes and tasks during a project planning and execution, which may have different outputs but specific steps must be taken every time. Depending on the project characteristics, such as the volume and the complexity, some of those steps are always required and some of them can be ignored. Nevertheless, the organization should form a road map of process flows that every time a new project is arriving the organization staff would have as a reference to follow. By doing so, the organization gains several advantages like avoiding crucial mistakes, which can occur because a specific process has been overlooked.. The project management related process flows of Softcom-Int are based on PMBOK. There are nine process flows, each one describing the specific steps that the project manager and the team should perform in every phase of the project lifespan. Those processes are:

1. **Project Feasibility Analysis - Initiation Process Flow**
2. **Project Feasibility Analysis – Planning Process Flow**
3. **Project Execution Preparation Process Flow**
4. **Phase Initiation Process Flow**
5. **Phase Planning Process Flow**
6. **Phase Execution Process Flow**
7. **Phase Monitoring & Controlling Process Flow**
8. **Phase Closing Process Flow**
9. **Project Closure Process Flow**

The first two process flows are being used during the examination of the project feasibility study. They follow the PMBOK practices and after their execution the organization would be in a position to define whether it can implement the specific project or not. That decision is based not only on the technical capability and capacity of Softcom-Int but also on the financial parameters of the project. These initial flows can

be considered like a feasibility study for new projects, which defines whether a particular project can be included in the interests of the organization.

The project execution preparation process flow is used to initiate the new acquired project. The rest of the aforementioned flows are performed during the project implementation. All the process flows must be executed in this predefined sequence, except monitoring and controlling process flow, which must run in a parallel way, according to the PMBOK directives. This process flow starts in the middle of the phase initiation process, continues through phase planning, executing and closing process flows and ends in the middle of the project closure process flow. This way we would be able to perform better monitoring and controlling to the project throughout its implementation.

In every process flow there are two major pools, one for the customer and one for Softcom-Int. Each one of them includes several lanes depending on the process flow, where the role of the person in the specific organization is being referred. In the project feasibility initiation process flow there is one pool for Softcom-Int, which includes two main lanes, one for the CEO and one for the project manager. There is also a pool with one lane for the customer.

There are also two types of milestones, the Internal Milestones (IM) and the Project Milestones (PM). Milestones are used to signify the completion of a key deliverable or reaching a crucial decision point. IM are used to signify that the process reached to a specific point according to Softcom-Int's policy and work flow. Those milestones could signify the end of a process and triggering of a new one. They are numbered with numbers 5 to 35. On the other hand, PM signifies several points in project work flow and they are numbered from 100 to 700. As it is stated in policy, some of the following processes are going to be used during SDLC iterations. In such cases and in order to distinguish them with each other, they will have the form of **100.i**, where **i** is the ascending number (of a specific work package) and iteration, during which the process flow is executed. In the following chapters, every process flow that has been designed is extensively described, including a picture which shows the sequence of the sub-processes that it contains. These pictures, in most of the cases, are extremely big and cannot be widely represented. For this reason, every process includes a basic

review picture in the forthcoming chapters, but one can see a more detailed view of the picture in the APPENDIX A (Appendix Figure 1 to 25).

In the following table, the major internal and project milestones that will be presented at the following sections are summarized. Those milestones are very important because they signify the completion of a part of the project.

Milestone	Description
IM5	CALLS/ STARTS THE M&C PROCESS FLOW
IM10	STARTS THE PROJECT FEASIBILITY ANALYSIS – PLANNING PROCESS FLOW
IM20	RELEASES THE OFFER OF SOFTCOM-INT
IM30	CONTRACT SIGNOFF
IM35	ENDS THE M&C PROCESS FLOW
PM100	PROJECT AWARDED TO SOFTCOM-INT
PM200	STARTS THE PHASE INITIATION PROCESS (GROUP) FLOW
PM300	STARTS PHASE PLANNING PROCESS (GROUP) FLOW
PM400	STARTS PHASE EXECUTING PROCESS (GROUP) FLOW
PM500	STARTS PHASE CLOSING PROCESS (GROUP) FLOW
PM600	STARTS PROJECT CLOSURE PROCESS FLOW
PM700	ENDS PROJECT

Table 9: Project Milestones

9.3 Project Feasibility Analysis – Initiation Process Flow

This process occurs when a new project/business opportunity arrives to Softcom-Int either by an RFP/RFI or directly from a customer. Following the initiation process of PMBOK, the project manager and the CEO of Softcom-Int are examining the feasibility of implementing the project through several steps. The main target of this process, for Softcom-Int, is to determine whether it is possible for the organization to undertake and execute the project or not. At the end of this process the CEO must make the call on whether Softcom-Int should deliver an official offer for the project implementation.

The starting point of this process is usually being triggered by an email, which is sent by a potential customer to Softcom-Int's CEO and it can include either an RFI/RFP or, in general, an offer request. Nevertheless, it usually contains a brief description of the project objectives, the high level requirements, the available budget (optionally) and some other information such as the delivery date and an overview of the requested project deliverables. When the CEO receives that email, the first business rule task that she performs is to assign a project manager (from the Softcom-Int staff) to handle this particular project. Since the project manager has been assigned, the CEO notifies the customer about the project manager's nomination as a Single Point of Contact (SPOC) for the project scope, along with her/his contact data.

The project manager should then perform a series of tasks. First of all, a manual task, the thorough study of all the available project information and documentation that has been delivered to Softcom-Int. After that, a business rule task, where a new project folder is created on the project server. Since he has finished studying the initial information about the offered project, he suggests through a send task a project approach to the CEO, which includes additional information about whether or not it is possible for the organization to undertake the project. This approach is then sent by email from the project manager to the CEO. The CEO receives the project manager's project approach and defines whether they should proceed or not. The next step is a gateway depending on the CEO's decision. If it is not feasible for the organization to proceed with this particular project, which means that the CEO defined a "NO GO" decision, the whole project is cancelled and the initiation process is concluded.

However, before reaching the end event of cancelling the project, the CEO notifies the customer by a send task about the final decision and then the project manager updates the project folder in the server with the additional information about this project. On the contrary, if the decision of the CEO is a “GO” the initiation process carries on.

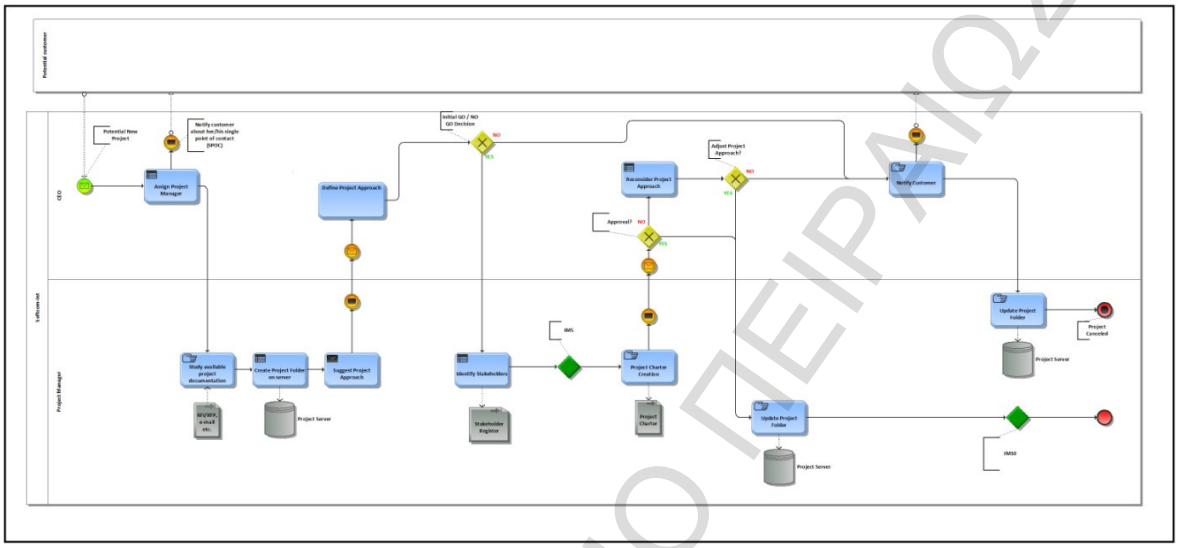


Figure 29: Project feasibility analysis – Initiation process flow

The project manager has the “GO” command from the CEO for the project, so, another round of feasibility evaluation begins. In this round the project manager performs two consecutive tasks; a business rule and a manual task. In the first one, he performs the “Identify Stakeholder” process, which, as a result, has the construction of the project stakeholder register. Between this task and the next one, there is the Internal Milestone 5, which triggers the Project Monitoring and Control Process Flow, which is to be described later in this chapter. The M&C process is, as stated earlier, a process that runs in parallel with the rest of the processes. So, the starting point of this process is here and the end of it at the Project Closing Process. In the second task, he performs the “Create Project Charter” process and then he creates the project charter document, by collecting all the information he has about the project. Since he has created the project charter and the stakeholder register, he sends them to the CEO for approval. The CEO receives those two initial documents and, depending on several factors, she either approves them or not. If the result of the evaluation is negative, then the CEO performs a business rule task, in which she reconsiders the project approach. If the

project approach cannot be adjusted, then the project is cancelled with an end event, after the customer has been notified by email and the project folder has been updated by the project manager in the server. On the other hand, if the project approach has been successfully adjusted by the CEO, or the two documents have previously been approved by her, then the initiation process continues.

Having gained the CEO's approval, the project manager updates the project folder in the server with the project charter and the stakeholder register. Then the initiation process reaches the IM10 and it ends triggering the next process.

9.4 Project Feasibility Analysis – Planning Process Flow

The planning process flow of the project feasibility analysis is being triggered since the initiation process reaches the IM10. Reaching this milestone means that the project charter and the stakeholder register have been created and approved, therefore the project manager holds the initial and required documents to start the planning phase according to PMBOK.

In this process there are two pools, the customer's and Softcom-Int's. Customer's pool is a single lane pool, while Softcom-Int's contains three lanes. First of all, it contains two lanes representing the CEO's and the project manager's activities. Furthermore, an additional lane for another actor who, in this case, is going to assume the role of the software design architect (or software architect). The first task that the project manager performs in this process is the "Collect requirements" task. During this activity, he collects all the available requirements for the project and creates the requirements management plan document. After that, there is the "Define Scope" business rule task with which the project manager creates the scope management plan document. Then he sends it along with the requirements management plan to the Softcom-Int's software architect, who is going to perform the requirements engineering sub-process, which is going to produce the Requirements Traceability Matrix (RTM). When that matrix is ready, the software architect sends it back to the project manager,

who then continues with the business rule task “Create WBS”, which has the result of creating the WBS and the WBS dictionary of the project. Having all those documents prepared, the project manager is in position to evaluate the project level. This means that along with the team they are able to categorize the project depending on several factors, among them the most important ones of the volume, the complexity and risk. That’s the business rule task “Evaluation of Project Level”, which creates the project scorecard document (not part of the PMBOK).

The next process of the project manager and the project team is to create the project management plan, which includes several sub-processes that have to be performed in parallel.

According to PMBOK, the project management plan includes the following processes. Firstly, the project time management sub-process. The project manager in this sub-process should perform a series of manual tasks starting with the “Define Activities” task, which produces the activity list document. Then, the “Sequence Activities” task and the “Estimate Activity Resources” task, which, as a result, produce the activity resource requirements, the milestone list and the Resource Breakdown Structure (RBS). Afterwards, there is the “Estimate Activity Durations” task, which produces the activity duration estimates and then the “Develop Schedule” task, which produces two important documents, the project schedule and the schedule data.

The next sub-process that the project manager must perform is the human resource management, which consists of one task, the “Develop Human Resource Plan”, which produces the human resource plan document. The next sub-process consists also from one task, which belongs to communication management process of PMBOK and by performing it the project manager creates three project documents, the communication management plan, the communication technology and the communication requirements analysis. The next two single-task sub-processes belong to procurement management and quality management processes of PMBOK accordingly. On the one hand, the first task is “Plan Procurements” and produces five documents; the procurement management plan, the procurement state of work (SOW), the make-or-buy decision, the procurements documents and the source selection criteria. On the other hand, the quality management process contains the “Plan Quality”

task, with the help of which the project manager creates three documents, the quality management plan, the quality metrics and the quality checklists. Finally, the last sub-process of the project management plan is the risk management process of PMBOK. This process includes the “Plan Risk Management” task that creates the risk management plan document, the “Identify Risks” task that creates the risk register, the “Perform Qualitative Analysis” task, the “Perform Quantitative Analysis” task and the “Plan Risk Responses” task.

The project manager and the team should gather all those documents into a single document if the type of the project is either I or II and into a folder in case of a type III project. Having all that information the next process of the project manager is to prepare the technical documentation. This process helps the project manager to create the technical offer, with which he updates the project folder at the server. Then he must send the technical documentation along with the project management plan to Softcom-Int’s CEO in order to be approved.

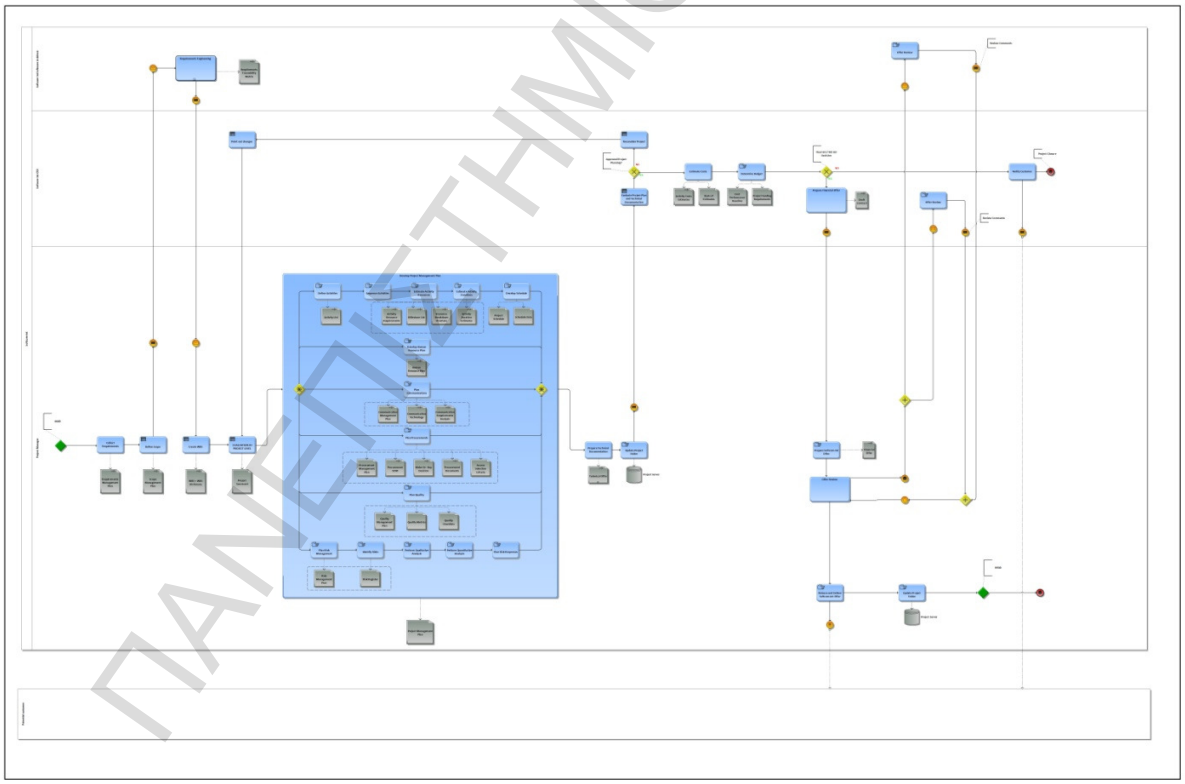


Figure 30: Project feasibility analysis – Planning process flow

Since the CEO receives those documents, she must evaluate them. If the result of the evaluation is negative, then she reconsiders the project planning and orders those changes to the project manager, who will reexamine the planning process from the evaluating project type process. In case of an affirmative evaluation of the project planning, she continues with the budget management process of PMBOK, because as stated before, according to the policy of Softcom-Int, she is responsible for the financial and budget issues of the organization. This process includes two tasks, the “Estimate Costs” and the “Determine Budget”. Each one of those tasks produces two documents, the first task creates the activity cost estimates and basis of estimates documents, while the second one, the cost performance baseline and the project funding requirements. By evaluating the results of the calculated budget of the project, she is be able to judge whether it is feasible and in the interest of the organization to proceed with this particular project or not. If she decides that the organization is not interested in undertaking this project, mostly because of financial reasons, she notifies the customer with a relevant email about this denial. In this case the planning process and, in extension, the whole project reaches the end by the event of a project closure. On the other hand, if she decides that it is feasible for Softcom-Int to implement the project, the next process is to prepare the financial offer. By the end of this process the CEO has created a draft contract, which is sent to the project manager with an email.

The project manager receives the draft contract, prepares the final Softcom-Int’s project acquisition offer and creates the Financial Offer document. When he finishes, he makes a review of the offer and sends an email to the CEO with the results of this process. Then the CEO makes her own review of the offer and sends her comments to the project manager. The project manager then makes the final offer adding any possible comments that the CEO made and releases the final offer by sending it to the customer and updates the project folder in the server. At this point, the feasibility planning process reaches the IM20, which means that the offer has been sent to the customer to consider it and the feasibility process ends with an end event.

9.5 Project Execution Preparation Process Flow

So far the process flow lies at the point, where the final (technical and financial) offer has been released to the possible customer and now Softcom-Int is waiting for his response or feedback. The customer considers Softcom-Int's offer about the project and replies whether the result is negative or positive. If it is negative, then all the processes of Softcom-Int about the particular project are finalized and concluded. However, if it is positive, then the customer informs Softcom-Int's CEO with an email that the project has been awarded to the organization. Since the CEO has received, this email the PM100 milestone has been triggered meaning that the project execution preparation process should begin.

This process flow contains two pools, one for the customer and one for Softcom-Int. The customer's pool consists of three actors, where each one has a lane. Those actors are the project sponsor, the project manager and the rest of the customer's stakeholders. Softcom-Int's pool also contains three lanes, one for the CEO, one for the project manager and, finally, one for the software architect/business analyst. The first task in this process belongs to the CEO, with which she informs Softcom-Int's internal stakeholders about the project acquisition. Therefore, she sends relevant emails to the project manager and the architect/business analyst. As they receive the emails, they start reviewing all the available project documentation by downloading the relevant document from the project server. Then the preparation for the project execution begins. The CEO performs the contract signoff process, which produces the project execution contract. Additionally, she sends this contract to the project sponsor, while the project manager of Softcom-int contacts with the customer's project manager, informing him about the next steps. The project contract signoff process, usually takes place at the costumer's offices and there both sides finalize the deal by signing the final contracts, which must be stored in the project server. At this point, the IM30 milestone has been reached. This means that the project officially has been awarded to Softcom-int.

With the triggering of the IM30, the project manager prepares the kickoff workshop and distributes the kickoff workshop agenda to Softcom-Int's CEO and architect/business analyst as well as to the project manager of the customer. Since they

have received this email, each one of them has usually 15 days (after agreement) to consider the workshop agenda. During this period, of time Softcom-Int's staff also performs several other necessary tasks, like resources freeing and allocation to the new project etc. After the kick off meeting, the project manager performs the process of preparing and distributing the minutes of the kickoff workshop (which produces the meeting minute's document). Then he sends with an email the minutes of the kickoff workshop to all internal and external stakeholders and he updates the project documentation on the server. Since he has done this, the PM200 milestone has been reached and the process of project execution preparation phase concludes with the corresponding end event.

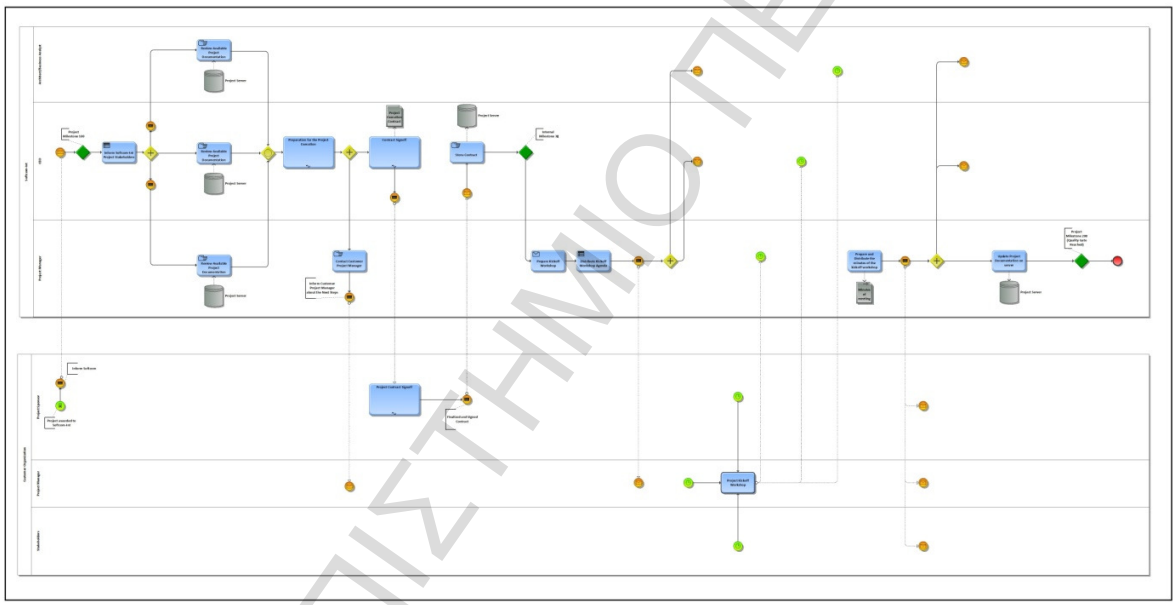


Figure 31: Project execution preparation process flow

9.6 Phase Initiation Process (Group) Flow

This process flow contains Softcom-Int's and customer's pools and it is triggered by PM200, meaning that the project has been officially awarded to Softcom-Int and relevant contracts were signed by both parties. Softcom-Int's pool consists of three main lanes, the usual two of project manager's and CEO's and a third one for the project

team, which is divided by two additional lanes, one for the business analyst and one for the solution architect, while the customer's pool is a single lane. During the two initial process flows, feasibility initiation and planning respectively, several processes of PMBOK were implemented, so at this point Softcom-Int has a general view about the two major documents that those processes produced, the project charter and the project management plan. However, because these documents were initially created for evaluation reasons, they have to be extensively reviewed again. This process is generally made by following the PMBOK best practices.

