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TESIS

A GUIDELINE TO IMPLEMENT THE "PROCESS MANAGEMENT" OF MOPROSOFT

PRESENTA

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Sin otro particular me permito saludarle muy afectuosamente.

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Gracias por ser el motor de mi corazón, el alimento de mi alma,

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ABSTRACT

This thesis presents a guideline to facilitate the implementation of the process “Process Management” (MAN.1) of the MoProSoft model. Such guideline was developed with the objective of helping the Small and Medium Enterprises (SMEs) to establish and manage their processes. A methodological research framework was established in order to carry out the research for the development of the guideline. As part of the research methodology an extensive review of literature was done, including maturity and capability models (such as CMMI, Competisoft, ISO/IEC 15504 - Part 2, among others). Also, the hypothesis that IDOV and DMAIC methodologies of Six Sigma may be helpful to develop the guideline arose. To confirm or revoke such hypothesis, the process MAN.1 of MoProSoft and the methodologies IDOV and DMAIC of Six Sigma were analyzed, as result nine relationships were found, and were taken into account as a theoretical basis to begin with the development of the guideline. As the process MAN.1 involves different knowledge areas such as project management and risk analysis, they were also explored in order to develop a guideline to facilitate the implementation of the process MAN.1, which includes a detailed description with recommended steps and nineteen templates to implement and facilitate through guidance the implementation of the process MAN.1 of MoProSoft. The validation of the guideline was made through a questionnaire that allows validating conceptual models. Such questionnaire is composed of eight questions that can be rated within a range of values between 1 and 5. Then, a group of 9 experts in Software Engineering was conformed in order to evaluate the guideline through the application of the questionnaire. The evaluation revealed that the guideline was conceptually valid and feasible because most of the aspects that were taking into account for the validation received a positive score and feedback. Finally, guidelines for future work were established, including the development of a first version of a notation for modelling processes, and the definition of information security practices to complement the process MAN.1.

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1. INTRODUCTION

1.1 CONTEXT OF THE RESEARCH.

As in other knowledge areas, the Software development has faced difficulties since it origin, as the time passes such problems have become bigger. To face this problem, the concept of Software Process Improvement (SPI) arose in the conference entitled “The Software Crisis” that was carried out in 1968 [1]. The principle behind the SPI is that the Software quality is strongly based on its development and maintenance process, therefore following guidelines to develop software in an ordered manner will lead to software quality. But what is software quality? According to Crosby [2], we can say that is when a product of software fulfills the expectations for which was created and therefore produces customer satisfaction. In order to achieve software quality, processes models and maturity models were created based on the SPI concept. Maturity models are “good practices” that the researchers have collected and documented from the industry. They had proven that an adequate implementation of them leads to the development of successful software of quality. As depicted in Fig. 1, several processes models have been developed over the time. Also, research is being done in order to take advantage of classic quality initiatives such as Six Sigma [3] and use them within the context of the SPI, e.g. the work presented by Sivy et al. in [4].