By triggering the PM200 the project manager begins with the initiation process phase. He downloads the stakeholder register and the project charter from the project server and updates both of them with new information that might have existed because of the kickoff workshop and the rest of interactions with the customer (that took place after the creation of those two documents). He releases the new versions of those documents and uploads them onto the project server. Then, he sends them to Softcom-int's CEO, the solution architect and the business analyst. Since they have received the emails, they must review the project charter and make, if necessary, review comments, which are sent back to the project manager. After that, the project manager runs an internal review process, which helps with the creation of the final project charter. This will have a release version similar to v.0.x and finally sends it to the customer's organization.

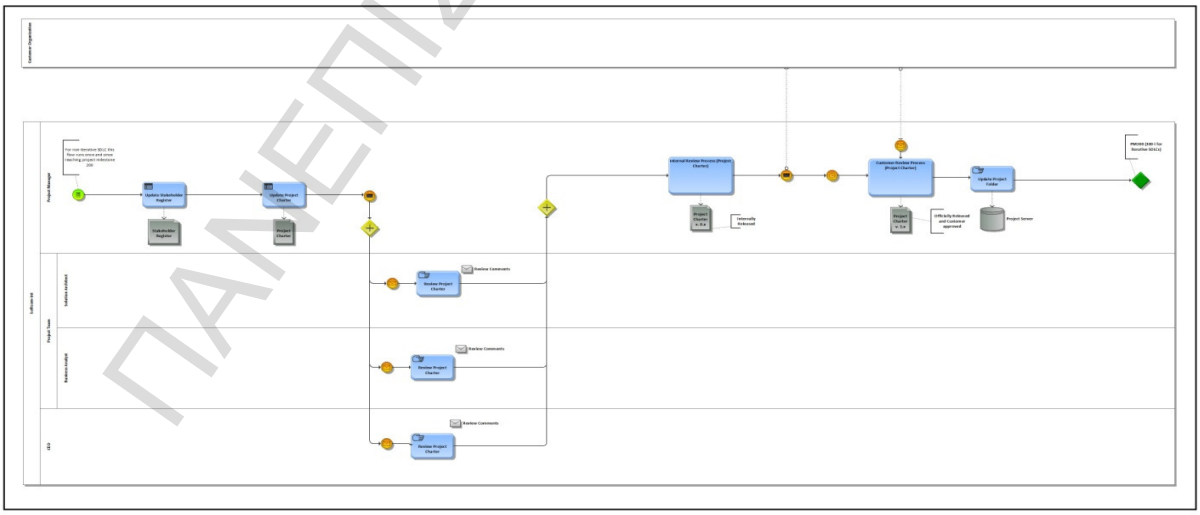


Figure 32: Phase initiation process flow

The project sponsor and his team have a predefined time (acc. to the review process) to review the current version of the project charter and make any comments. If they don't reply in this certain time period, according to Softcom-Int's policy, which is going to be also a part of the contract, the project charter is supposed to be automatically accepted by the customer. The customer may send back his review comments to the project manager of Softcom-Int, who evaluates them (so as to be accepted or rejected). Finally, by the end of all the reviews cycles from both sides and the having approval of the customer, the final version of the project charter is released. The project manager stores it to the project folder on the project server and the process reaches PM300 or PM300-i (if the process is running in an iteration of an iterative SDLC).

9.7 Phase Planning Process (Group) Flow

When the work flow of the project reaches PM300, the phase planning process begins. This process contains two main pools as well, for the customer and Softcom-Int. Customer's pool contains a single lane and Softcom-Int's pool three lanes, one for the project manager, one for the CEO and one for the project team. At this point the final version of the project charter has been created, which includes all the initial information that is available for the project execution. Additionally the project charter has been approved by both sides.

Since the PM300 has been triggered, the phase planning process starts with an exclusive gateway, which defines which track should be followed depending on the project type. The question that is stated at this point and defines which route to take is whether any additional requirements for the project exist. This gateway is used in order to distinguish whether the process is running in iteration of an iterative SDLC or on its own. In case of running in an iteration or it is a time and material project and there are several new requirements, it takes the route of "YES". Otherwise, the process carries on taking the route of "NO".

Firstly, assuming that the process has followed the “YES” route, project manager should notify the CEO and the project team by email, inform them about the additional. In the next step the project manager is going to perform the same group of processes and tasks that he had performed during the feasibility Initiation process. However, this time this process has to be executed more thoroughly, unlike during the feasibility planning process, which represented an initial approach. This group of sub-processes and tasks starts with collecting additional requirements, updating the scope and WBS, and producing each time updated versions of their documents. Furthermore, the project manager performs the very-same tasks – with the project feasibility planning flow- in order to create or update the project management plan document. When he finishes working with the project management plan document, he immediately updates the project folder in case of any change and sends it to the project team, which updates the technical documentation bundle and the project folder at the server.

This is the sequence of processes that the project manager follows in case of an affirmative answer to the previous stated question. In case of negative answer the project manager discards all the previous process flows and moves on to the current point. So, either by running with an iterative SDLC or as a project phase, the process flow continues from this point. The next task for the project manager is to send the updated project documentation for a review to the rest key stakeholders of Softcom-Int. Each one of them makes her/his own comments and then they have an internal review meeting, from which the updated documentation internally released.

After that release the CEO performs the estimate costs and determines budget tasks. Those tasks produce the activity costs, the basis of estimates, the cost performance baseline and the project funding requirements. Finally, she updates the project folder. In case of time and material project, the CEO calculates the additional funds and makes a new financial offer, which is sent to the costumer for approval. In any other case those two processes are part of the reporting process.

The documentation and the financial offer are sent to the customer. The customer then has some certain time to consider and review them and after that he replies making, if there are any, additional comments. Since the project manager has received this email, he makes a review and in case of nothing more is needed to be

added, the documentation is officially released. Then he updates the project folder at the server and the process flow reaches the PM400 or the PM400-i, where i is the serial number of the specific iteration, in case of an iterative SDLC method.

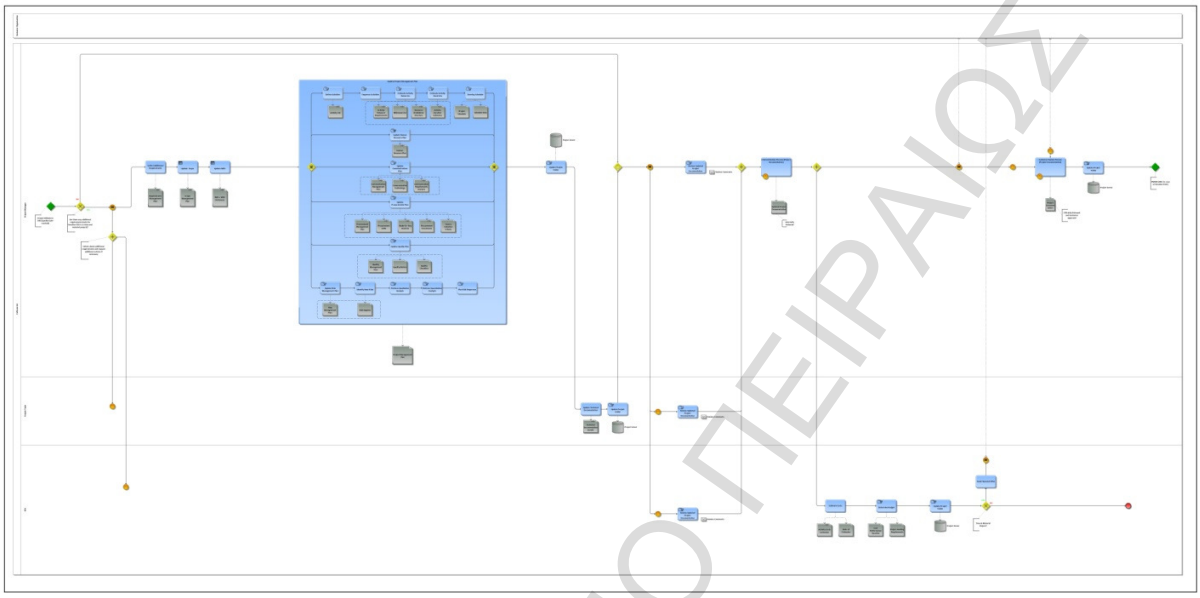


Figure 33: Phase planning process flow

9.8 Phase Executing Process (Group) Flow

By triggering PM400 the Executing phase of the process flow begins. This process flow contains just one pool for Softcom-Int because there are no interactions with the customer during the execution of this process. The pool consists of two lanes, one for the project manager and one for the project team.

The basic sub-process of this flow, according to PMBOK, is to direct and manage the project execution. This sub-process contains four knowledge areas of PMBOK and the project manager needs to perform several tasks, which are grouped based on the knowledge area they belong. The first group includes three tasks and it belongs to the human resource management area. The first task is the “Acquire Project Team” task and it produces two documents; the project staff assignments and the resource calendar. The second is the “Develop Project Team” task, which helps creating the

team performance assessments document, and the third one is the “Manage Project Team” task.

The next knowledge area, which is included in the executing process, is the procurement management knowledge area. It contains only the “Conduct procurements task, which produces the procurement contract award document. The direct and manage project execution sub-process also contains the communication management knowledge area, which includes two tasks; the “Distribute Information” task and the “Manage Stakeholder Expectation” task. The final task belongs to the quality management knowledge area of PMBOK and is the “Perform Quality Assurance” task, which produces the quality audits document. In parallel with those sub-processes there is the main sub-process of the project, which is the software development part. This sub- process, which is called SDLC, is performed by the project team during the execution process and apart from the development process includes several other sub-processes like testing (Quality Assurance) and secure SDLC.

The whole sub-process of directing and managing the project execution helps the project manager with the collection of the work performance information. Since this document has been created, the project work flow can now reach the PM500 or PM500-I milestone.

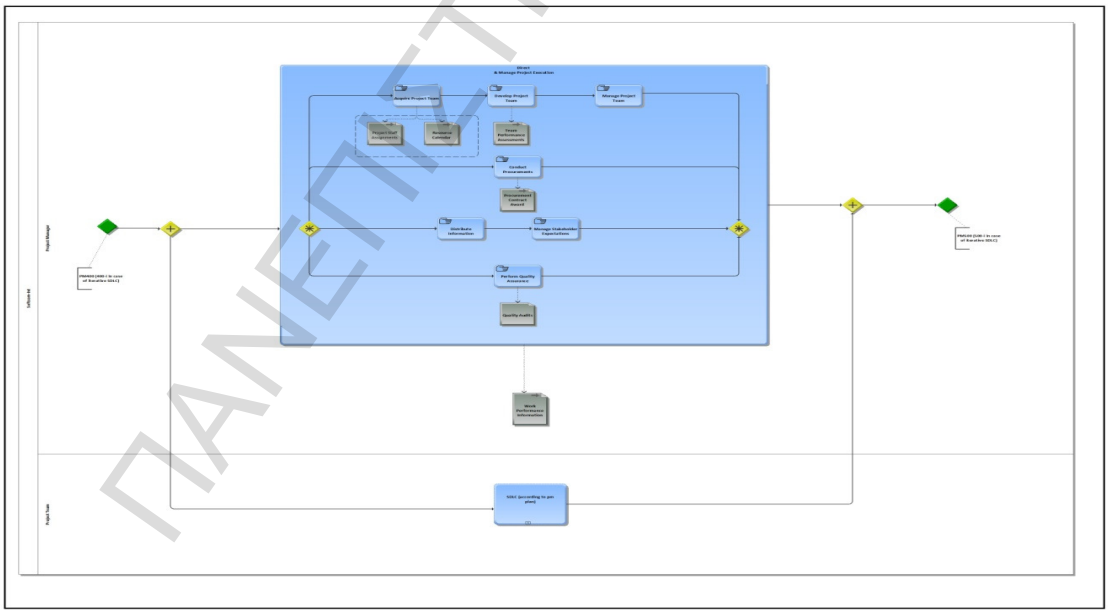


Figure 34: Phase executing process flow

9.9 Phase Monitoring and Controlling Process (Group) Flow

This process is performed throughout the entire project life cycle. It starts in the middle of the feasibility initiation process and ends in the middle of the closing project process. It contains two pools, one for the customer, which is a single lane, and one for Softcom-Int. Softcom-Int's pool consists of three lanes; one for the project manager, one for the CEO and one for the project team. The process is triggered by the IM5, which can be found in project's feasibility initiation process.

At the beginning of the monitoring and controlling process flow, the project team must send all the available reports to the project manager and also perform, in parallel, two sub-processes; the monitoring and controlling project work and the perform integrated change control. The first one consists of several tasks and processes, all of which belong to the eight knowledge areas of PMBOK, except from configuration management and issue management. Those processes are not a part of PMBOK, but it was decided to consider them as knowledge areas for Softcom-Int. These tasks or processes, which belong to the same knowledge area, are performed in a row.

The first two serial tasks of the monitor and control project work sub-process belong to the scope management knowledge area. They are the "Verify Scope" task, which produces the accepted deliverables document and the "Control Scope" task. The procurement management knowledge area is represented by the "Administer Procurements" task, which helps with the creation of the procurement documentation. Furthermore, time management is represented by the control schedule task, while the communication management knowledge area has the "Report Performance" task, which produces the performance reports.

One of the most crucial processes of software development, configuration management process, is also a part of the monitor and control project work sub-process and helps the project manager to create the configuration management documentation with the support of the QA team. The next task, "Perform Quality Control" produces three documents; the quality control measurements, the validated changes and the validated deliverables, which belong to the quality management knowledge area. The issue management and the root cause analysis are the next two grouped processes of

the monitor and control project work sub-process, which both produce one document, the issue resolution report and the root cause analysis report respectively. The last task belongs to the risk management knowledge area and is the task of “Monitor and Control Risks”, which creates the risk audits document.

Finally, the Perform integrated change control sub-process, which must run in parallel with the monitor and control project work sub-process, produces the change request documentation.

Since the documents and the work of those sub-processes have been finalized the project manager updates the project management plan with the possible changes that might have occurred, from the last version, and then he updates the project folder on the project server as well. This action triggers the IM35 and signifies the end of the project monitor and control process flow.

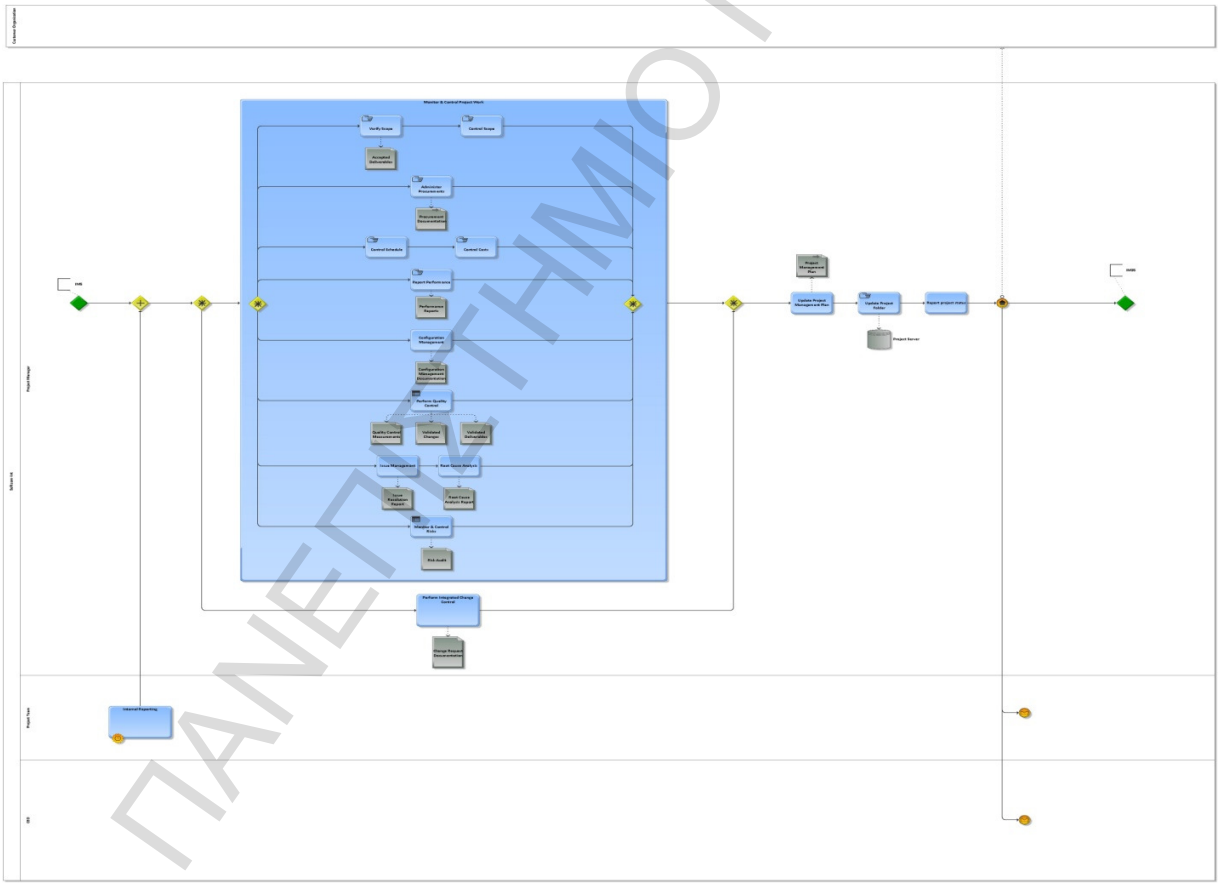


Figure 35: Phase monitoring and controlling process flow

9.10 Phase Closing Process (Group) Flow

The phase closing process is triggered by the PM500. It contains two pools for Softcom-Int and the customer. The customer's pool is a single lane, while Softcom-Int's pool consists of three pools; one for the CEO, one for the project manager and one for the project team.

The first sub-process of the project manager is to close the procurements, which produces two documents, the procurement audits and the closed procurements. Then he must prepare the quality gate meeting, for which he sends invitations to all the interested parties and the meeting is scheduled. The quality gate meeting is preplanned and takes place at the customer's premises. During this meeting several decisions are made, which will ensure project quality (based on synchronized and comprehensive transparency about the project status). The next step is the close phase sub-process, in which the project manager updates the project management plan, uploads the possible updated/modified documents to the project server and releases them to the customer. The phase closing process flow ends by reaching the milestone PM600 or 500-i in case of iterative SDLC**.**

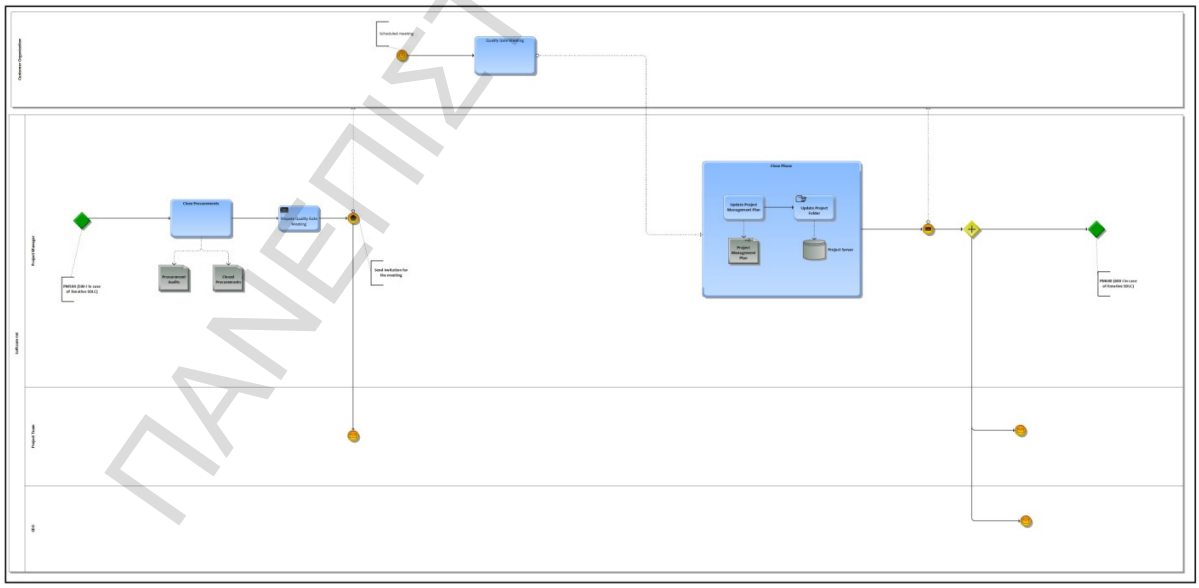


Figure 36: Phase closing process flow

9.11 Project Closure Process Flow

The last process is the project closure process, which is triggered by the PM500 or PM500-i. It contains two pools, one for the customer, which has only one lane, and one for Softcom-Int, which has the project manager, the CEO and the project team lane.

The project closure flow is very similar to the previous phase (closing process flow). The work of project manager continues with the sub-process of closing procurements, which produce exactly the same documents as in the previous process flow. The main difference is that the next process of lessons learned exists only here and it is the process, during which the project team and the project manager discuss on the issues that appeared during the project execution. This sub-process creates a document, in which those lessons learned are recorded for future use (and as part of historical data for Softcom-Int).

Then the project manager updates the project management plan so as to upload it onto the project server. The project closure process flow and the project in general finishes when it reaches milestone PM700.

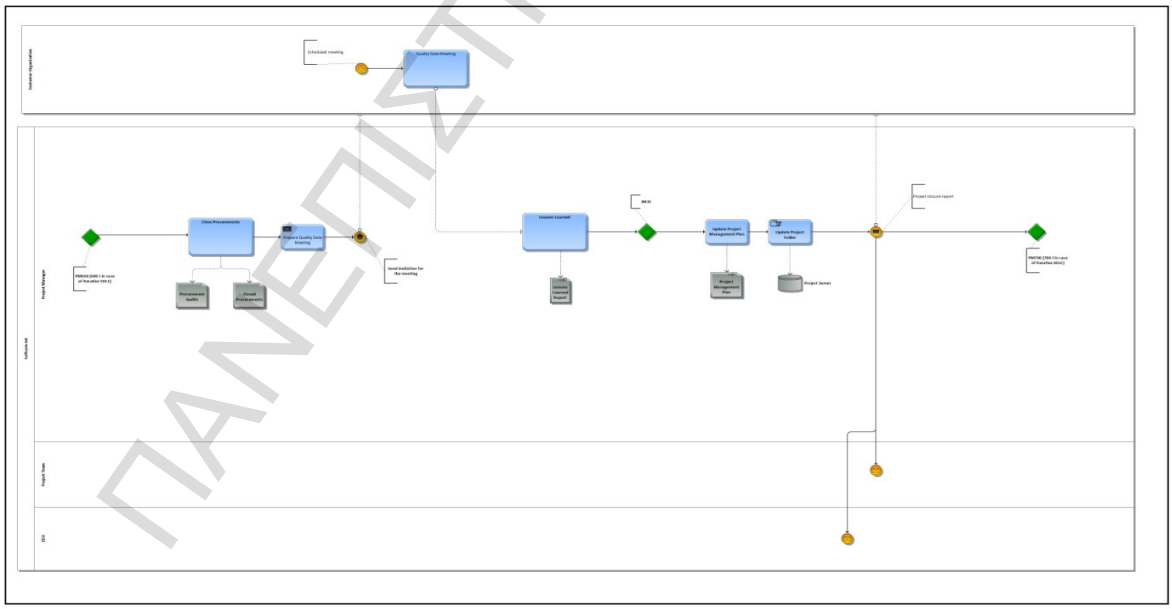


Figure 37: Project closure process flow

10. Mapping PMBOK Documents According to Project Type

It is very important for every organization to have a helpful set of rules so as to proceed with the project categorization and a well-defined how-to so as to support the project team to structure and organize the project documentation. The importance of the aforementioned factors is tied up with the need for successful project management. As it is revealed at a previous chapter, in which the PMBOK analysis takes place, it is crucial for a project in order to be successful, to have well defined boundaries. These boundaries need to be precise and determined before the beginning of the project's planning and execution processes. They are not always the same for every project, but by considering numerous variables they are designated by each organization. Depending on the selected variables the organization constructs categories, using which the projects can be categorized. Thus, it is easier for the Project Manager and the Project Team to be able not only to control the whole execution of the project more effectively, but also to implement the right practices, depending on the needs and the nature of the project.

The categorization of projects is a vital process for every organization. It can save both time and effort for the staff of the company, because projects with the same characteristics can be directly recognized and put in the same category. This basically means that they need almost the same attention and effort to be successfully executed. Besides, each category will have one specific way of handling projects with a similar work flow and the amount of the documentation, which is needed by every project, will be defined depending on the category. This automatically means less time spent on organizing and planning the execution of the project. Consequently, this is the main reason why project categories are important. Another reason is because of the PMBOK. PMBOK is a standard, created by the best project managers in the world. So as a practice, its processes can be aligned with the ones that an organization can have. Sometimes it gets really complicated when the situation does not demand that much complexity. For example, there could be projects that do not really need the

procurement processes. In this case, it is up to each organization whether it is going to execute those processes or not. The same could happen with any process that PMBOK suggests and the answer is different each time depending on the complexity and the various characteristics of each project. Thus, by being able to categorize a group of projects with the same characteristics, better implementation of PMBOK can be achieved.

10.1 Project Categorization

Project categorization is not an easy task. There should be a certain amount of key variables, as it was previously mentioned, which makes easier to distinguish the different categories. In Softcom-Int's case those variables for an incoming project are the following:

- Project Type
- Project Assignment Process
- Project Volume
- Project Complexity
- Delivery Time
- Estimated Effort
- Outsourcing or In-house development

As it is quite obvious, those characteristics are not obligatory for every organization. Each one can decide what the appropriate categorization criteria should be, judging from their own needs. For "Softcom-Int" those are the variables on which categories are going to be built. On the following figure, Softcom-Int's categorization tree for projects is depicted.

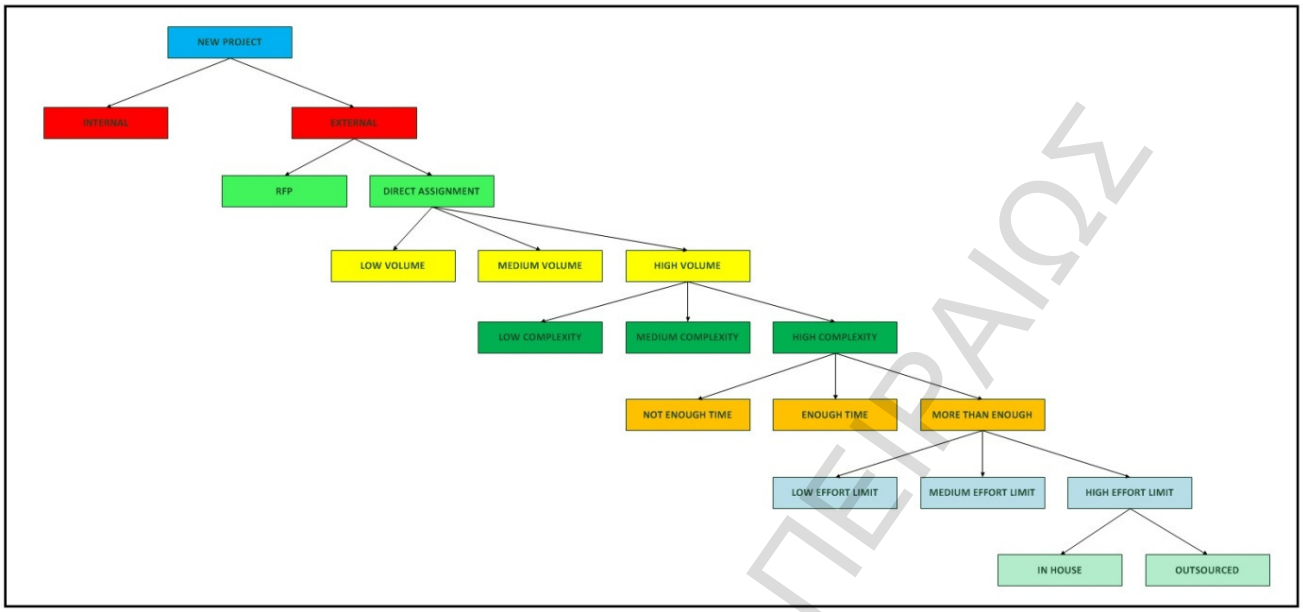


Figure 38: Project Categories

10.1.1 Type of Project Category

The process of accurate categorization for each project should start at the very first phase. Once a new project arrives, the response must be immediate. The first variable that must be examined is the type of the project. There can only be two types of projects, the internal and the external ones. The main differentiation factor between those two is the sponsor of the project. If the sponsor of the project is the organization itself then it is an internal project, or else it is an external one. Internal projects are projects that are implemented by the organization in order either to improve an internal system or process or to create potentially profitable final products, which are to be released in the market. On the other hand, external projects have an external sponsor. Those are projects that are implemented because the organization was asked to develop them.

As it easily assumed, the implementation of an external project is more difficult than an internal one. Usually, organizations that implement an internal project do not include strict schedule and cost baselines. It may take more time to be completed

without really causing important troubles, whereas such thing in an external project is impossible. Therefore, in case of having a same project implemented by an organization, when this project is external it must have greater degree of difficulty from when it is internal.

10.1.2 Project Assignment Process Category

In the next category belongs the type of process, during which a project is being assigned to the organization from an external sponsor. There are two ways for the organization to undertake an external project; the project can either be earned by an RFP (Request for Proposal), or be directly assigned to the organization by the customer. Usually, n software development industry, where Softcom-Int belongs, software development houses are considered to be suppliers. Thus, in order to get an RFP from an external customer, the software development houses need to be in the customer's procurement database and more specifically in the approved suppliers list. Therefore, when a customer organization wishes a new software development product, it usually publishes a RFP to all the suppliers on its list. RFPs include the necessary information that a supplier needs in order to make an offer for a specific product, like high level requirements, deliverables, budget etc. After the supplier's offer, the customer organization decides, according to its needs, which supplier is going to be assigned with the implementation of the project. Moreover, there is an option for projects that are not announced on the supplier's lists. In that case, the customer makes an open invitation for every interested organization. This procedure is similar to the previous one. As far as the direct assignment option is concerned, the process is easier and more straight-forward. In this instance, the customer assigns a project directly to a supplier without publishing any invitation.

The necessity of differentiating those two types of project assignment and creating this category lays on two facts; the evaluation of the budget and the resources, which in each case is different. That's because, in the first situation, the software development organization needs to embody the presales costs in the offer, while in the second there is no such need. Presales costs are the costs for evaluating the

requirements of the RFP and the amount of effort and time that will be needed to develop the project. They include the cost that the organization needs to pay for preparing and submitting an offer to a customer, but they do not involve any real project execution work. This cost is included at the final offering budget for the project execution and the organization might either get paid if it gets the project, or not if it doesn't. This is an unavoidable risk that any organization has to take. In addition, there is a differentiation in the resources as well. In the case of RFPs, the procedure of the announcement about who is going to execute the project, might take a long time. That means the organization should be able and ready to use the amount of the required resources to start a project at any time, since, the time when the supplier is going to assign the project, is not predetermined. Effective planning of resources is very important and might be tricky as well in such cases especially when the supplier is a small software development houses, having limited staff. On the other hand, during direct assignment, things are way different. There is no waiting period and, since a project has been directly assigned to an organization, normally it will start in the near future.

10.1.3 Project Volume Category

The next important category, that differentiates projects from each other, is the project volume category. It is applicable for both internal and external projects and basically has to do with the budget to be spent for each project. There are three values in this field, low, medium and high. The low volume projects are those, which cost up to 249.999€, the medium volume projects costs fluctuate between 250.000€ and 499.999€ and, lastly, the high volume project, the budget of which is more than 500.000€.

COST	VOLUME
0€ – 249,999€	LOW
250.000€ - 499.999€	MEDIUM
500.000€ - and further	HIGH

Table 10: Project Costs and Volume

Depending on the available budget, the project management approach for each project differs.

For instance, high volume projects require good estimation of the availability of resources, better quality check and accurate risk management. On the other hand, low volume projects, may need less accurate risk management process (i.e qualitative instead of quantitative), or less work in procurements.

10.1.4 Complexity Category

Project complexity is another important factor in project categorization. It is not an easy task to define the level of complexity of each project, especially at the very beginning. The project complexity can be operationalized in terms of differentiation, interdependencies or connectivity. Differentiation appears on various elements of the project, such as tasks or specialists, whereas interdependence illustrates the degree of interrelation between these elements. Furthermore, it can encompass anything characterized by difficulty within project processes and procedures.

There are several variables and certain areas, which have to be closely examined in order to be able to define the degree of complexity of a specific project. In spite of the difficulty, defining the complexity has to be effective and successful, because wrong judgment would have a negative impact on the final result of the project and might lead it to failure. By determining correctly the complexity, it is feasible to take the appropriate managerial actions for the project to be successfully completed.

There are several aspects of a project that are strongly influenced by the level of complexity. Apart from the obvious effect that it can have on the project's objectives of time, cost and quality, the importance of complexity in the project management process is acknowledged as critical factor for numerous other reasons, such as:

- It helps determine planning, controlling and coordinating processes;
- It usually blocks the clear identification of objectives in big projects;

- It is usually a criterion of selecting the appropriate organization form for some projects
- It influences the selection of project inputs
- It is frequently used as a criterion in the selection of the suitable project procurement arrangement

Apart from the above project characteristics that define the degree of complexity, there are some other factors that are essential as well. Like the technologies and the expertise level that is requires.

Project manager and the project team must evaluate the level of complexity in relation to the volume as follows:

VOLUME / COMPLEXITY	LOW	MEDIUM	HIGH
LOW	1	2	2
MEDIUM	2	2	3
HIGH	2	3	3

Table 11:Project Volume and Complexity

10.1.5 Time, Effort and Outsourcing Categories

The first factor is the time that the project manager and the project team have at their disposal, so as to complete the project. By reviewing the objectives and the

desired deliverables of the customer's project, as well as the deadline for the delivery, it can be evaluated, whether the time they have is enough, more than enough or not enough. Depending on the previously defined type of the project and the value of the time factor, the project team should be in position to plan better the project. For example, if the project is of type III, which could mean that it is high in volume and complexity, and, meanwhile, the available time for the delivery is not enough, then, more resources would have to be found, in order to meet the objectives.

The next factor to be considered is the effort that is required for the project completion. This factor can either be low, medium or high. Those values can result again from the evaluation of the requirements, the objectives, the available capacity and expertise for a certain project. This would help in better planning, risk management and other issues as well. Quantitative effort estimation is the outcome by the effort estimating process.

Finally, the last factor to be examined is whether any modules/components of the project have to be outsourced. When a project is to be outsourced, the level of risk automatically increases. For instance, assuming that a project that was previously categorized of type I, has a core component of it outsourced, then, it immediately becomes of type II. The same thing happens to projects of type II.

VOLUME / COMPLEXITY	IN HOUSE (√) / OUTSOURCING (X)	RESULTS
1	√	1
	X	2
2	√	2
	X	3
3	√	3
	X	3

Figure 39: Project volume/complexity and outsourcing or in house development

10.2 PMBOK Processes According to Type

PMBOK offers a series of processes for the project management process, in order to successfully execute a project. This standard contains five process groups, each one of which has several steps – processes that need to be executed. Every process needs inputs and produces specific outputs. Therefore, it should not be executed at a random time during the whole procedure, but in a precise flow. Nevertheless, depending on the nature of the project, some of those processes and their outcomes are not always important. Nevertheless, those processes can be discarded and the project team can carry on working with the next ones in the flow. Determination of which PMBOK processes may be discarded and under which circumstances is part of Softcom-Int's policy as recommendation but stay always under the judgment of the responsible project manager. The basic criterion for such decision should be the project scorecard as aforementioned.

PMBOK can be aligned with the organization strategy, culture and way of doing business. Therefore, each company can adjust part of it, either by adding or discarding processes. In the figures below, the sequenced entire set of processes that PMBOK suggests is depicted as they are, aligned to Softcom-Int's organizational needs and priorities. The well-known Chevron diagrams will be used for this purpose.. Process Groups are indicated with blue boxes, the processes of PMBOK with green and, the processes that PMBOK does not cover, -but were added by Softcom-Int- are yellow colored.

The Softcom-Int project management process begins with the Initiating Process Group, which encapsulates two sub-processes. These sub-processes are vertically stacked in the figure, meaning that the top one must begin first and the next one should wait until the previous one is concluded. Near the middle of the Initiating Process Group, starts, in parallel, the Monitoring and Controlling Process Group and until the middle of the Closing Process Group. For Softcom-Int, this process group is active throughout the project management process in order to control the projects in the best possible way. Afterwards, the Planning Process Group takes place. It starts with the "develop project management plan" sub-process and it is followed by several sub-

processes, which mainly contribute in the creation of the project management plan. Usually, in big enterprises, each one of those sub-processes requires a dedicated process manager. However, in SMB's the project manager is usually responsible for all of them (unless a separated procurement department exists). As it was stated in a previous chapter, in project types I and II, there is a project management plan document, whereas in type III, a management plan document for each sub-process, stored in the project management plan folder. The next one that follows is the Executing Process Group and finally the Closing Process Group, which concludes the project management process.

At a glance these are the processes that are performed in case of type III projects. Type III projects are very demanding, meaning that PMBOK must be followed precisely, so as to maximize the chances for success in Type II projects a more lightweight process approach can be equally effective. Therefore, non-crucial processes of PMBOK can be discarded without serious trade-offs.

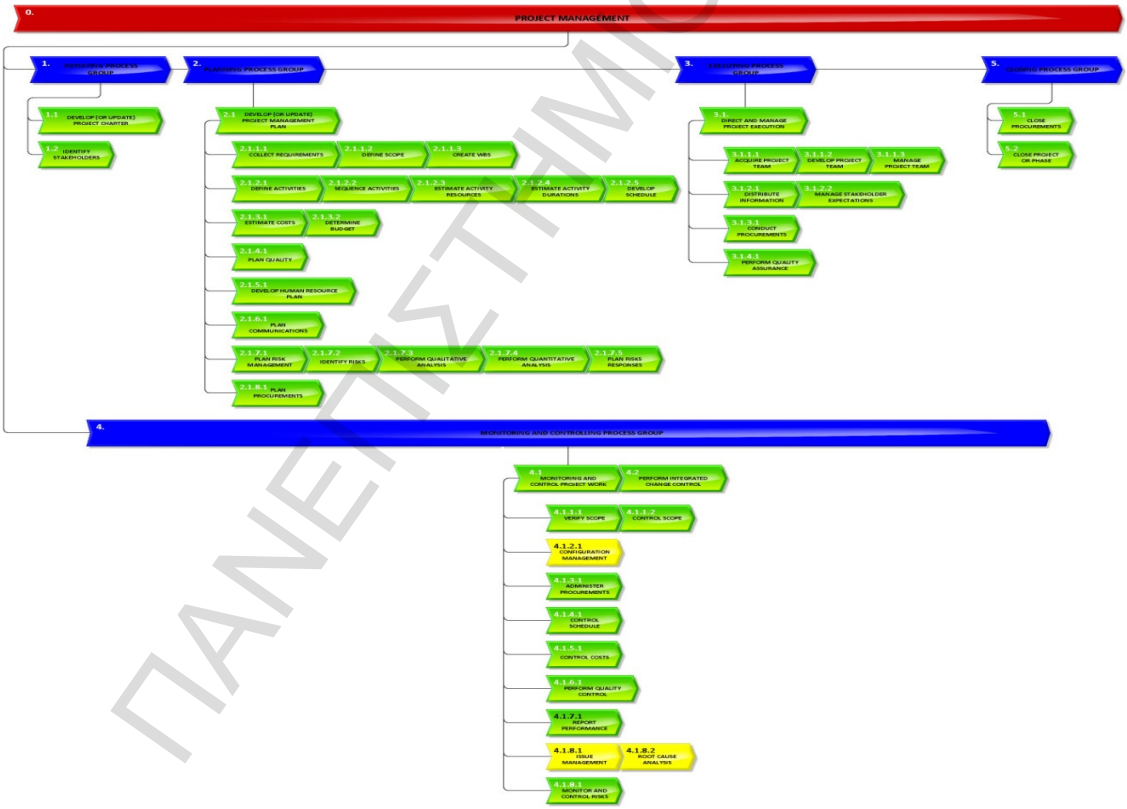


Figure 40: PMBOK according to project Type III

The effort spent for project management should be aligned with the project importance. In the following figure, the processes to be left aside are depicted in red boxes.

Figure 41: PMBOK according to project Type II

Eventually, for the Type I projects, which have low risk and are quite smaller both in terms of volume and complexity (usually at least), the processes to be discarded are even more, as it is obvious from the following picture

Figure 42:PMBOK according to project Type I

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The pictures are presented in more details in APPENDIX A (Project Types and PMBOK 1 - 9).

10.3 Structure of the Project Folder

During the project management process and throughout the lifecycle of every project, all the aforementioned documents should be stored in a special folder in the organizational project database (on a specific server). Document should have non-overlapping content and should cover specific areas of project execution. Some of them are used to describe the project procedures, others to define the project work, report or document several project issues and so on. Moreover, traceability and easy access are key requirements and advantages for the project monitoring and controlling. In addition they are part of the historical data of the organization and must be available for future reference, use or auditing purposes. That's the reason why every organization needs a well-structured project folder, where all the documents and important files of a particular project are stored. Its structure should be simple and accessible to every stakeholder from both parties (permanently or on demand). However, depending on the nature of the document, it is possible to have limitations for some stakeholders (especially the externals). For the above reasons, a project folder for Softcom-Int has been created. This folder has a unique structure and contains several templates. It is the same for every project regardless its category (that means standardized structure). On the following picture, one can look inside the project folder of Softcom-Int and all the directories and files that it contains.

Figure 43: Project Folder structure

It is important to clarify which are the contents of the project folder. First of all, the Softcom-Int internal directory, as its name imposes, includes files that can be accessed only by the Softcom-Int staff. In this folder the organization stores all the files that are for internal use only, either because the customer does not need, or is not supposed to see. Such files are the internal reports, the project scorecard and documents such as the stakeholder management strategy.