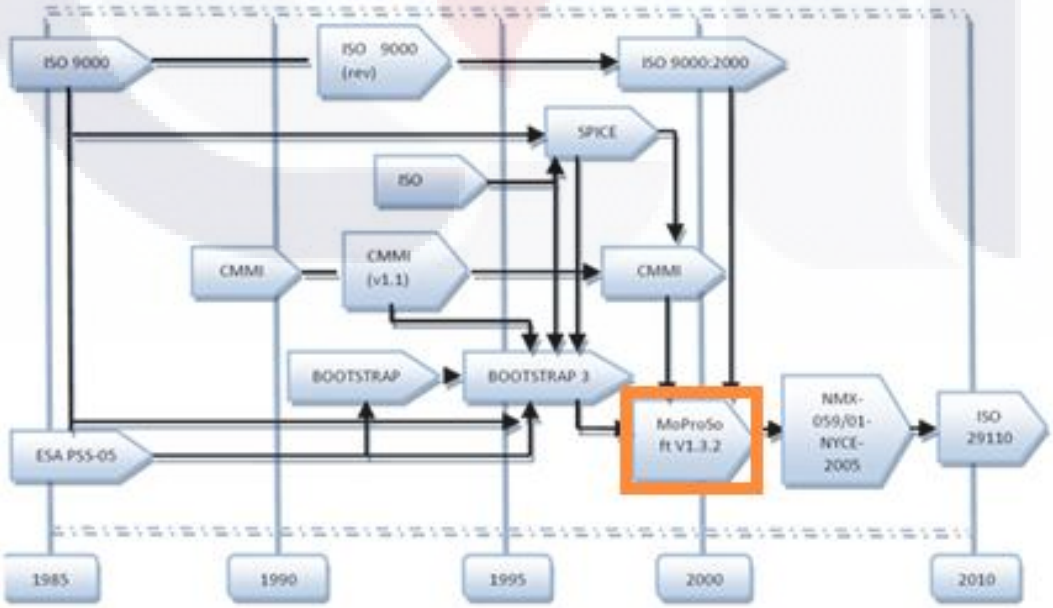


Figure 1. Evolution of the maturity models (quoted from [5]).

This research is based on the MoProSoft model (depicted in Fig. 1 with a darker border), which was developed by request of the Mexican Ministry of Economy. MoProSoft is a processes model addressed for Small and Medium Enterprises (SMEs), mainly based on the model CMMI V1.1 [6], ISO 9000:2000, PMBoK and ISO/IEC 15504, which are maturity models internationally used and recognized for big enterprises.

1.2 PROBLEM AND RELEVANCE.

As in Mexico, Europe, Canada, and mostly around the world, the majority of Information Technology (IT) sectors, that develop software are SMEs, i.e. they have around 25 employees. As reported by Oktaba in [7] and Laporte in [8], in Mexico, 92% of the enterprises are SMEs, in Europe 85%, in the Montreal area of Canada 78%, in Brazil it is around 70%, and finally in Ireland the 61% of enterprises are SMEs.

Considering that an important number of enterprises around the world are SMEs, is accurate to say that there is a need to support this kind of organizations, so they can grow and be successful. To do so, the statement proposed by Siviy et al., [4] is supported, such statement refers to the fact that the implementation of process management activities in SMEs such as definition, implementation, measurement, analysis, improvement, control, and verification, are a key point to develop software of quality, because allows to have a structured and organized manner to execute activities.

This research is based on MoProSoft as is an adequate candidate because is a model for that was created for SMEs, moreover it specifies a process for to manage processes, which is called “Process Management” (MAN.1), different from CMMI, that as reported by Oktaba [9] and Staples et al. [10], is not appropriate for SMEs, because it is too big, complex and expensive to implement them in this kind of organizations. MoProSoft was selected as the basis of this research because is a recognized model, it has been used as basis to develop the international standard ISO/IEC 29110 [11] and the COMPETISOFT [12] model.

1.3 CONTRIBUTION OF THE RESEARCH.

This research presents a guideline to facilitate (not to provide a magic solution that assure) the implementation of the process MAN.1 of MoProSoft. Such guideline includes a set of recommendations and templates to implement the activities of MAN.1. Also, as guideline for future work, a set of information security management practices were identified, wiling to integrate them into the process MAN.1, or even propose a new process to complement the MoProSoft model, and therefore support the SMEs to implement security management practices.

1.5 DESCRIPTION OF THE CHAPTERS.

The remaining of this document is organized as follows:

- **Chapter 2 – FORMULATION OF THE RESEARCH:** This section presents the problem, objectives, hypothesis, and methodology of the research
- **Chapter 3 – TEORETHICAL FRAMEWORK:** Presents an overview of the MoProSoft model, Six Sigma, and presents the related work.
- **Chapter 4 – MOPROSOFT'S MAN.1 AND SIX SIGMA:** Presents a set of relationships between the process MAN.1 of MoProsoft and the IDOV and DMAIC methodologies of Six Sigma.
- **Chapter 5 – A GUIDELINE TO IMPLEMENT THE PROCESS MANAGEMENT OF MOPROSOFT:** Presents the contribution of this research, which is a guideline to implement the process MAN.1 of MoProSoft.
- **Chapter 6 – VALIDATION OF THE RESEARCH:** This section presents the artefact that was used to evaluate the research work, as well as the results and interpretation of them.
- **Chapter 7 – CONCLUSIONS:** Presents the conclusions and discusses the future work, research in progress and published papers during the development of the research.