The customer input folder contains all the available information about the project that Softcom-Int received from the customer. This can include the RFI or RFP, which was initially sent by the customer, or any other specific information about the project objectives and initial input. It can also contain information which was gathered by the project team, from all the possible interviews with the customer. The Softcom-Int offer directory includes the financial and the technical offer that Softcom-Int delivered for the particular project. It is useful to store information about the offers and keep the justification, not only if the project is successful, but also if it fails to supports business development and sales in the future. The contract folder contains the agreements (i.e. MoU and NDAs) and the signed contract. The project charter folder contains the project charter. The project charter contains valuable initial information about the project and many times during its execution, it must be accessed by the stakeholders, and that is why it is important to easily track the changes made. The management plan folder contains the bundle of management plans of the project. The exact content of this folder depends on the type of the project. If it is type of I, it contains a general project management plan document, while for type III it can contain up to twelve distinguished management plan documents. This directory is mostly for internal use, unless the two sides have tailoring rules agreed and the customer needs to review the planning process followed by Softcom-Int for the project. The risk register folder could be stored on the management plans folder, as part of risk management plan, but it is preferred for accessibility reasons to be left alone in the project folder. It contains all the forecasted risks, so it is important to be easily accessed and examined ad hoc and periodically throughout the project lifecycle. The minutes of meetings folder contains all the information that has to be reported after a project related meeting. The status reports

directory contains the weekly, monthly or annual reports depending on the agreed communication plan. Here are being stored all kinds of reports that must be available for the customer and Softcom-Int. The change request folder exists only if there is a change request from the customer and it contains all the important information and documentation that justify the decision path for the implementation or not of a change. The procurement folder contains all the data regarding procurements tasks and SLAs for the particular project. The lessons learned folder is also very important and should be easily recognized and accessible by the Softcom-Int staff. The same stands also for the project deliverables.

The issue report directory contains all the reports referring to the issues that arose during the project execution as well as the remedy actions information.

Finally, the project folder includes two additional files: a) the requirements traceability matrix, which is produced by the requirements engineering process and contains all the requirements of the project, and b) the (Microsoft) project plan, which contains the schedules (Gantt charts), the deadlines and much more valuable information.

10.4 Documents per Project Type

During the implementation of PMBOK several documents and files are created. Almost every process of PMBOK produces one or more outputs, which may include documents, checklists, matrices and information that can be used as a project artifact. Those outputs however, depending on the nature of the project, are not always necessary. According to the Lean PM approach, some of those outputs can be considered as “muda” therefore it is useful to eliminate them in order to achieve better results with the minimum possible effort.

In a previous chapter, projects were categorized depending on their key characteristics. Accordingly, depending on the volume, complexity and effort, three types of projects were created for Softcom-Int. Whenever a new project arrives, the project manager and the project team should label it accordingly. By doing so, it is

possible to save time for the execution and also follow the path that was previously settled for each type of project. Each of the three types requires a specific management effort to be accomplished. Furthermore, each has a range of necessary documents that need to be created during its execution. Obviously, type III category has to be more extended and needs more effort to be completed than the other two types. One of the indicators of the level of effort is the management documents that are produced during the processes for the project execution. In the following sections the documents that need to be produced, depending on the project type, are going to be presented. Although it is suggested to follow this strategy, it doesn't mean that it is mandatory. It is up to the project manager to judge, depending on the nature of his project, whether those documents are enough for a particular project or more is needed.

10.4.1 List of Documents in Type I Projects

Type I corresponds to the simplest category of software development projects for Softcom-Int. It includes low-complexity and low-volume projects; therefore the project will probably have a small budget and need limited amount of resources. In such cases, the organization does not need to spend a lot of effort and time to managerial overhead. For this reason, the managerial work flow must be minimized and the documents that are produced by the project team should be comprehensive.

In the following table, the documents that must be created by the project management process for the project type I are illustrated. The first column contains the process group, during which the document has been created, according to PMBOK. At the second column, the name of the document is contained and at the third one, the path inside the project folder is depicted. Furthermore, this table contains recommendations about its accessibility to externals, its format/type and, finally, its priority. Some of these documents are mandatory and others are optional. It depends on the project and it is up to the project manager to decide whether there is a need to create an optional or not.

The first document that is created is the project charter. The project charter is a template which contains cornerstone information about the project, such as the

business needs. It includes the project purpose or justification, the project objectives and, also, some high-level initial requirements, description and risks. Moreover, it contains the summary milestone schedule, project budget as well as the assigned project manager and the roles and responsibilities of the key stakeholders. Finally, it includes the stakeholder analysis with the stakeholder register. In type I projects usually the requirements are not so numerous so the objectives of the project should be clear from the beginning. That's the reason why in this type of projects the project charter is very important. There is the intensive need to freeze the requirements and the budget as soon as possible. All that work usually is being depicted in project charter.

During the initiating process group on the type I projects the contract is Crucial Right after the initiation process, the planning process begins. The first document that is created in this phase is the project scorecard, which is an internal document that justifies the project categorization.

PMBOK during the planning phase suggests that a management plan should be created for every important aspects of the project. That's why it suggests creating a management plan for schedule, cost, requirements, communication, configuration, procurements, quality, risks etc. Also there should also be a project management plan, which will control the whole management process of the project. Although it very useful for the success of the project, to create a management plan for every crucial aspect a lot of effort, resources and time are needed. Type I projects from their nature, do not need that extended analysis, for the reason that their budget and the resources working on such project are limited. So, in type I projects, Softcom-Int's policy is to create a single Project Management Plan document, which will contain a summary of the most important parts of the rest management plans. This document will contain a brief presentation of the actions that should be made and will have one chapter for each management plan. For example, it will have a chapter for the risk management plan, which will also contain the risk register and all the possible risks that might occur. Only the procurement management plan is excluded from this document mainly because it is optional. Furthermore, during the planning phase two additional documents are created, the technical and the financial offers.

At the executing phase for type I project, only the reports are mandatory such as the project status reports. Also a procurement contract award document is may be created, if applicable, in this phase. During the monitoring and controlling phase several documents are being produced from the project management process. Some of them are mandatory, which means that in every project they must be created, some optional and some can be created only if the situation that they describe is applicable for the project. The mandatory documents are a) quality gates, b) the release notes and c) the accepted deliverables. In case that a change request occurred, a change request form should be completed. Moreover in case of a raised issue, an issue report document and a root cause analysis document must be created.

Finally, in the closing process the lessons learned document must be delivered, which should include all the valuable information that the project team gained from the execution of the particular project. Also the close project document, which defines the end of the project and the acceptance of the final result from both parties, must be created and signed by the project sponsor (or her representative).

PROCESS GROUP	DOCUMENT NAME	PROJECT FOLDER PATH	AVAILABILITY	DOCUMENT TYPE	PRIORITY
INITIATING	**PROJECT CHARTER**	D. Project Charter/	TO ALL	TEMPLATE	MANDATORY
	CONTRACT	C. Contract/	TO ALL	TEMPLATE	MANDATORY
PLANNING	**PROJECT SCORECARD**	0. Softcom-Internal/	INTERNAL	TEMPLATE	MANDATORY
	ACTIVITY ATTRIBUTES	0. Softcom-Internal/	INTERNAL	TEMPLATE	OPTIONAL
	ACTIVITY LISTS	0. Softcom-Internal/	INTERNAL	TEMPLATE	OPTIONAL
	BASIS OF ESTIMATES	0. Softcom-Internal/	INTERNAL	TEMPLATE	OPTIONAL
	WORK BREAKDOWN STRUCTURE	0. Softcom-Internal/	INTERNAL	TEMPLATE	MANDATORY
	PROJECT MANAGEMENT PLAN	E. Management Plans/	TO ALL	PLAN DOCUMENT	MANDATORY
	PROCUREMENT MP	E. Management Plans/	TO ALL	PLAN DOCUMENT	OPTIONAL
	TECHNICAL OFFER	B. Softcom-Int Offer/B.1 Technical Offer/	TO ALL	PLAN DOCUMENT	MANDATORY
	FINANCIAL OFFER	B. Softcom-Int Offer/B.1 Financial Offer/	TO ALL	PLAN DOCUMENT	MANDATORY
EXECUTING	**PROJECT STATUS**	H. Status Reports/	TO ALL	TEMPLATE	MANDATORY

	REPORTS				
	INTERNAL STATUS REPORTS	0. Softcom-Internal/Internal status reports/	INTERNAL	TEMPLATE	MANDATORY
	PROCUREMENT CONTRACT AWARD	L. Procurement	TO ALL	TEMPLATE	OPTIONAL
M&C	**ROOT CASE ANALYSIS**	J. Issue Reports/	TO ALL	TEMPLATE	IF EXIST
	ISSUE REPORT	J. Issue Reports/	TO ALL	TEMPLATE	IF EXIST
	PROJECT COST PERFORMANCE	H. Status Reports/	INTERNAL	TEMPLATE	OPTIONAL
	PROJECT SCHEDULE PERFORMANCE	H. Status Reports/	INTERNAL	TEMPLATE	OPTIONAL
	MINUTES OF MEETINGS	G. Minutes of Meetings/	TO ALL	TEMPLATE	IF EXIST
	QUALITY GATES	K. Quality Gates/	TO ALL	TEMPLATE	MANDATORY
	RELEASE NOTES	O. Deliverables	TO ALL	TEMPLATE	MANDATORY
	ACCEPTED DELIVERABLES	O. Deliverables	TO ALL	MATRIX	MANDATORY
	CHANGE REQUESTS	I. Change Requests	TO ALL	TEMPLATE	IF EXIST
	PROCUREMENT DOCUMENTS	L. Procurement	TO ALL	TEMPLATE	OPTIONAL
CLOSING	**LESSONS LEARNED**	M. Lessons Learned	INTERNAL	TEMPLATE	MANDATORY
	CLOSE PROCUREMENTS	L. Procurement	TO ALL	TEMPLATE	OPTIONAL
	CLOSE PROJECT	P. Project Acceptance	TO ALL	TEMPLATE	MANDATORY

Table 12: List of Documents in project Type I

10.4.2 List of Documents in Type II Projects

The initiating process in type II projects also produces the project charter and the contract documents same as in type I. The contents of those documents here may be more detailed than in the previous case. An additional document that can be created in this type of projects is the stakeholder management strategy, which is an internal document and describes what actions or what approach may the project manager and the project team use in order to manage external stakeholder expectations. However, this is an optional document and it is not necessary for all the projects.

Moving to the planning process, the project scorecard is, same as in type I, the first document to be created. The forthcoming documents are the various management plans. In type II projects, the management plan document should be more detailed as far as the subsidiary plans are concerned. For this reason, instead of adding them as chapters in the project management plan document separated standalone documents are created. Such subsidiary plans are the risk management and the quality

management plan. All the rest management plans may be included in the project management plan as chapters. These documents are mandatory except the procurement management plan, which also in this type is optional. Furthermore, the risk register, the technical and financial offers are three additional mandatory documents that need to be created in the planning phase. The risk register is a matrix, which includes all the possible identified risks that can occur during the project management process and in the project implementation as well. The rest of the process groups create the same documents as those of the type I. On the following table, all the documents and their additional characteristics that need to be produced whenever a type II project is to be implemented are presented.

PROCESS GROUP	DOCUMENT NAME	PROJECT FOLDER PATH	AVAILABILITY	DOCUMENT TYPE	PRIORITY
INITIATING	**PROJECT CHARTER**	D. Project Charter/	TO ALL	TEMPLATE	MANDATORY
	STAKEHOLDER MANAGEMENT STRATEGY	D. Project Charter/	INTERNAL	TEMPLATE	OPTIONAL
	CONTRACT	C. Contract/	TO ALL	TEMPLATE	MANDATORY
PLANNING	**PROJECT SCORECARD**	0. Softcom-Internal/	INTERNAL	TEMPLATE	MANDATORY
	PROJECT MP	E. Management Plans/	TO ALL	PLAN DOCUMENT	MANDATORY
	QUALITY MP	E. Management Plans/	TO ALL	PLAN DOCUMENT	MANDATORY
	PROCUREMENT MP	E. Management Plans/	TO ALL	PLAN DOCUMENT	OPTIONAL
	RISK MP	E. Management Plans/	TO ALL	PLAN DOCUMENT	MANDATORY
	RISK REGISTER	F. Risk Register	TO ALL	MATRIX	MANDATORY
	ACTIVITY ATTRIBUTES	0. Softcom-Internal/	INTERNAL	TEMPLATE	OPTIONAL
	ACTIVITY LISTS	0. Softcom-Internal/	INTERNAL	TEMPLATE	OPTIONAL
	BASIS OF ESTIMATES	0. Softcom-Internal/	INTERNAL	TEMPLATE	OPTIONAL
	WORK BREAKDOWN STRUCTURE	0. Softcom-Internal/	INTERNAL	TEMPLATE	MANDATORY
	TECHNICAL OFFER	B. Softcom-Int Offer/B.1 Technical Offer/	TO ALL	PLAN DOCUMENT	MANDATORY
	FINANCIAL OFFER	B. Softcom-Int Offer/B.1 Financial Offer/	TO ALL	PLAN DOCUMENT	MANDATORY
EXECUTING	**PROJECT STATUS REPORTS**	H. Status Reports/	TO ALL	TEMPLATE	MANDATORY
	INTERNAL STATUS REPORTS	0. Softcom-Internal/Internal status reports/	INTERNAL	TEMPLATE	MANDATORY
	PROCUREMENT CONTRACT AWARD	L. Procurement	TO ALL	TEMPLATE	OPTIONAL
M&C	**ROOT CASE ANALYSIS**	J. Issue Reports/	TO ALL	TEMPLATE	IF EXIST
	PROJECT COST PERFORMANCE	H. Status Reports/	INTERNAL	TEMPLATE	OPTIONAL
	PROJECT SCHEDULE PERFORMANCE	H. Status Reports/	INTERNAL	TEMPLATE	OPTIONAL

	ISSUE REPORT	J. Issue Reports/	TO ALL	TEMPLATE	IF EXIST
	MINUTES OF MEETINGS	G. Minutes of Meetings/	TO ALL	TEMPLATE	MANDATORY
	QUALITY GATES	K. Quality Gates/	TO ALL	TEMPLATE	MANDATORY
	RELEASE NOTES	O. Deliverables	TO ALL	TEMPLATE	MANDATORY
	ACCEPTED DELIVERABLES	O. Deliverables	TO ALL	MATRIX	MANDATORY
	CHANGE REQUESTS	I. Change Requests	TO ALL	TEMPLATE	IF EXIST
	PROCUREMENT DOCUMENTS	L. Procurement	TO ALL	TEMPLATE	OPTIONAL
CLOSING	**LESSONS LEARNED**	M. Lessons Learned	INTERNAL	TEMPLATE	MANDATORY
	CLOSE PROCUREMENTS	L. Procurement	TO ALL	TEMPLATE	OPTIONAL
	CLOSE PROJECT	P. Project Acceptance	TO ALL	TEMPLATE	MANDATORY

Table 13: List of Documents in project Type II

10.4.3 List of Documents in Type III Projects

Type III projects are the most demanding among the possible types of projects undertaken by Softcom-Int. Both complexity (in the vast majority of the cases) and the volume are high, which means that they need special attention in order to ensure the successful execution. For this reason, Softcom-Int's policy clarifies that all processes that PMBOK suggests, shall be followed during the project execution. This also means that this type should have the biggest amount of produced documents. Thus better handling on the project is ensured and also the possibility of negative impact due to missing controls is decreased.

The initiating process produces the same three documents as in the previous two types. The mandatory documents of project charter and contract as well as the optional one of the stakeholder management strategy are created. Nevertheless differentiation exists in the planning process. In type III there is no project management plan document. Instead, a project management plan folder must be created, in which all the applicable management plans should be included. Thus, apart from the project scorecard, the planning process would also require the human resource plan document, the requirements management plan document, the process improvement management plan and the rest of the plans as it is depicted in the following table. By paying special attention to the various parameters of the project issues may be identified and resolved at an early stage minimizing the negative impact and chain reactions. Besides the management plans, the risk register, the financial and the technical offers are going to be created during the planning process.

In executing, monitoring & controlling and closing process groups, the same documents with the other two types are going to be produced. The Softcom-Int artifacts policy for type III projects is summarized on the following table:

PROCESS GROUP	DOCUMENT NAME	PROJECT FOLDER PATH	AVAILABILITY	DOCUMENT TYPE	PRIORITY
INITIATING	**PROJECT CHARTER**	D. Project Charter/	TO ALL	TEMPLATE	MANDATORY
	STAKEHOLDER MANAGEMENT STRATEGY	D. Project Charter/	INTERNAL	TEMPLATE	OPTIONAL
	CONTRACT	C. Contract/	TO ALL	TEMPLATE	MANDATORY
PLANNING	**PROJECT SCORECARD**	0. Softcom-Internal/	INTERNAL	TEMPLATE	MANDATORY
	REQUIREMENTS MP	E. Management Plans/	TO ALL	PLAN DOCUMENT	MANDATORY
	QUALITY MP	E. Management Plans/	TO ALL	PLAN DOCUMENT	MANDATORY
	HUMAN RESOURCE MP	E. Management Plans/	TO ALL	PLAN DOCUMENT	MANDATORY
	PROCESS IMPROVEMENT MP	E. Management Plans/	TO ALL	PLAN DOCUMENT	MANDATORY
	COMMUNICATION MP	E. Management Plans/	TO ALL	PLAN DOCUMENT	MANDATORY
	RISK MP	E. Management Plans/	TO ALL	PLAN DOCUMENT	MANDATORY
	RISK REGISTER	F. Risk Register	TO ALL	MATRIX	MANDATORY
	SCHEDULE MP	E. Management Plans/	TO ALL	PLAN DOCUMENT	MANDATORY
	COST MP	E. Management Plans/	TO ALL	PLAN DOCUMENT	MANDATORY
	SCOPE MP	E. Management Plans/	TO ALL	PLAN DOCUMENT	MANDATORY
	PROCUREMENT MP	E. Management Plans/	TO ALL	PLAN DOCUMENT	MANDATORY
	CONFIGURATION MP	E. Management Plans/	TO ALL	PLAN DOCUMENT	MANDATORY
	CHANGE MP	E. Management Plans/	TO ALL	PLAN DOCUMENT	MANDATORY
	ACTIVITY ATTRIBUTES	0. Softcom-Internal/	INTERNAL	TEMPLATE	OPTIONAL
	ACTIVITY LISTS	0. Softcom-Internal/	INTERNAL	TEMPLATE	OPTIONAL
	BASIS OF ESTIMATES	0. Softcom-Internal/	INTERNAL	TEMPLATE	OPTIONAL
	WORK BREAKDOWN STRUCTURE	0. Softcom-Internal/	INTERNAL	TEMPLATE	MANDATORY
	TECHNICAL OFFER	B. Softcom-Int Offer/B.1 Technical Offer/	TO ALL	PLAN DOCUMENT	MANDATORY
	FINANCIAL OFFER	B. Softcom-Int Offer/B.1 Financial Offer/	TO ALL	PLAN DOCUMENT	MANDATORY
EXECUTING	**PROJECT STATUS REPORTS**	H. Status Reports/	TO ALL	TEMPLATE	MANDATORY
	INTERNAL STATUS REPORTS	0. Softcom-Internal/Internal status reports/	INTERNAL	TEMPLATE	MANDATORY
	PROCUREMENT CONTRACT AWARD	L. Procurement	TO ALL	TEMPLATE	OPTIONAL
M&C	**ROOT CASE ANALYSIS**	J. Issue Reports/	TO ALL	TEMPLATE	IF EXIST
	PROJECT COST PERFORMANCE	H. Status Reports/	INTERNAL	TEMPLATE	MANDATORY

	PROJECT SCHEDULE PERFORMANCE	H. Status Reports/	INTERNAL	TEMPLATE	MANDATORY
	ISSUE REPORT	J. Issue Reports/	TO ALL	TEMPLATE	IF EXIST
	MINUTES OF MEETINGS	G. Minutes of Meetings/	TO ALL	TEMPLATE	MANDATORY
	QUALITY GATES	K. Quality Gates/	TO ALL	TEMPLATE	MANDATORY
	RELEASE NOTES	O. Deliverables	TO ALL	TEMPLATE	MANDATORY
	ACCEPTED DELIVERABLES	O. Deliverables	TO ALL	MATRIX	MANDATORY
	CHANGE REQUESTS	I. Change Requests	TO ALL	TEMPLATE	IF EXIST
	PROCUREMENT DOCUMENTS	L. Procurement	TO ALL	TEMPLATE	OPTIONAL
CLOSING	**LESSONS LEARNED**	M. Lessons Learned	INTERNAL	TEMPLATE	MANDATORY
	CLOSE PROCUREMENTS	L. Procurement	TO ALL	TEMPLATE	OPTIONAL
	CLOSE PROJECT	P. Project Acceptance	TO ALL	TEMPLATE	MANDATORY

Table 14: List of Documents in project Type III

11. Conclusion

Projects, especially in the software development industry, are very complicated and their successful implementation depends on various imponderable factors. Finding, describing and analyzing all the involved factors that affect the execution of a project, in other words the project management processes, is a mandatory task, however it is not panacea. Projects can still fail, but the possibilities are dramatically reduced. Many studies have recently shown that projects in every industry, which are implemented using a project management technique or project management tools are more likely to be successful than projects not using any of those techniques.

With the adequate designing of the project management process, the continuous monitoring and controlling of all the project aspects during its implementation as well as the feedback that these processes can provide, the organization can confront with all the project difficulties and manage better the project results. Therefore, it is easily assumed that integrating project management processes within the other processes of the organization can be beneficial for the project execution and the final result for the organization.

However, in order to be able to monitor the project execution and control it as well, throughout its lifecycle, it is very crucial for the various metrics (KPI) of the project processes to be well-defined. This is not an easy task because the metrics that are used for monitoring the project performance are different for each project. The PMBOK includes several rules in defining the metrics in the right way, making it easier for the project managers to control the projects.

As a conclusion, PMBOK is vital for the project implementation and execution. However, there are several other techniques, guidelines and theories about how to handle a project better. Combining them with PMBOK can provide the project manager with additional information and handling tools so as for a project to be successful. Project management is no longer optional, the market demands it.

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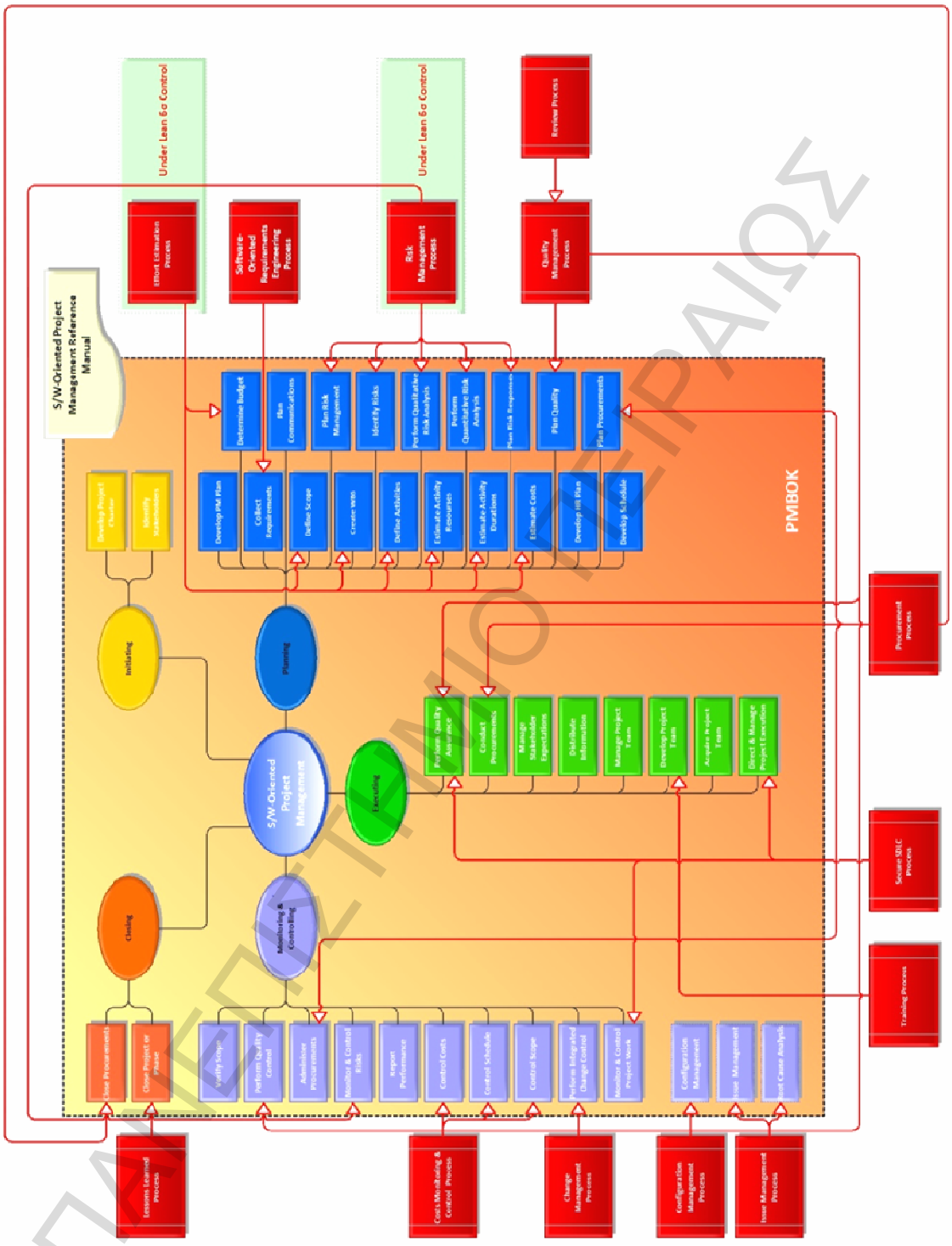
ABBREVIATIONS

BAC	Budget At Completion
BPD	Business Process Diagram
BPMN	Business Process Modeling Notation
B2B	Business to Business
CCPM	Critical Chain Path Management
CPM	Critical Path Management
CEO	Chief Executive Officer
CMMI	Capability Maturity Model integration
CoJ	Court of Justice
COTS	Commercial Of-The-Shell
DIGIT	Directorate-General for Informatics
EAC	Estimation At Completion
EC	European Commission
ECP	European Central Bank
EFQM	European foundation for Quality Management
EP	European Parliament
ERP	Enterprise Resource Planning
EU	European Union
FB	Feeder Buffer
HR	Human Resource
ICT	Information Communication Technology
IFB	Invitation For Bids
IM	Internal Milestones
IP	Internet Protocol
IT	Information Technology
ITIL	Information Technology Infrastructure Library
J2EE	Java Platform Enterprise Edition

KPI	Key Performance Indicators
LPM	Lean Project Management
PB	Project Buffer
PM	Project Milestones
PMBOK	Project Management Body of Knowledge
PMI	Project Management Institute
PMO	Project Management Office
QMS	Quality Management System
RB	Resource Buffer
RFB	Request For Bids
RFP	Request For Proposal
RFQ	Request For Question
RFI	Request For Information
ROI	Return On Investment
RTM	Requirements Traceability Matrix
RUP	Rational Unified Process
RUP@EC	Rational Unified Process at European Commission
R&D	Research & Development
SDLC	Software Development LifeCycles
SIP	Session Initiation Protocol
SLA	Service License Agreement
SMB	Small Medium Business
SOW	Statement Of Work
SPOC	Single Point of Contact
TAXUD	Taxation and Customs Union Directorate-General
TCP	Transmission Control Protocol
TEMPO	Telecommunications Modernization Project
TES	Taxation trans-European System
TPS	Toyota Production System
UAT	User Acceptance Test
UDP	User Datagram Protocol

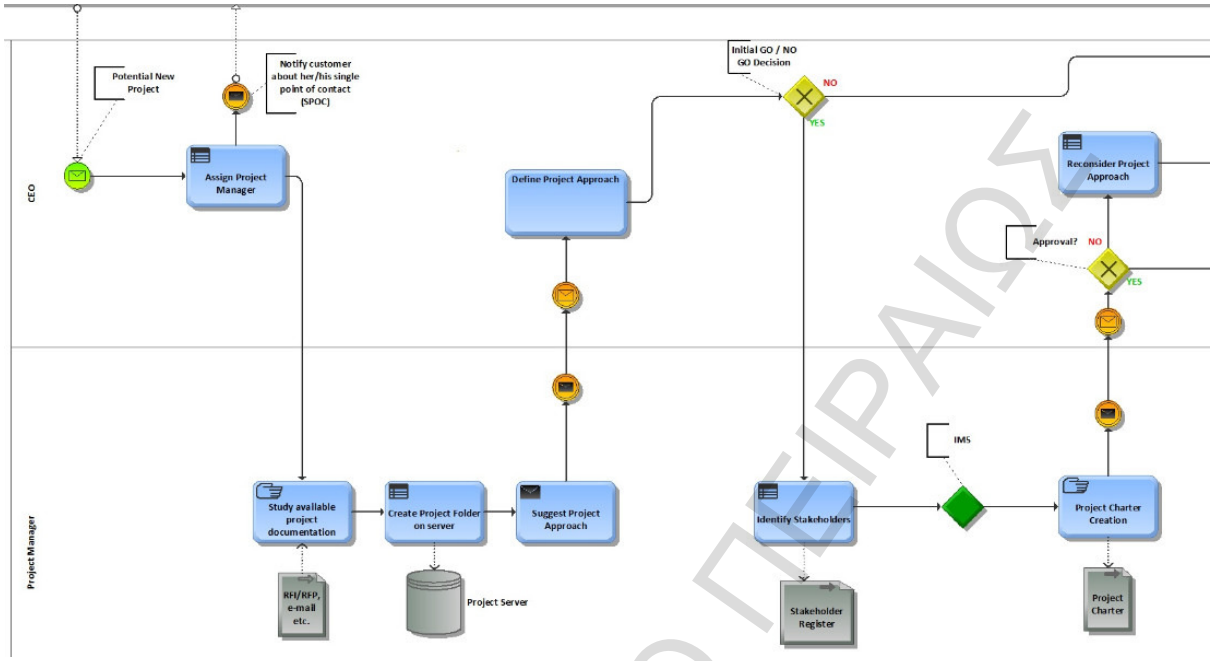
VoIP	Voice over Internet Protocol
WBS	Work Breakdown Structure

APPENDIX A - PICTURES

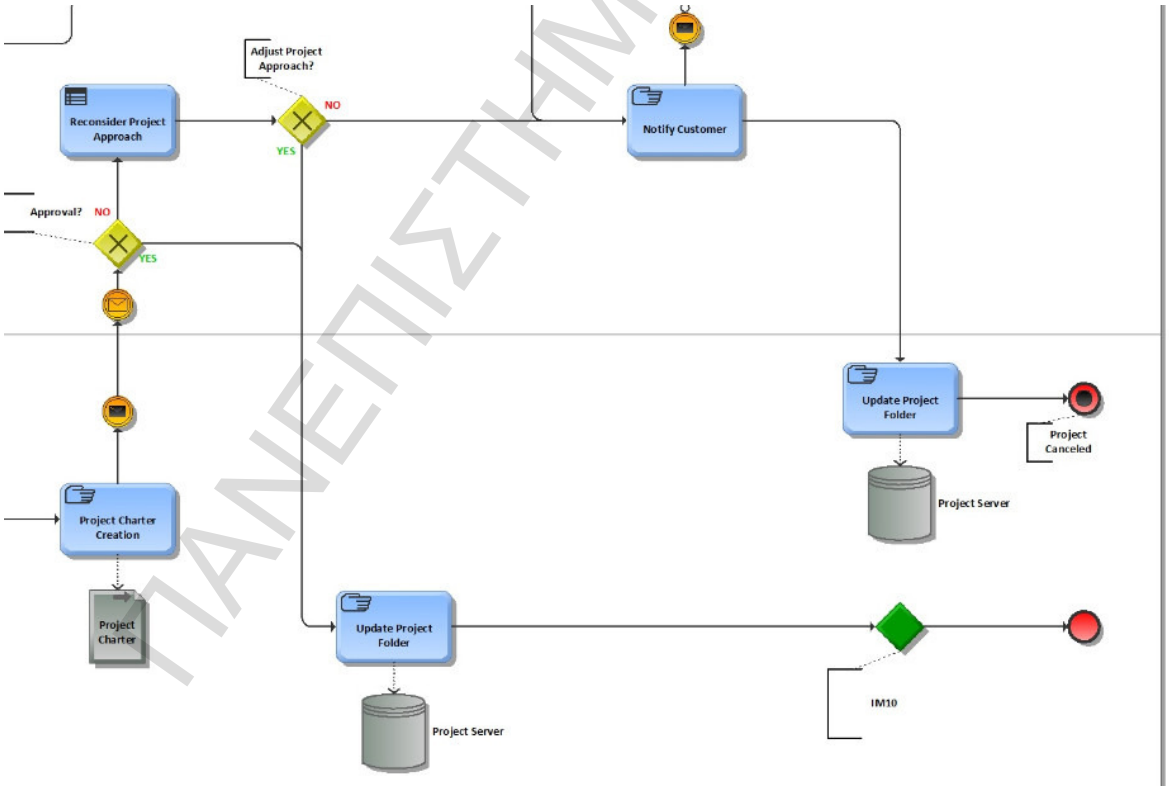


Appendix Figure 1: Softcom-Int's Processes and their relationship with PMBOK processes

Project Feasibility Analysis – Initiation Process Flow

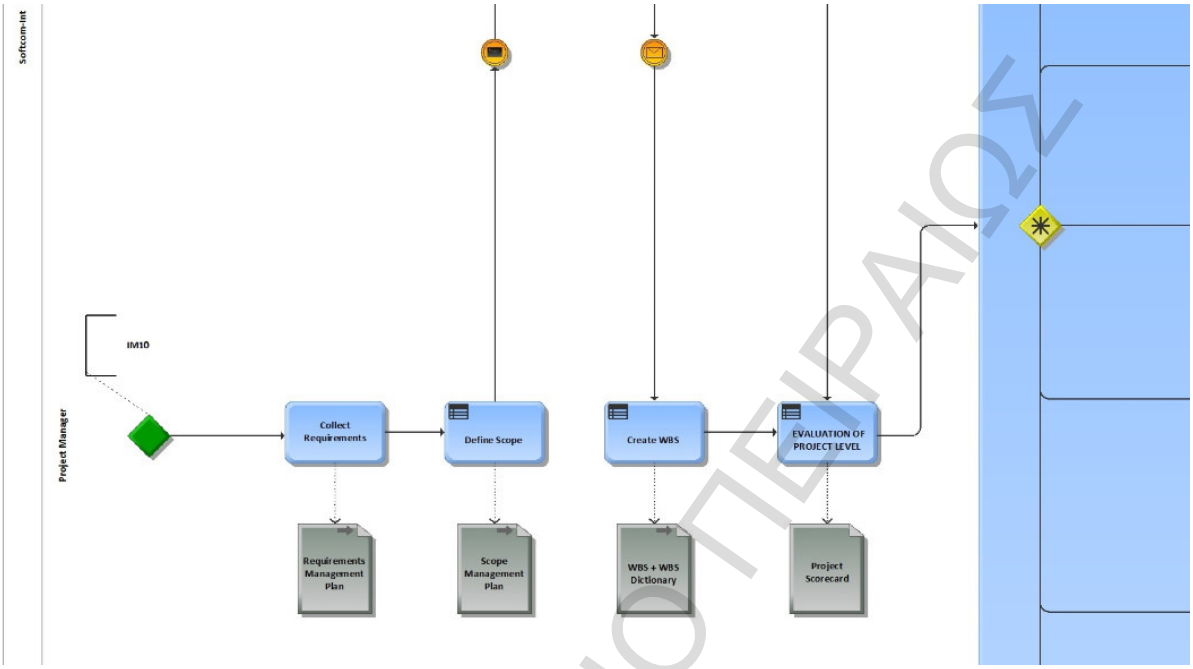


Appendix Figure 2: Project feasibility analysis-Initiation-part 1

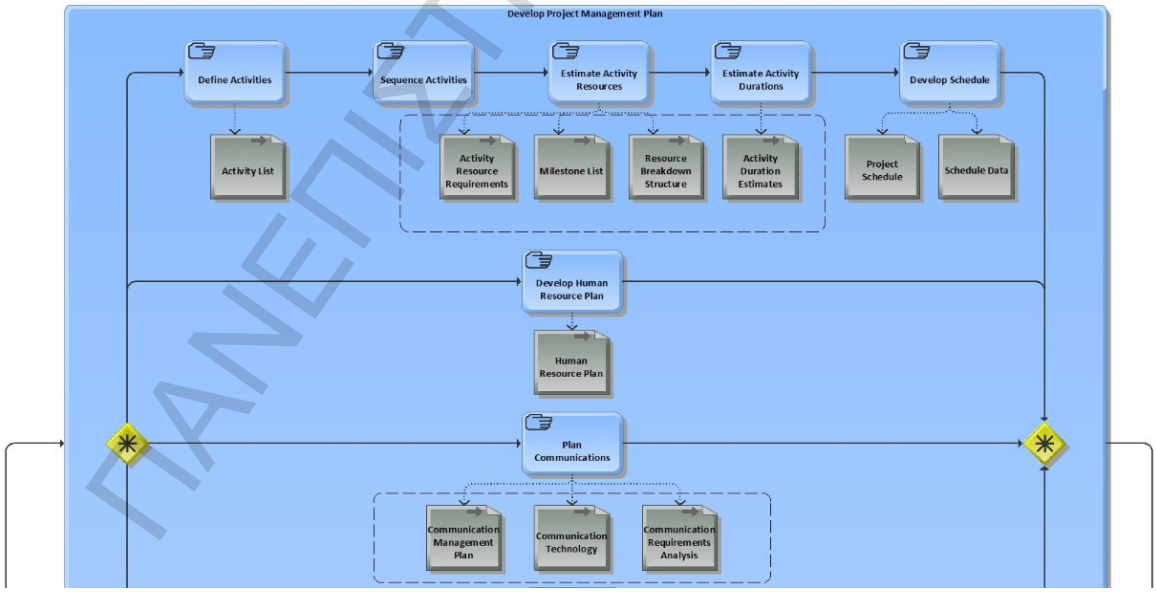


Appendix Figure 3: Project feasibility analysis-Initiation-part 2

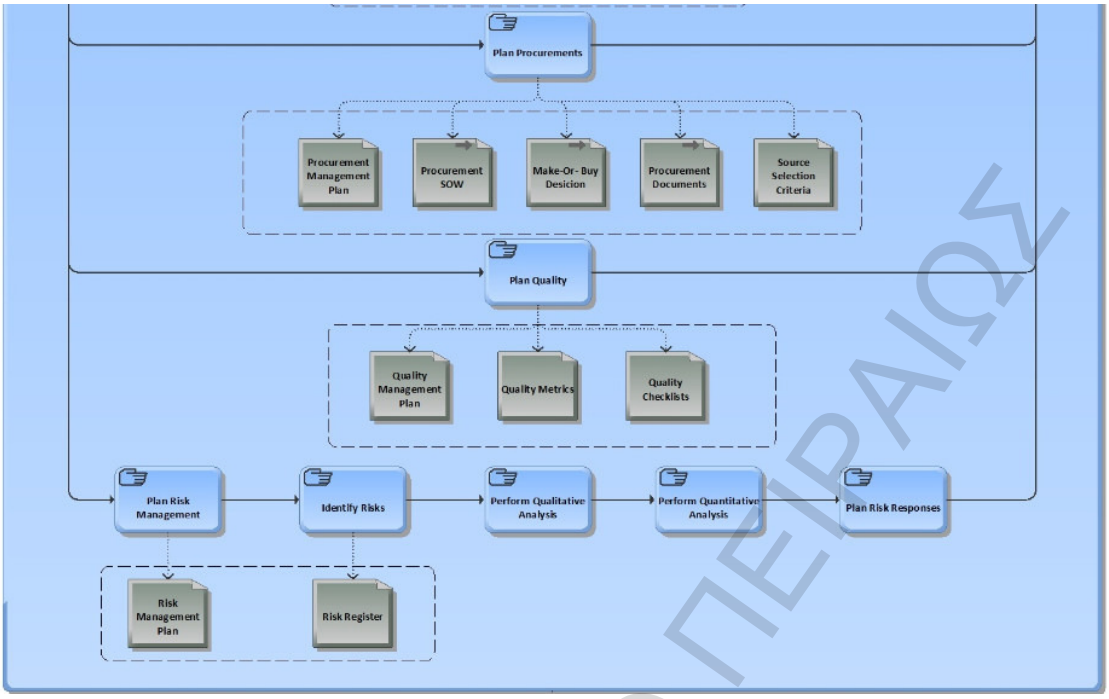
Process Feasibility Analysis – Planning Process Flow



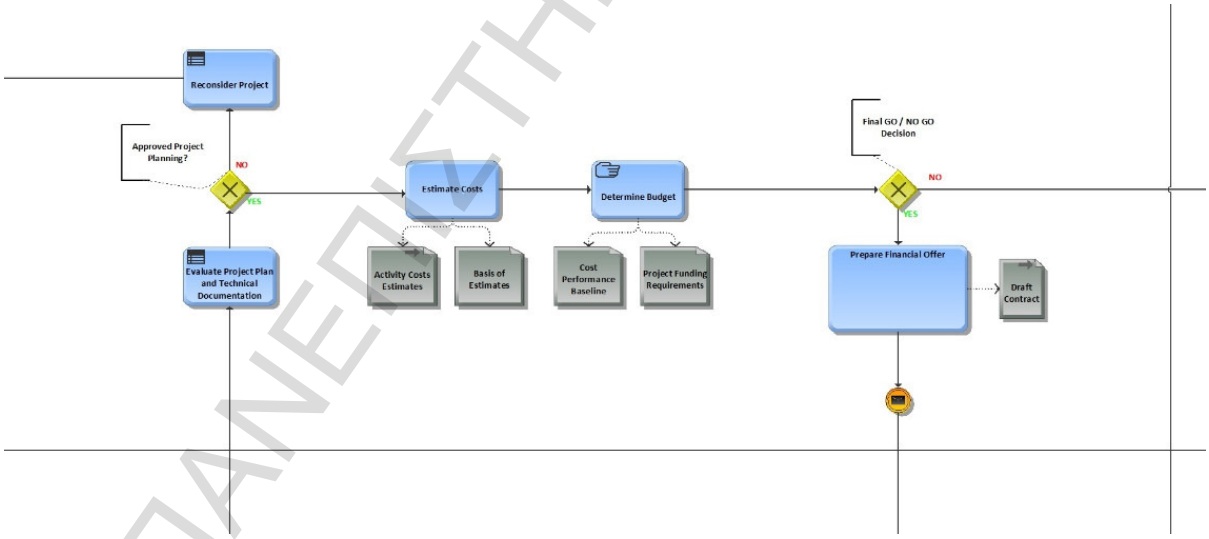
Appendix Figure 4: Project feasibility analysis-Planning-part 1