2. FORMULATION OF THE RESEARCH

2.1 RESEARCH PROBLEM

As previously mentioned, nowadays an important number of IT enterprises around the world are SMEs. There is a need to support them in order to become successful and grow, the management of their processes is essential to achieve such goal. MoProSoft is a Mexican model that is addressed for SMEs, it contemplates a process area called "Process Management" (MAN.1), which focuses on define and implement, improvement activities within the processes of the enterprises. A problem arises at this point, because there are no tools that guide the implementation of this process. To help solving this problem, the following objectives are considered:

2.2 OBJECTIVES OF THE RESEARCH

General objective: Develop a guideline to facilitate the implementation of the process "Process Management" (MAN.1) of the MoProSoft model.

Specific objectives:

O1. Verify whether there are relationships between the process MAN.1 of MoProSoft, and the methodologies IDOV and DMAIC of Six Sigma, in order to identify Six Sigma elements that could be useful to develop the guideline.

O2. Develop a set of recommended steps and templates as part of the guideline to implement the process MAN.1 of MoProSoft.

O3. Verify the conceptual validity and feasibility of the guideline.

2.3 HYPOTHESIS

H1. There are relationships between the process MAN.1 of MoProSoft and the methodologies IDOV and DMAIC of Six Sigma that could help the development of the guideline to implement the process MAN.1 of MoProSoft.

2.4 RESEARCH QUESTION

Q1. What are the relationships between the process MAN.1 of MoProSoft and the methodologies IDOV and DMAIC of Six Sigma?

2.5 RESEARCH METHODOLOGY

In order to carry out the research, an adaptation of the methodological framework for conceptual research proposed by Mora et al. [13] was done. Fig. 1 depicts this idea followed by the description.

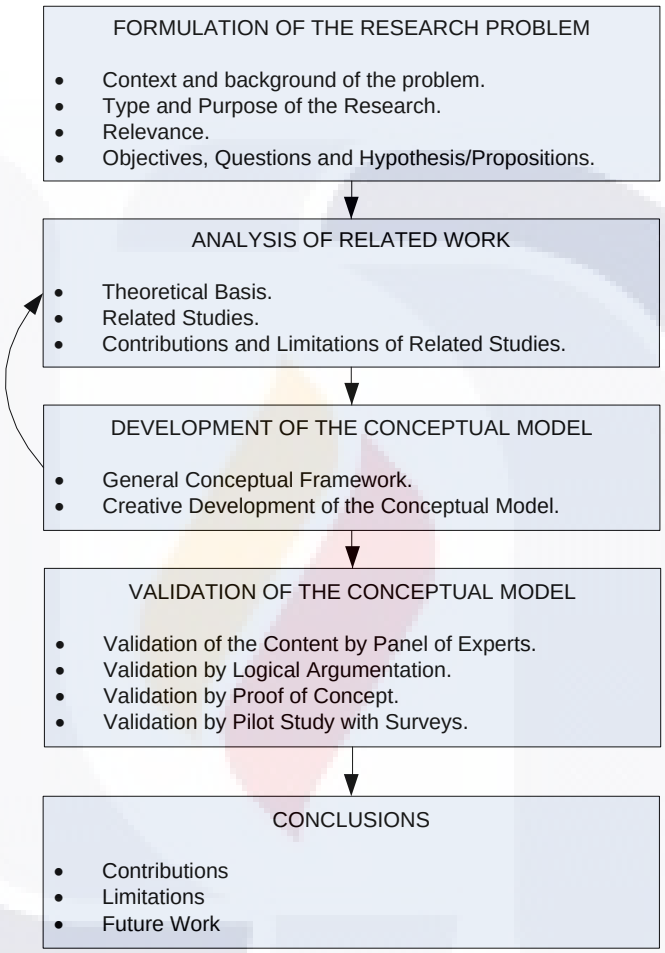


Figure 2 Research methodology.