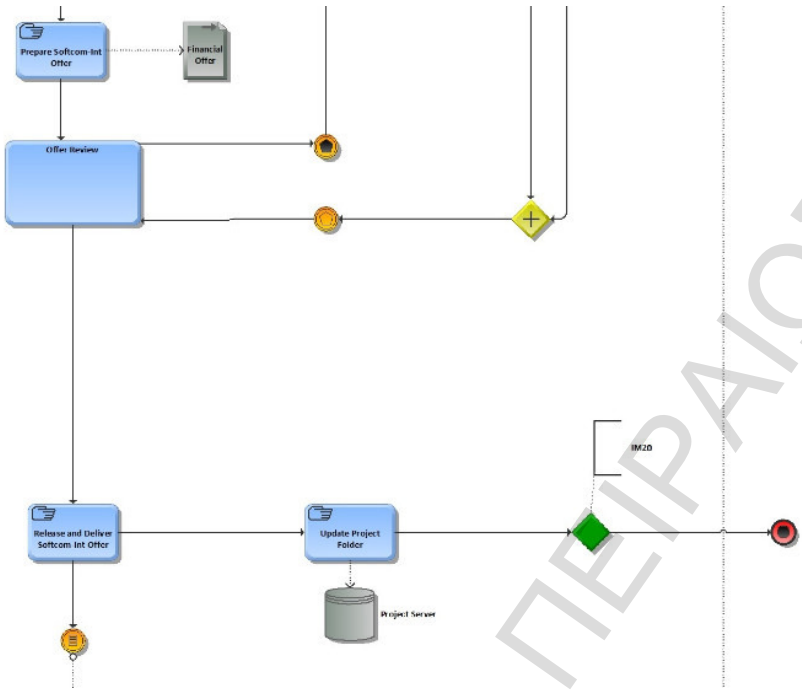
Appendix Figure 5: Project feasibility analysis-Planning-part 2



Appendix Figure 6: Project feasibility analysis-Planning-part 3

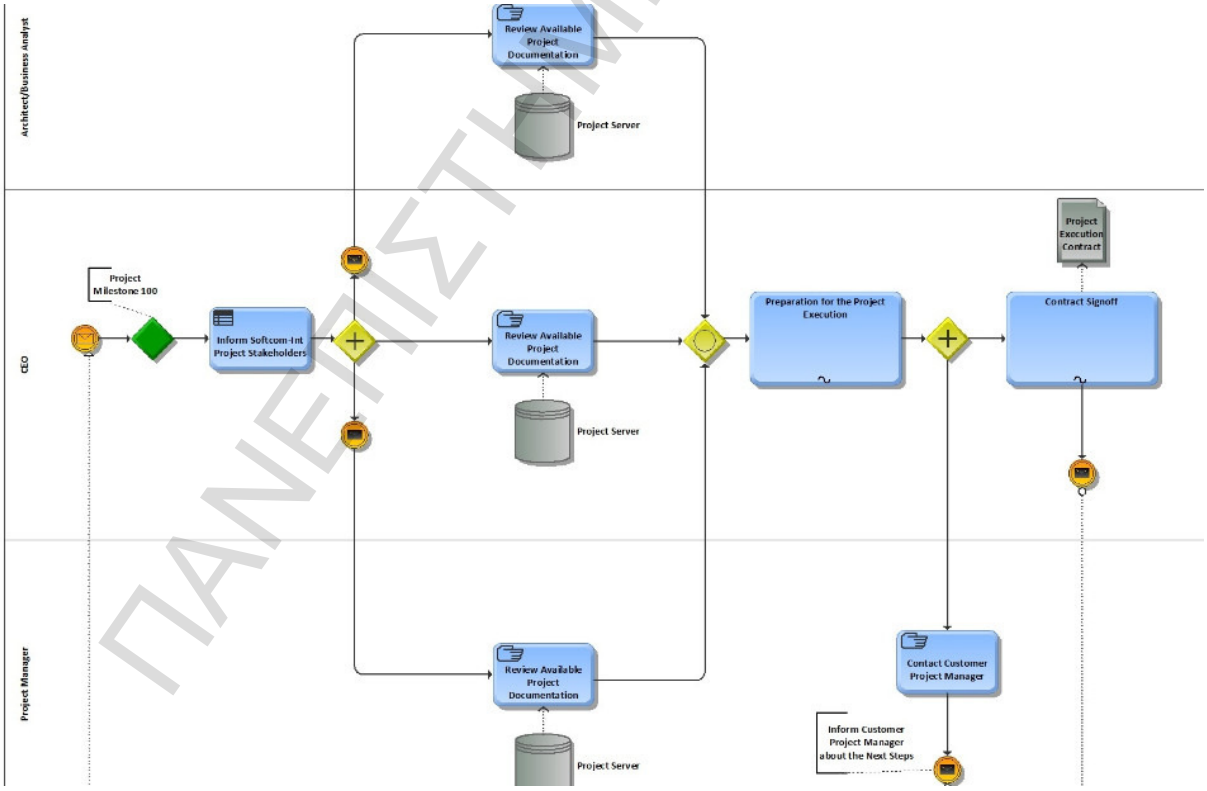


Appendix Figure 7: Project feasibility analysis-Planning-part 4

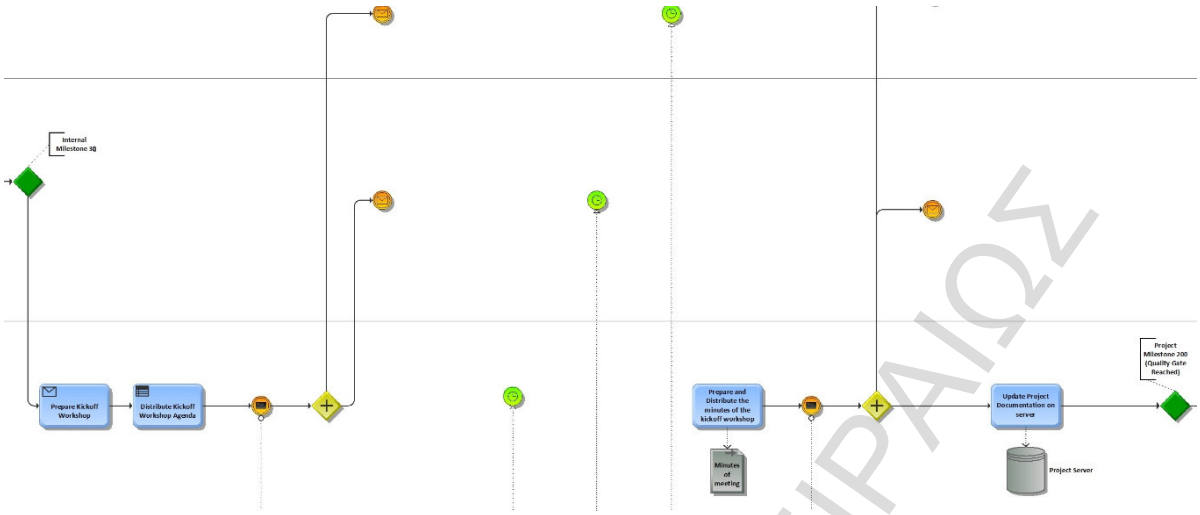


Appendix Figure 8: Project feasibility analysis-Planning-part 5

Project Execution Preparation Process Flow

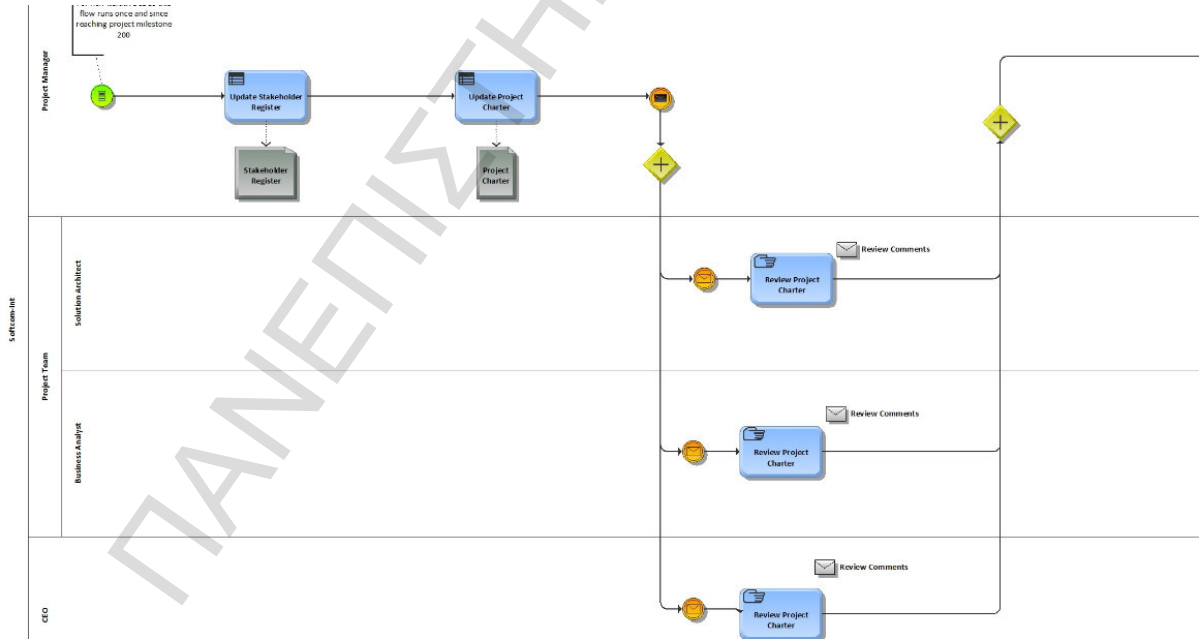


Appendix Figure 9: Project execution process flow- part 1

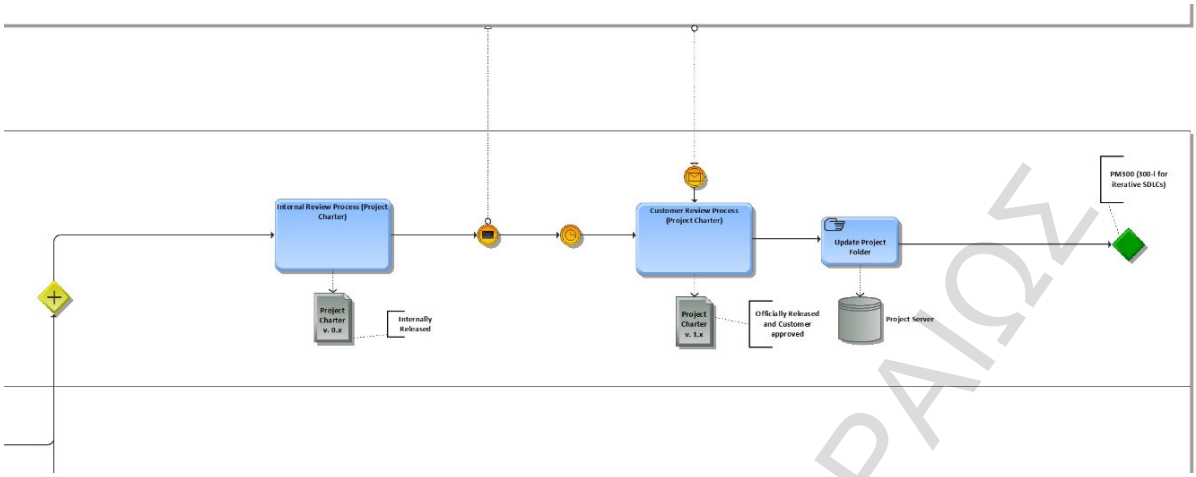


Appendix Figure 10: Project execution process flow- part 2

Phase Initiation Process (Group) Flow

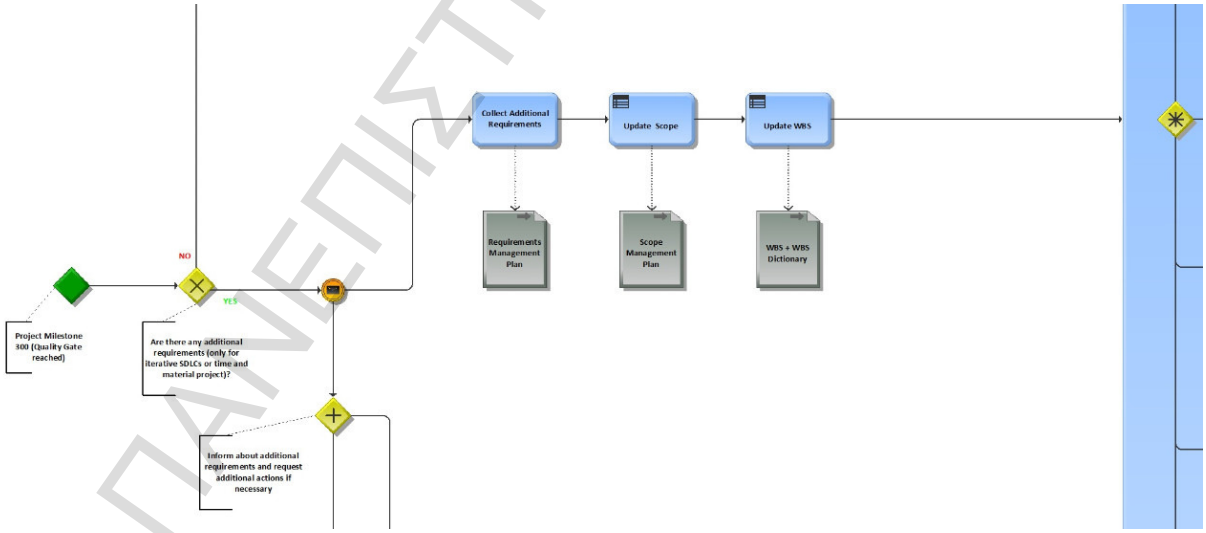


Appendix Figure 11: Phase initiation process flow – part 1

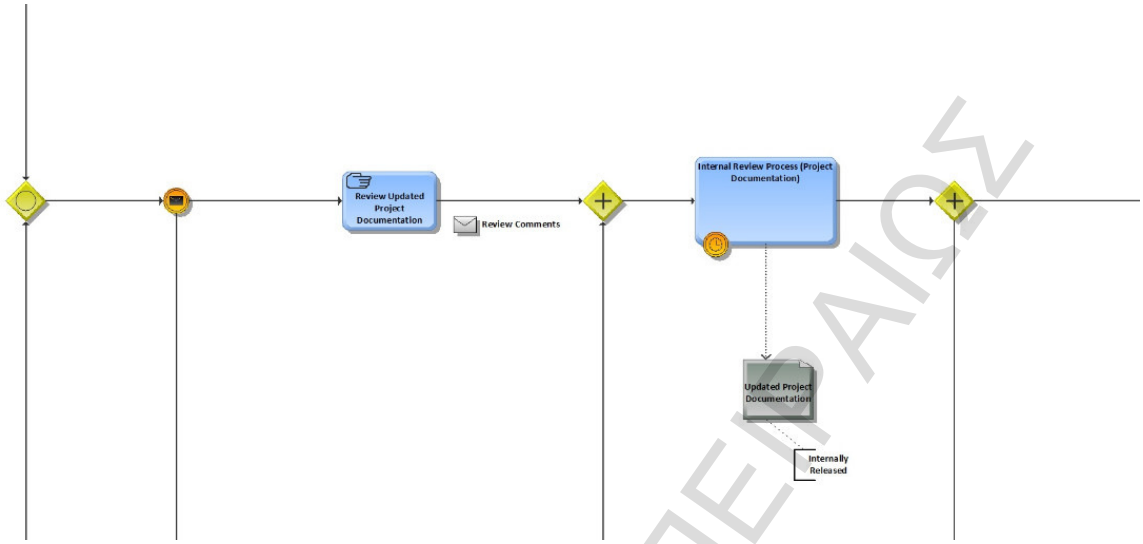


Appendix Figure 12: Phase initiation process flow – part 2

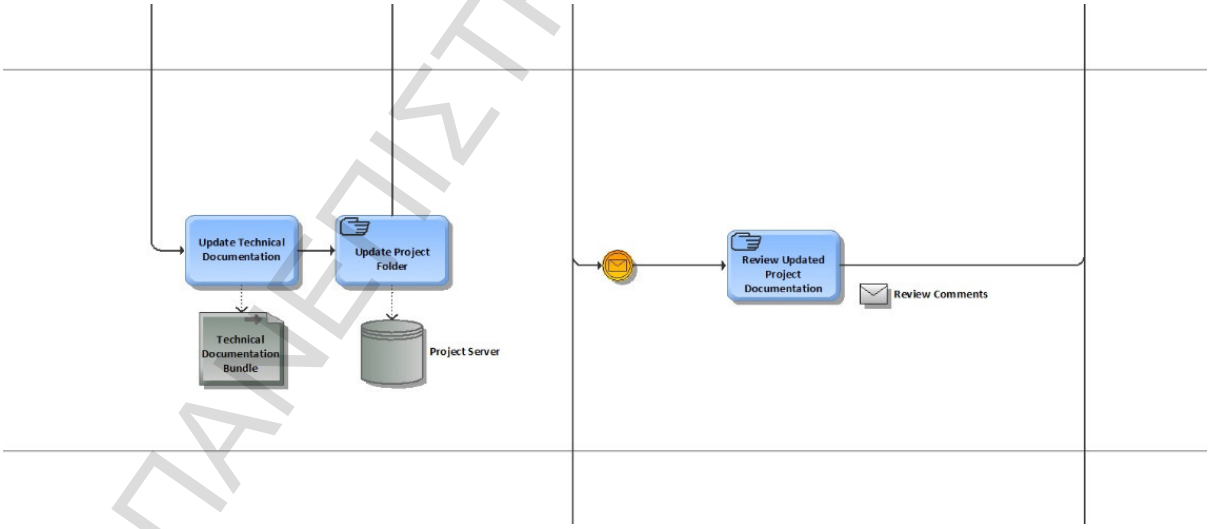
Phase Planning Process (Group) Flow



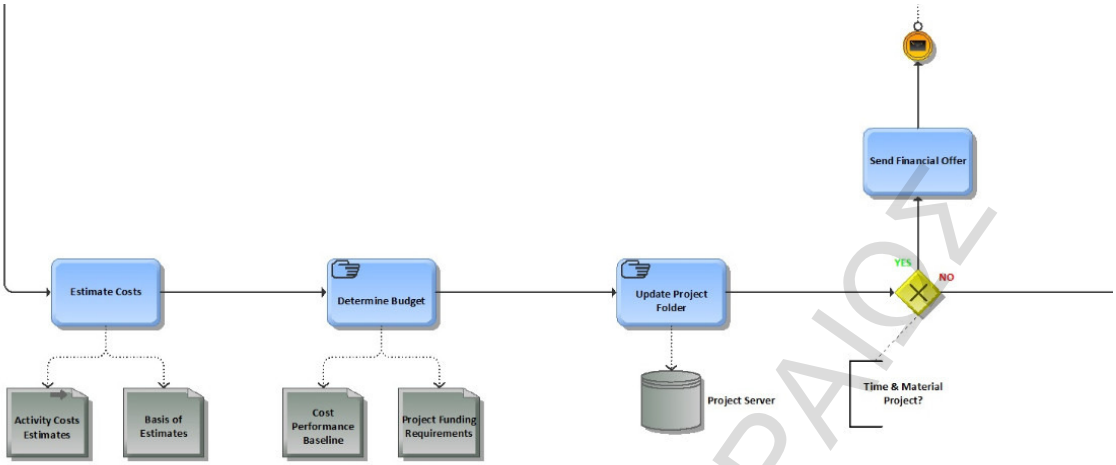
Appendix Figure 13: Phase planning process flow – part 1



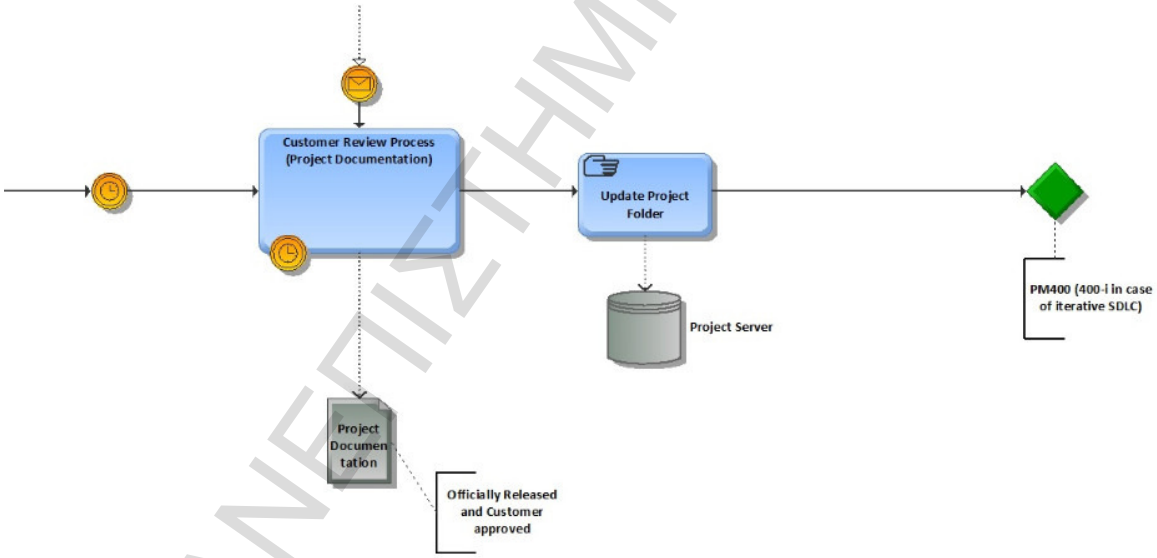
Appendix Figure 14: Phase planning process flow – part 2