Formulation of the research problem: In this phase are defined the context of the research, research problem, relevance, justification, objectives, hypotheses, and research methodology.

Analysis of related work: In this phase are reviewed the theoretical basis of the concepts associated to the problematic (mainly in research books), the related studies associated to the problematic (mainly in scientific journals), and performed an analysis of the contributions and limitations of the previous two.

Development of the conceptual model: this phase is where is made the contribution of the research by creativity supported in robust theoretical basis. In this phase are developed:

- General Conceptual Framework: presents the relationships between theories, models, and models that support the research.
- Conceptual Model: the intellectual product of the analysis and synthesis the researcher carries out.

Validation of the conceptual model: in this phase is carried out the evaluation of the model, in order to determine whether the conceptual model meets the following criteria:

- The conceptual model is supported by robust theories and principles.
- The conceptual model is logically coherent, congruent with the study and whit the purpose it was designed.
- The conceptual model contributes with something new and it is not a replica of something existent.

Conclusions: This phase has as purpose presenting the main contributions of the research as well as the limitations and the future work that is expected to do.

3. THEORETICAL FRAMEWORK

3.1 THE MOPROSOFT MODEL

Description of the MoProSoft Model

MoProSoft is a model of processes for Mexican SMEs that was created by request of the Economy Secretariat of the Mexican Government. Its purpose is to ensure that these companies be able to exploit its potential by adopting the best practices of the Software Engineering that are internationally used and accepted.

It is based on the ISO 9001:2000 and levels two and three of CMMI V1.1. [6] It uses the ISO/IEC 15504 Part 2 [14] as general framework for the evaluation of the processes, and incorporates best practices of the PMBOK (Project Management Body Of Knowledge) and SWEBOK (Software Engineering Body of Knowledge.

As can be seen in Fig. 3, he MoProSoft model is constituted of 9 processes, which are grouped in the 3 typical categories of an organizational structure: Top Management (TM), Management (MAN) and Operations (OPE).

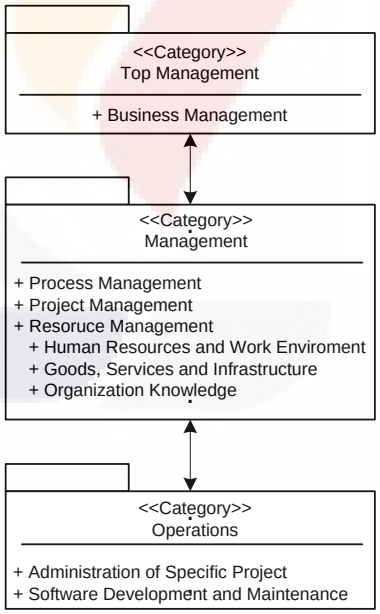


Figure 3. Structure of MoProSoft

Top Management

The TM category is focused on the practices of business management of an organization. In it is contained the TM.1 process called Business Management (TM.1). Which establishes guidelines for processes of the MAN category, also receives information from them for decision making.

Management

The category MAN, establishes the practices for the process MAN.1, Project Portfolio Management (MAN.2) and Resources Management (MAN.3) based on the guidelines established by the process TM.1.

Also, MAN provides the elements for the functioning of the processes contained in the OPE category, and receives, analyzes and evaluates the generated information by them, which is communicated to the category of TM.

The process MAN.1 is central element of this research, its purpose is to "Establish the Required Processes" of the organization that were identified in the "Strategic Plan" of TM.1, as well as define, plan, and implement improvement activities in them. MAN.1 consists of 3 main activities: Planning of the Processes, Preparation to Implantation as well as Evaluation and Control of the Processes.

Operation

The category OPE establishes the practices for the development and maintenance of the software. In the processes of this category are realized activities in basis of the elements provided by the category of MAN, to which is delivered the information and products generated.

Relevance of MoProSoft

The MoProSoft model has been well accepted internationally, as reported by Oktaba in [15] and Laporte in [11], it has been a key piece in the development of new maturity models, such as the international standard ISO/IEC 29110, and the COMPETISOFT project, both of them are based on the MoProSoft model.

3.2 SIX SIGMA

Six Sigma is a philosophy of quality that has two approaches, one administrative and other technical. The administrative focuses on improve the satisfaction of the customer either internal or external in order to raise the profitability of the business. In the other hand the technical approach focuses on the continuous improvement of the processes through the reduction of his variation as well as the prevention and elimination of defects by statistical analysis, this is called Statistical Thinking, which is present in the methodologies of Six Sigma. In the following paragraphs is given a brief description of the Six Sigma methodologies.

Design For Six sigma (DFSS)

DFSS is used to design or redesign processes or products. Its objective is to achieve that the organizations be able to have efficient processes and meets its requirements before they are implanted. This methodology is very varied in his implementation, i.e. exist different roadmaps such as: IDOV (Identify, Design, Optimize and Validate) which was analyzed in this work, DMADV (Define, Measure, Explore, Develop and Implement) and DMEDI (Define, Measure, Explore, Develop and Implement) among others.

As presented by Woodford in [16], the IDOV methodology is composed of the following phases:

- Identify: Consist in get the Voice of the Customer (VOC), determine the elements that are Critical To Quality (CTQ's), and establish the technical requirements as well as quality objectives.
- Design: Its aim is to transform the needs of the customer into functional specifications, and on this basis develop alternative and creative solutions.
- Optimize: Focuses on predict the performance and quality of the processes through the use of statistic techniques.
- Validate: Consist on validate prototypes, assess performance and reliability as well as iterate the design requirements if they have not been covered.

The objectives of the phases “Optimize” and “Validate” are often confused. The difference is that the phase of “Optimize” focuses on predict the capability of the design to meet the CTQ’s., while the phase of “Validate” focuses on validate and test the design.

DMAIC

According to Tonini et al., [17] the DMAIC methodology is used to improve existing processes that have significant variation and that do not have an acceptable performance, or that produce a significant amount of defects. The DMAIC methodology is composed of the following phases:

- Define: It focuses on identifying problems and situations that can be improved as well as determine the VOC and CTQ's.
- Measure: Its objective is to identify sources of data collection in basis of the CTQ's, as well as collect such data.
- Analyze: Consist in measure the process and identify the root causes that are responsible of the identified problems.
- Improve: Specifies and applies the characteristics of improvement to process.
- Control: Documents and monitors the process that has been improved.

Lean

Lean refers to the lightening of processes. It can be implemented through the frameworks of DFSS or DMAIC, is used to examine processes and identify the elements that do not add value, which are known as waste. According to Siviy et al., [4] by eliminating the waste is possible to make improvements to the processes because the phases that cause rework or do not add value are eliminated.

As can be seen in the descriptions above, although each method has different approaches, they have phases with similar and common goals. Both, IDOV and DMAIC are oriented to the implementation and definition of processes. According to Tonini et al. [17], the difference between DMAIC and IDOV is that DMAIC is oriented to measurement, analysis and control, whereas IDOV focuses on design and validation. However their tool's framework is similar, as they share some common tools and methods.

3.3 RELATED WORK

This chapter presents the related work that was carried out with the purpose of identifying conceptual relationships between theories, tools, frameworks, methodologies or any kind of knowledge that could be useful to establish a path to follow, during the inception and development of the guideline to facilitate the implementation of the process MAN.1 of MoProSoft.

In [4], Siviy et al. presents an overview of the CMMI and Six Sigma initiatives, as well as a set of strategies and tactics, in order to integrate both initiatives with the purpose of accelerate and successfully implement and manage processes within an organization. The strategies include recommendations to implementing CMMI process areas as Six Sigma projects; the use Six Sigma as a tactical engine for high capability and maturity, and to improve or optimize strategies and processes within an organization; and define standard operational procedures for the execution of projects based on CMMI, Six Sigma and other improvement initiatives. The tactics focuses on look for connections between CMMI process areas and Six Sigma methodologies and tools, so the best practices of CMMI can be complemented using Six Sigma methods and tools. Although their proposal is valuable as presents a general idea of how CMMI and Six Sigma initiatives could work, they do not present a specific guideline that may be followed in order to implement their proposal. However this work helps to understand the synergies between two different initiatives and the possible integration of them, making possible to establish a conceptual basis to develop guidelines to implement maturity models taking into account Six Sigma elements.