Appendix Figure 15: Phase planning process flow – part 3

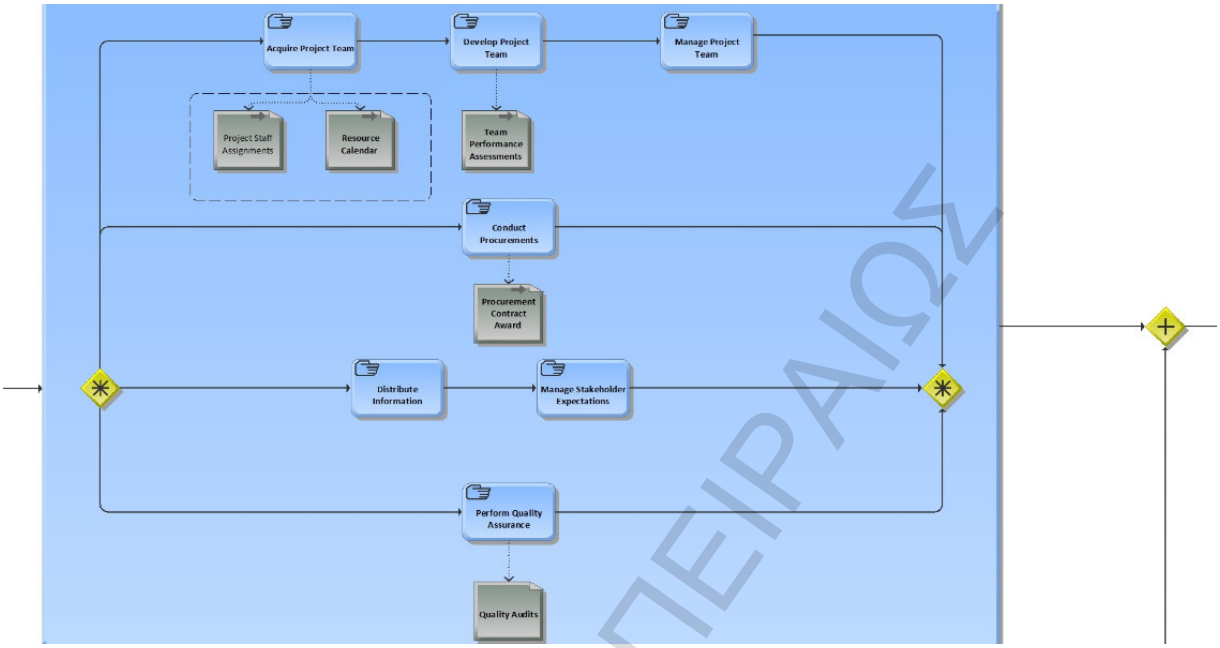


Appendix Figure 16: Phase planning process flow – part 4



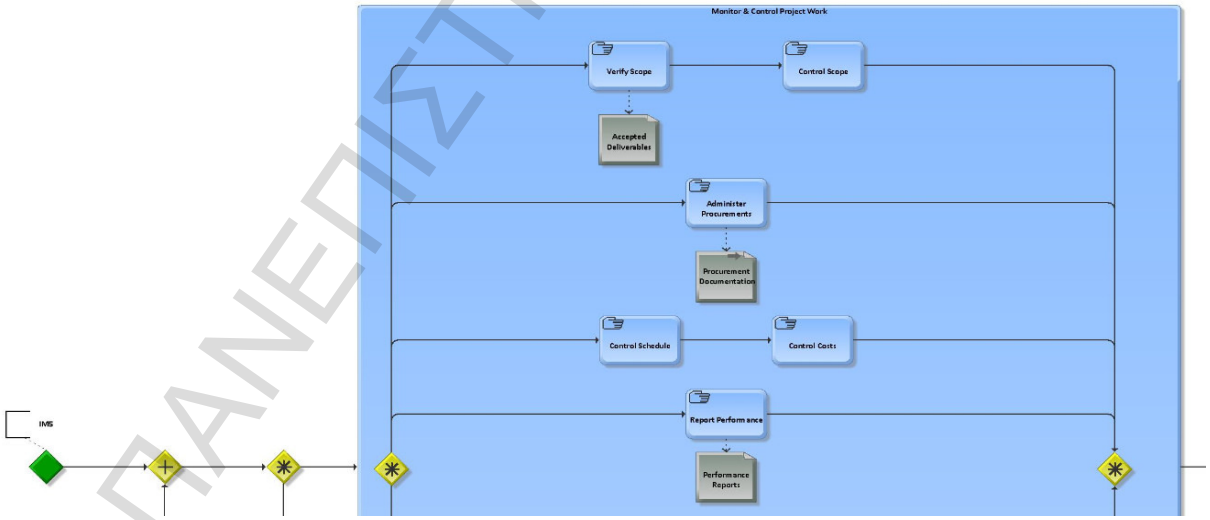
Appendix Figure 17: Phase planning process flow – part 5

Phase Executing Process (Group) Flow

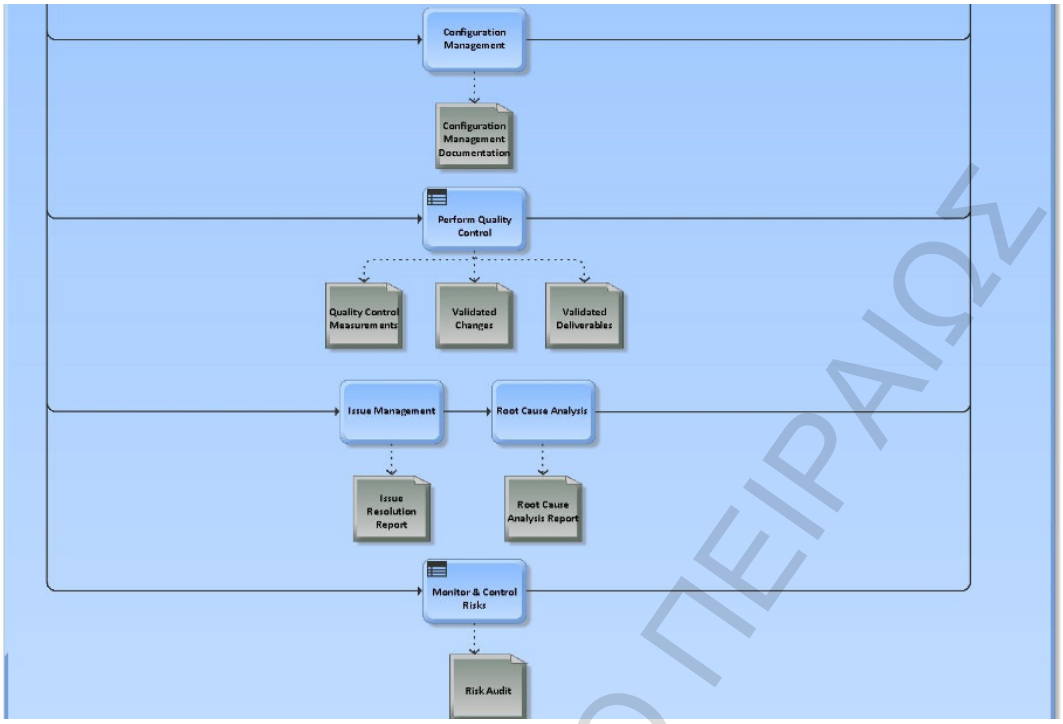


Appendix Figure 18: Phase executing process flow

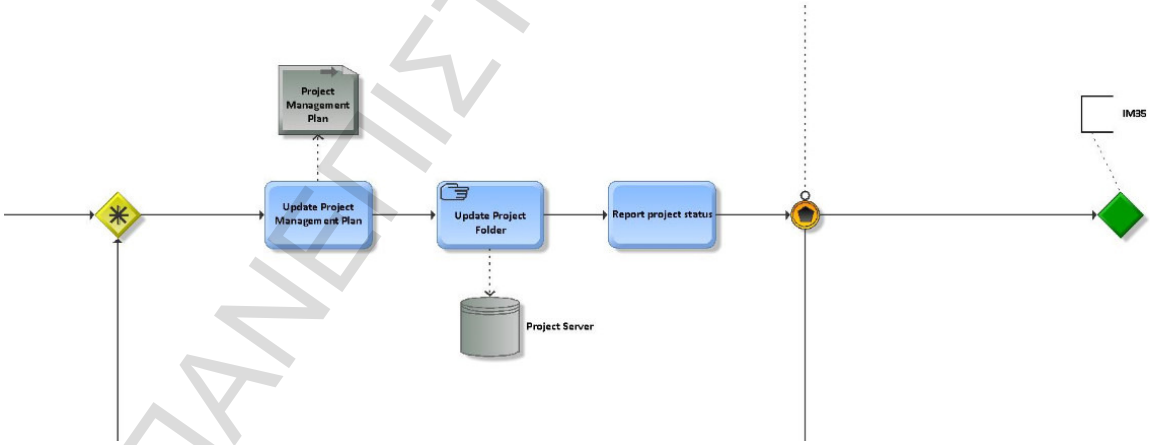
Phase Monitoring and Controlling Process (Group) Flow