Álvarez et al. in [18], presents a guideline that includes a set of templates mapped in processes diagrams to implement processes areas of CMM in SMEs. Also presents an example of the implementation their proposal in a case study. Although the proposal is congruent and logic and useful, some elements are missing such as the definition and assignation of roles for each template and task of the activities, as well as specific recommendations to implement their proposal. However the templates and activity diagrams may be considered as basis to develop a more specific guideline.

Reyes et al. presents in [19] a methodology and a tool based on the process MAN.1 of MoProSoft to help SMEs evaluate their processes. A weakness in this proposal is that they don't define required tools and procedures to carry out the assessment. Also it does not take into account the evaluation criteria for each activity, i.e. how to know if the activity is being really executed and correctly?, is there any evidence?. A strong point is that it although the evaluations are informally executed; they still provide numerical data which allows determining the maturity of the processes of an organization in a general but more formal manner.

There are some content management tools that have been developed with the purpose of supporting the implementation of the MoProSoft model, but they are costly as an example the one developed by NYCE [20]. Other remain lost or not released, just as Kuali [21], (see Figs. 4 and 5 for snapshots of the tool) that is/was? a content management tool that included recommendations on how to implement each activity of the MoProSoft model. Another tool is the one presented by [22] which is also a content management tool, a weak point is that is not based on a maturity model, it just stores and extracts documentation, neither present guidance on the implementation of activities according to maturity models.

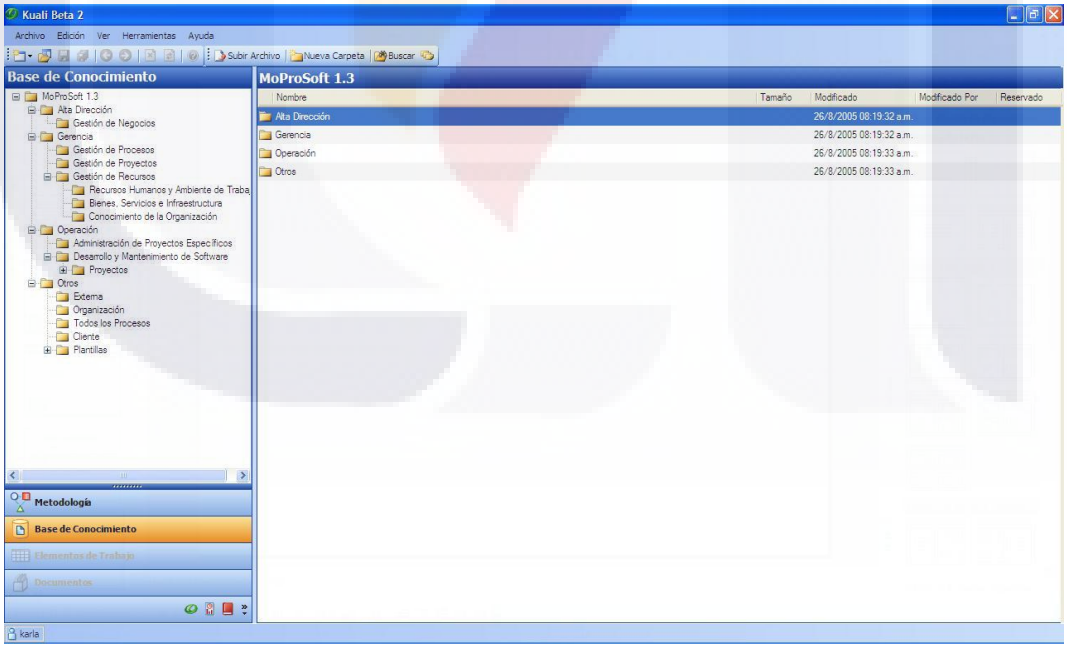


Figure 4. Kuali, a content management tool to implement MoProSoft.