Appendix Figure 19: Phase monitoring and controlling process flow – part 1

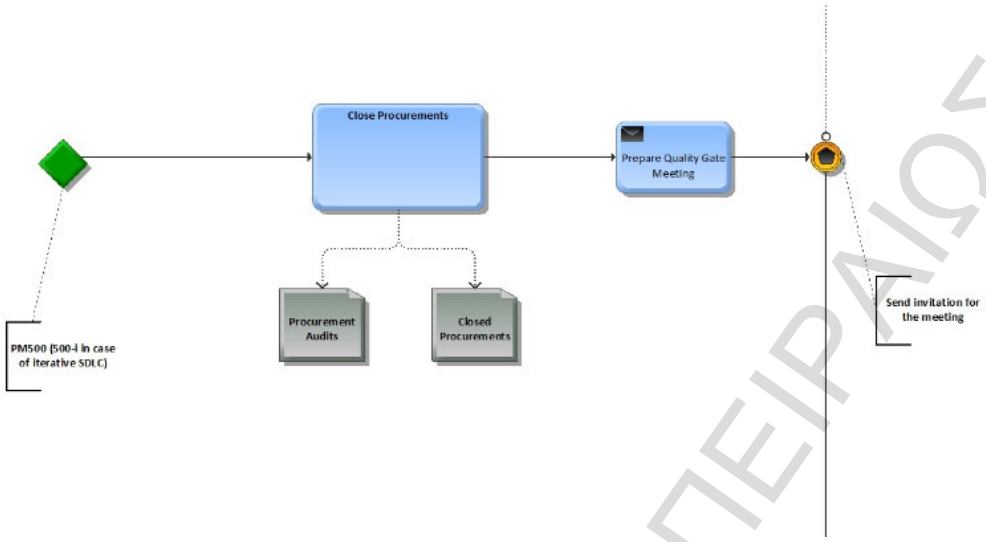


Appendix Figure 20: Phase monitoring and controlling process flow – part 2

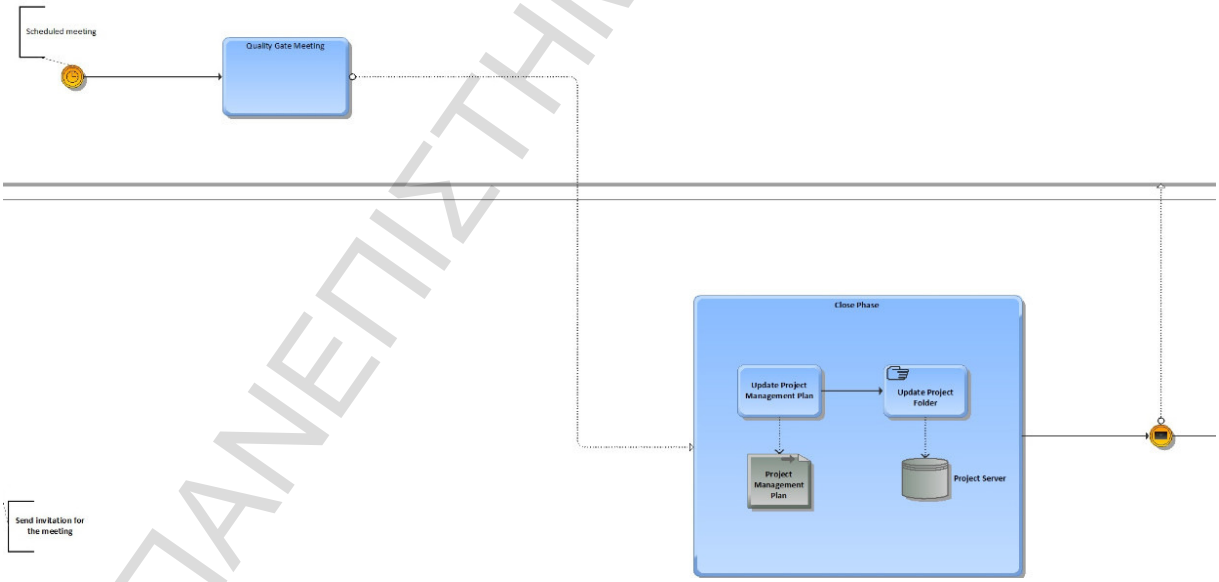


Appendix Figure 21: Phase monitoring and controlling process flow – part 3

Phase Closing Process (Group) Flow

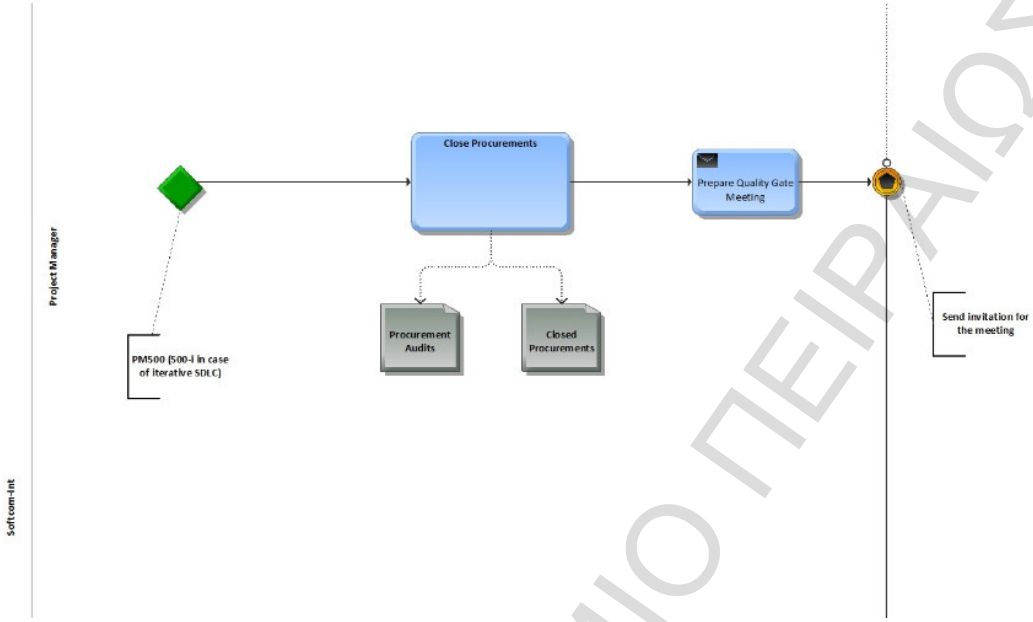


Appendix Figure 22: Phase closing process flow – part 1

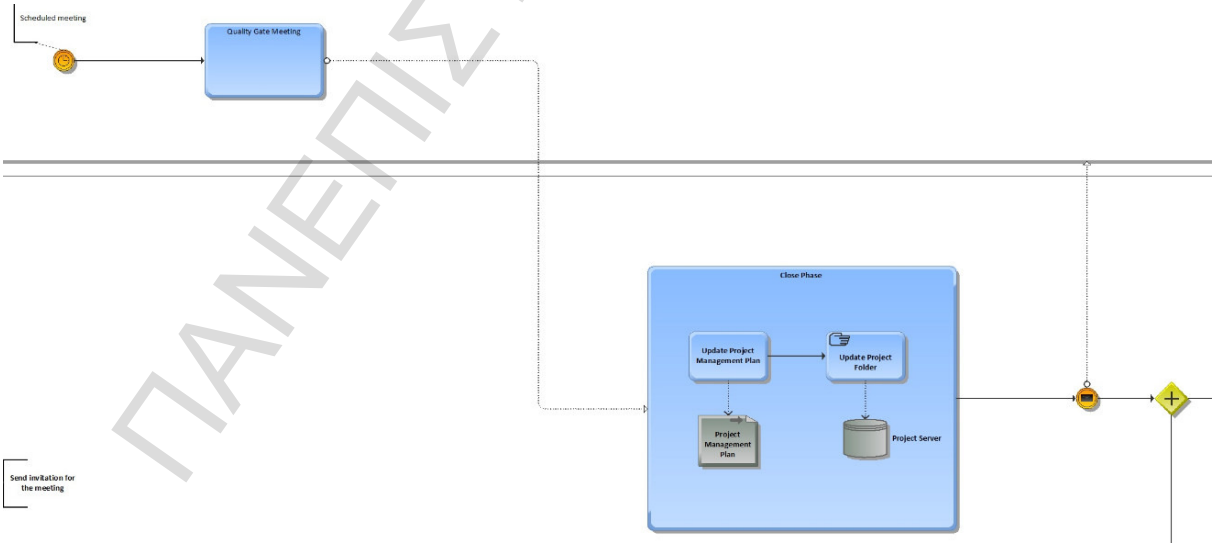


Appendix Figure 23: Phase closing process flow – part 2

Project Closure Process Flow

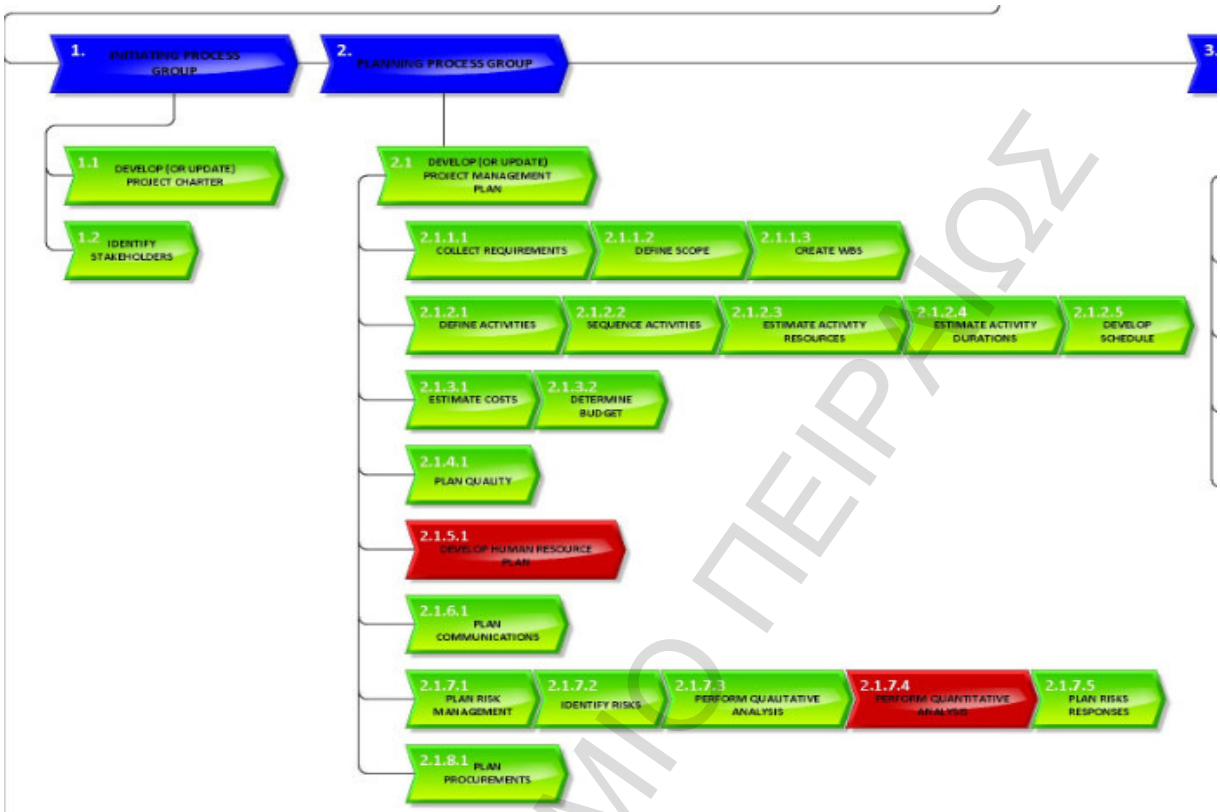


Appendix Figure 24: Project Closure process flow – part 1

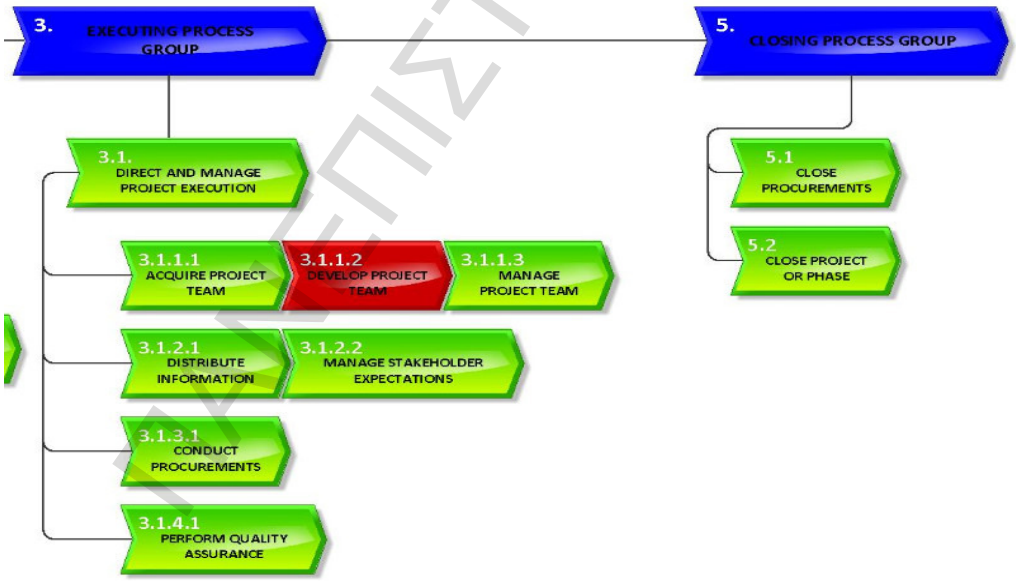


Appendix Figure 25: Project Closure process flow – part 2

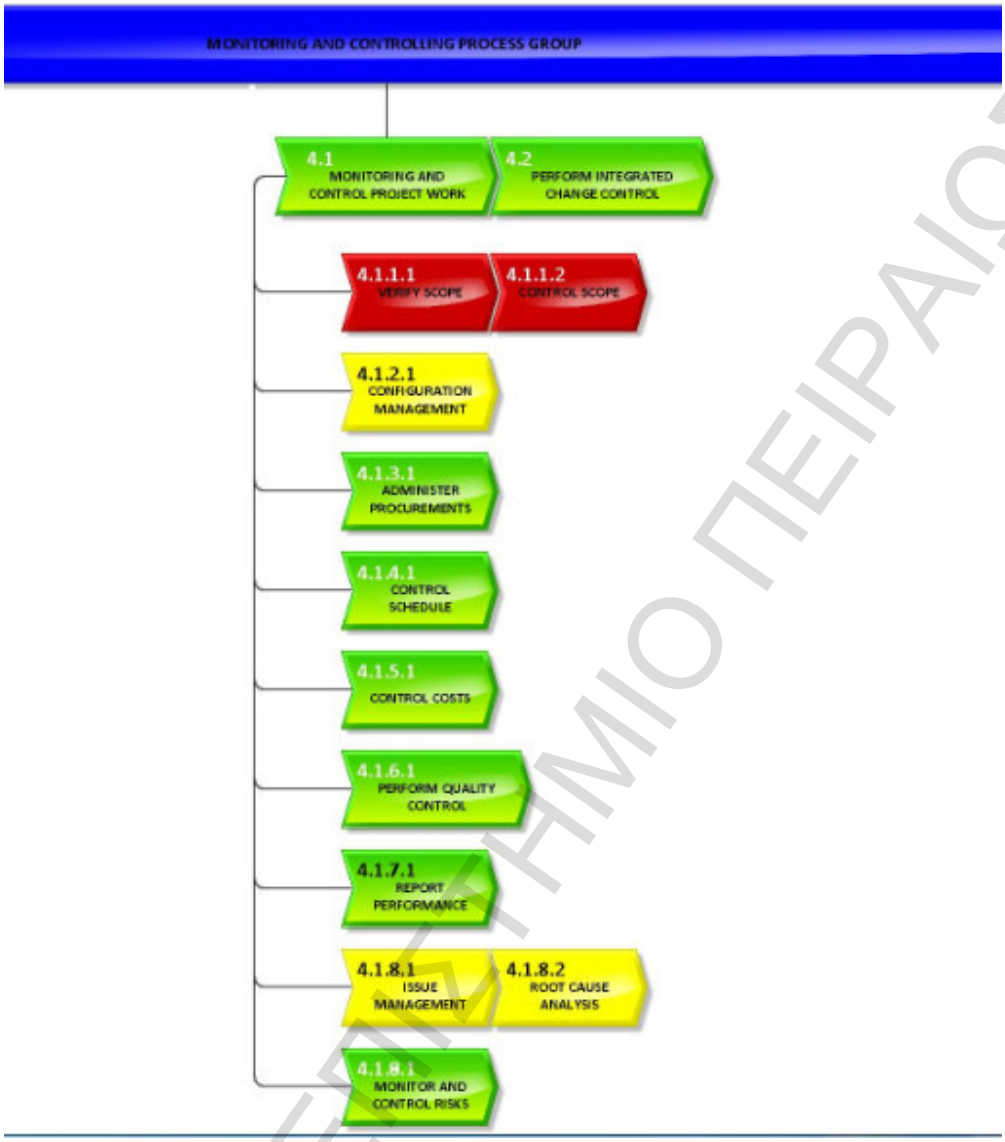
PMBOK at Type I projects



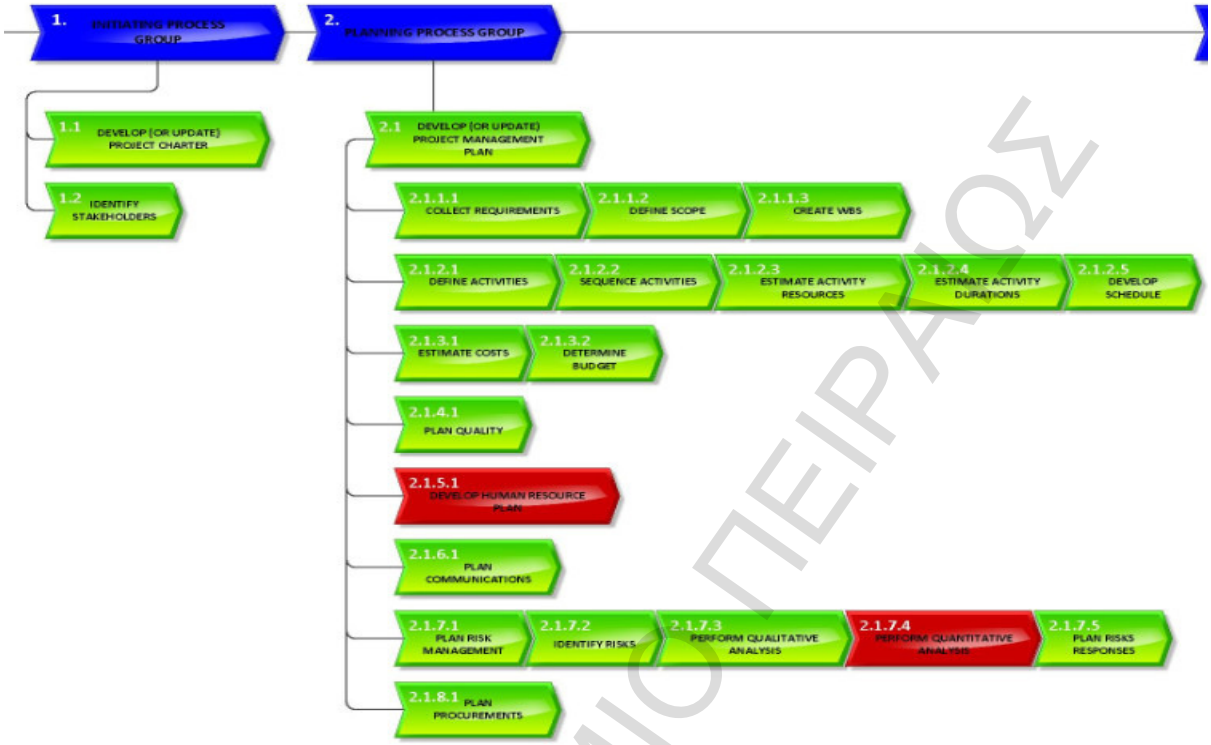
Project Types and PMBOK 1: PMBOK at Type I projects



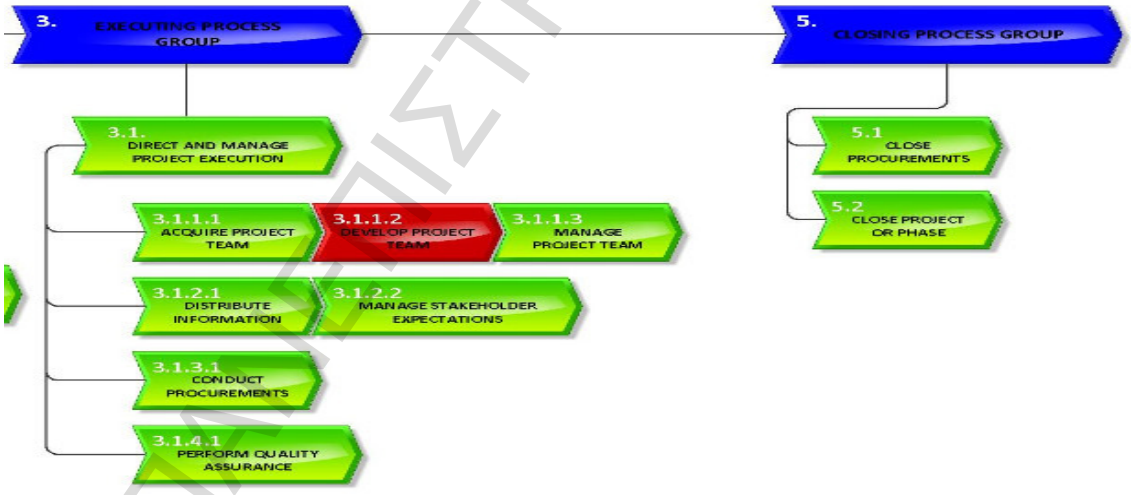
Project Types and PMBOK 2: PMBOK at Type I projects



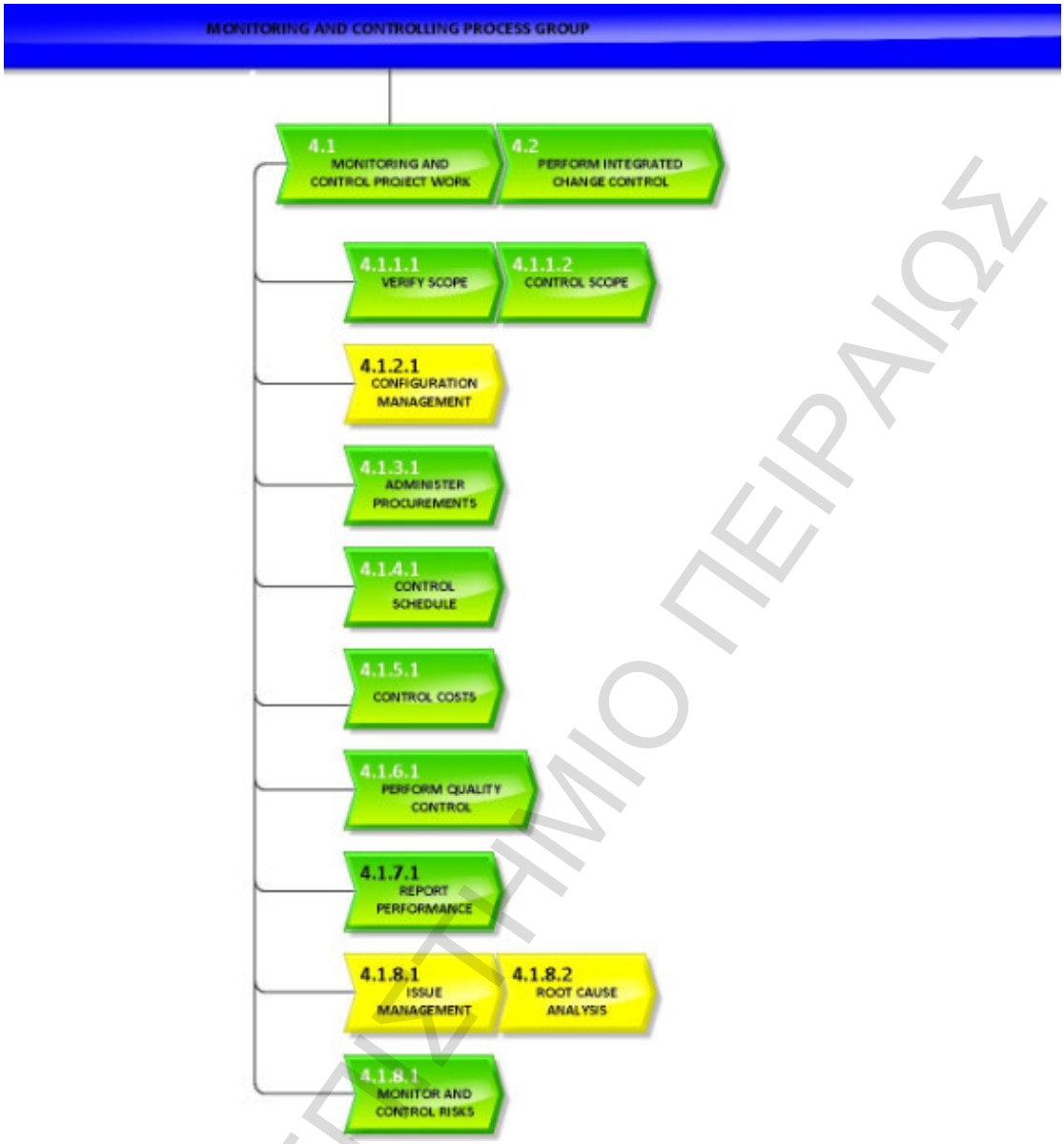
Project Types and PMBOK 3: PMBOK at Type I projects



Project Types and PMBOK 4: PMBOK at Type II projects

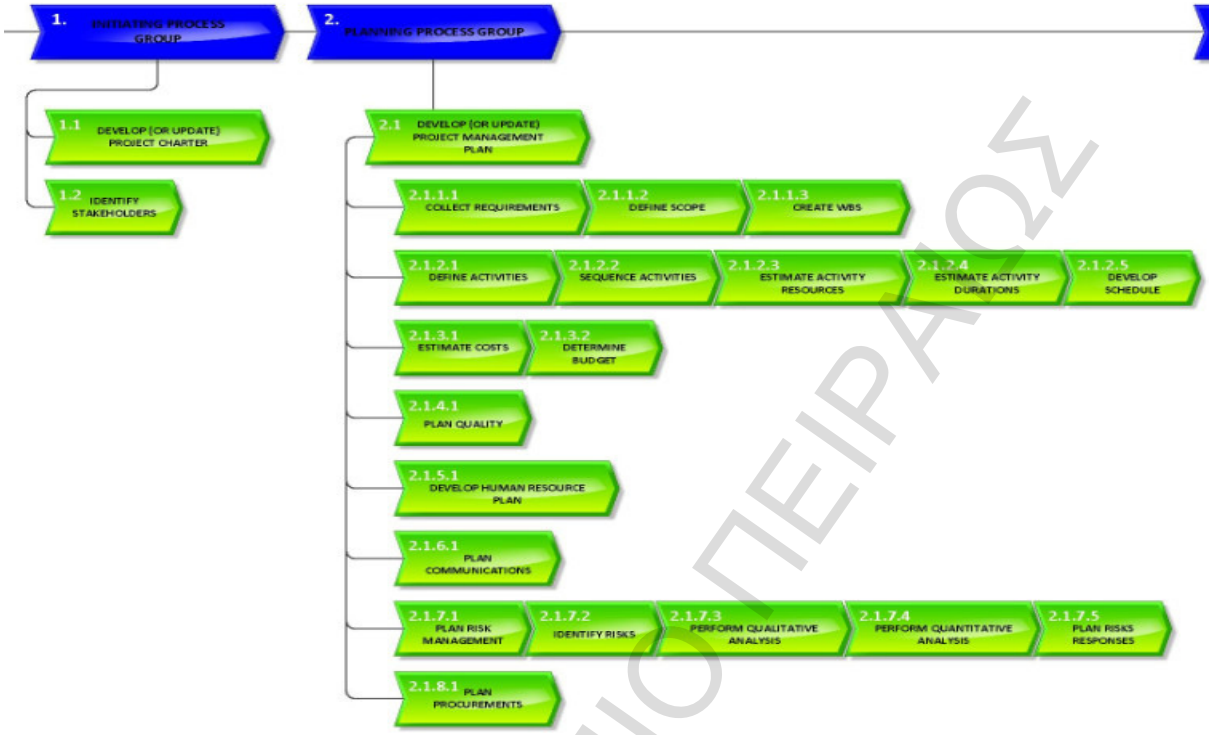


Project Types and PMBOK 5: PMBOK at Type II projects

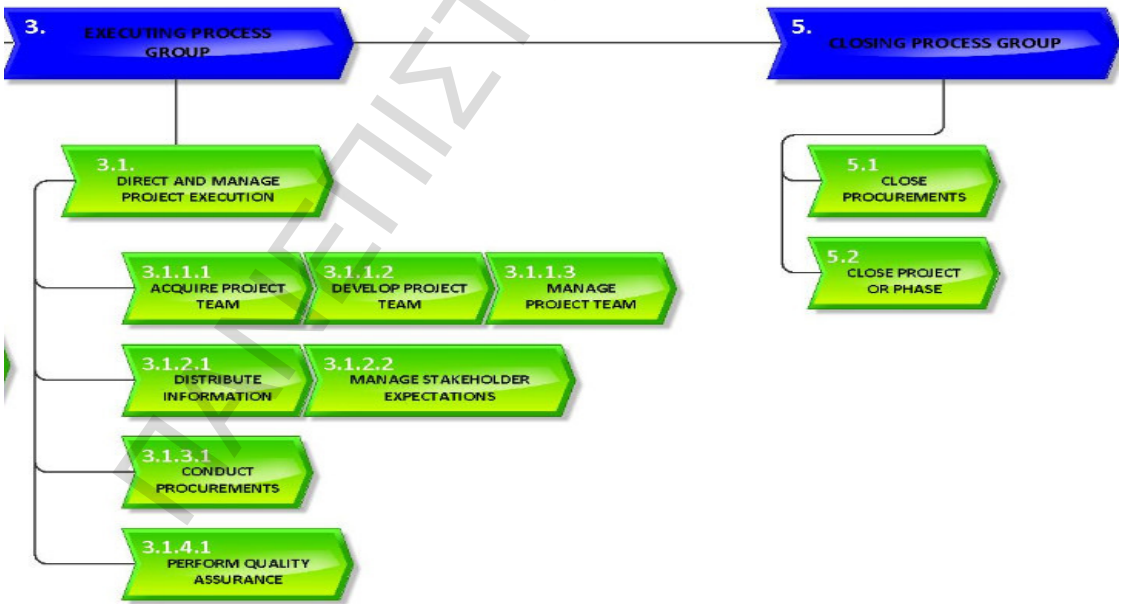


Project Types and PMBOK 6: PMBOK at Type II projects

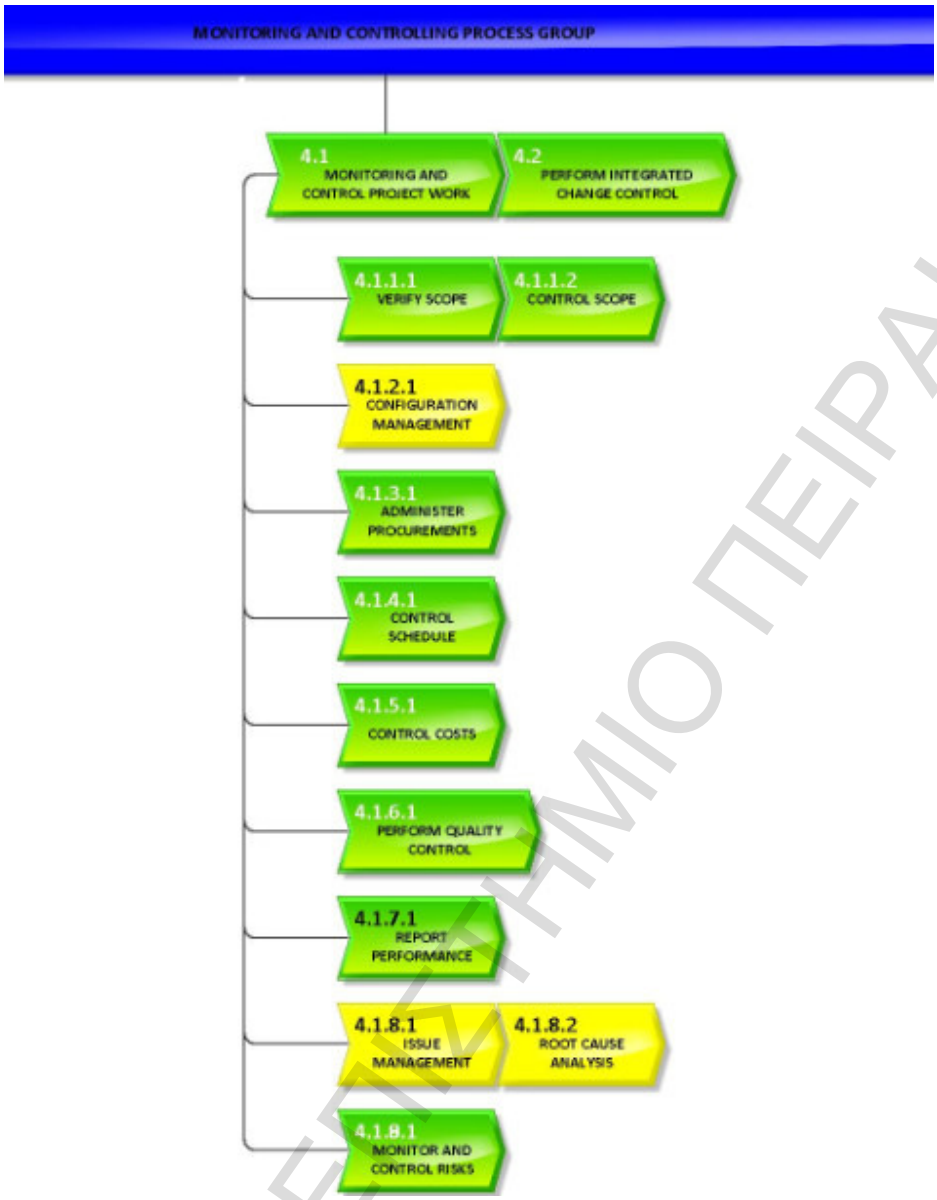
PMBOK in Type III projects



Project Types and PMBOK 7: PMBOK at Type III projects



Project Types and PMBOK 8: PMBOK at Type III projects



Project Types and PMBOK 9: PMBOK at Type III projects

APPENDIX B – DOCUMENTATION TEMPLATES

During this thesis, there were designed four project management processes. This Appendix contains the Project Cost control Process and the Project Effort Estimation Process.

As it was previously stated, based on this thesis, 35 documents were created for the project management process of Softcom-Int. 12 of these documents are management plans and the rest 23 are for general project management activities. In Appendix B two general documents and one management plan is included. Those are the Project Charter and the Project Scorecard and the cost management plan. All the other documents are included in the CD.