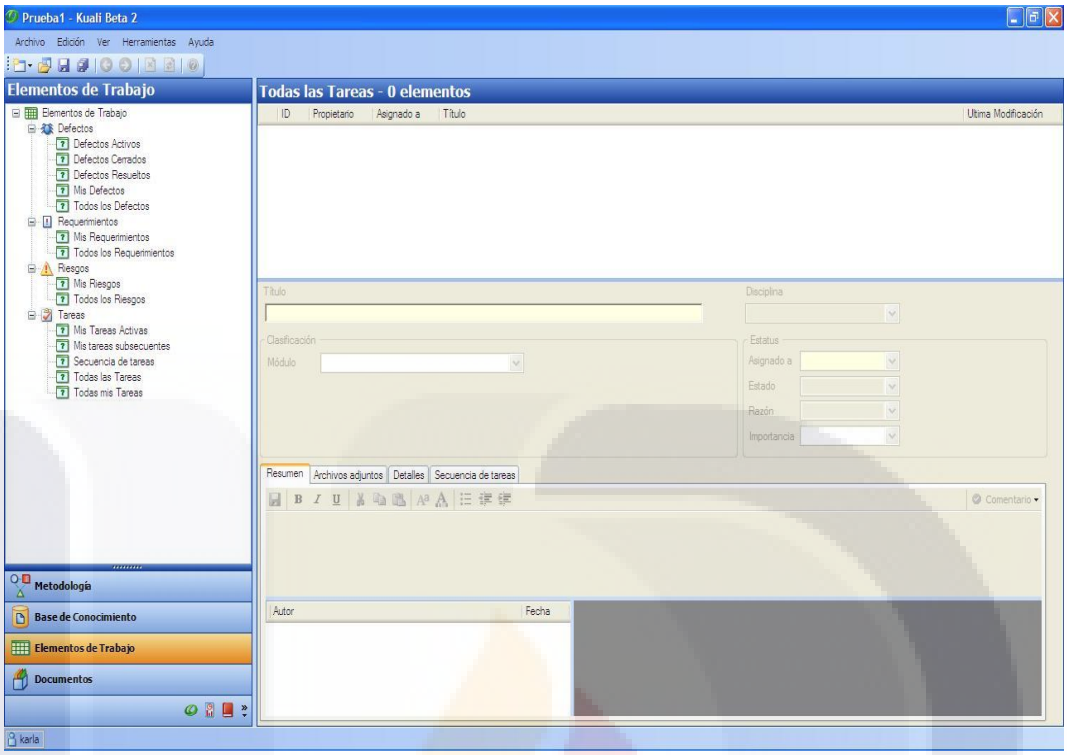


Figure 5. Kuali, content management tool to implement MoProSoft

4. MOPROSOFT'S MAN.1 AND SIX SIGMA

Whit the purpose of identifying possible Six Sigma tools that could complement the guideline to implement the process MAN.1 that was developed within this research, an analysis was carried out to determine possible relationships between the MAN.1 and the IDOV and DMAIC methodologies of Six Sigma.

4.1 SYNERGIES BETWEEN MOPROSOFT AND SIX SIGMA

Six Sigma is a philosophy in which everything is defined as a process, so if an organization wants to implement it, must have an approach oriented to the SPI. MoProSoft has a SPI focus too, so the methodologies IDOV and DMAIC of Six Sigma are complement of the processes MAN.1 and TM.1 of MoProSoft, which provides "Best Practices" with "WHAT" to do, whereas Six Sigma provides methods and tools that through interpretations could answer "HOW" to achieve these "Best Practices". Fig. 6 shows how Six Sigma together with MoProSoft helps to define a model of interpretation with methods and tools to accelerate the implementation and continuous improvement of processes.

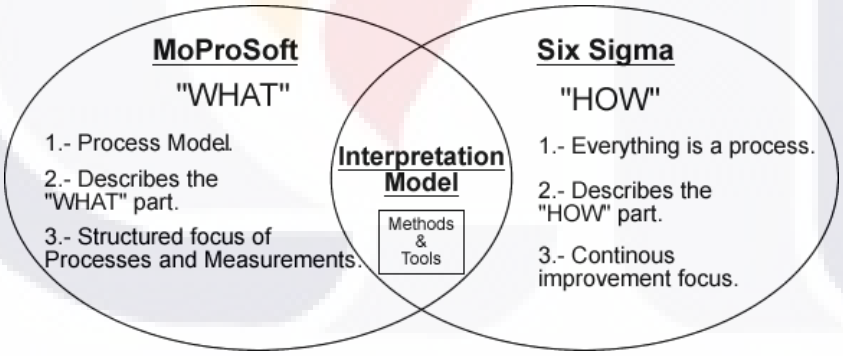


Figure 6. Synergies between MoProSoft and Six Sigma.

To design an interpretation model that allow implanting the process MAN.1 of MoProSoft is necessary understand the relationships and synergies between it and Six Sigma. To integrate Six Sigma with the process MAN.1 it should be mapped the model to the process, not the process to the model [4].

4.2 RELATIONSHIPS BETWEEN MOPROSOFT AND SIX SIGMA

To determine the relationships between MoProSoft, DMAIC and IDOV, the adjacent processes to the process MAN.1 of MoProSoft, and the phases of the methodologies DMAIC and IDOV were analyzed by looking for similarities between its phases. As result of the analysis that was carried out, it was determined that is necessary to involve the process of TM.1 since it contains the activity to "Define or Update the Processes and Projects, and Consider whether there are Proposals for Improvement", because through this are defined the "Required Processes" of the organization. Also it was developed a model of relationships between the processes TM.1 of the "Top Management" category and MAN.1 of the "Management" category of MoProSoft with the phases of IDOV and DMAIC (see Fig. 7).

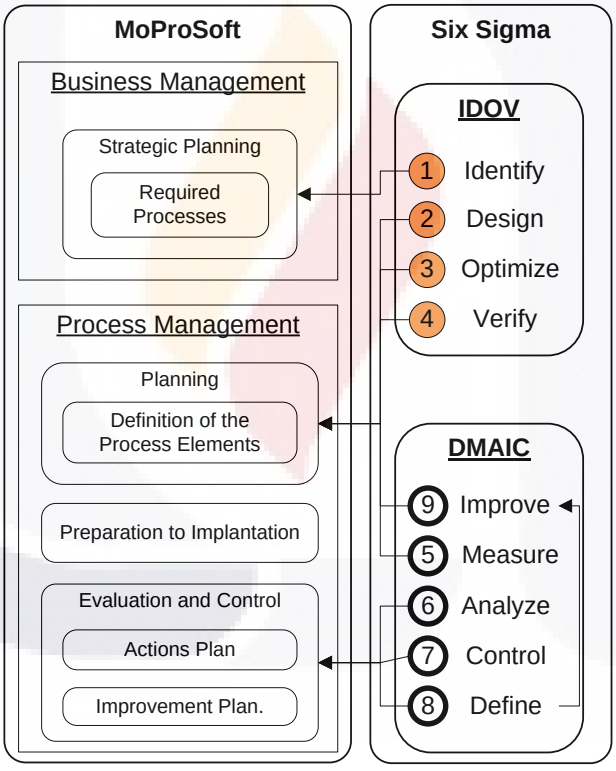


Figure 7. Relationships between MoProSoft (MAN.1) and Six Sigma (IDOV and DMAIC)

It was found that the IDOV methodology must be the first to be implemented because with this are determined the structure and elements of the processes. Following must be implemented the DMAIC methodology because with it can monitor and continuously improve of the processes.

It also was found that the phases of the DMAIC methodology not necessarily have to be executed in the order specified by her, because it uses the existing elements of IDOV for its implementation.

And was determined that the TM.1 process has a relation with the phase of "Identify" of IDOV, because is the starting point in which are assigned the roles and are determined the "Required Processes" of the organization. Furthermore the MAN.1 process has a relation with the phases of "Design", "Optimize" and "Validate" of IDOV as well as those specified by DMAIC.

Following are described the relationships between the methodologies of IDOV and DMAIC with the activities of "Strategic Planning" of the process TM.1 and all the specified by the process MAN.1.

Relationship 1: Identify – Strategic Planning

In the category of “Top Management” of the MoProSoft model is found the process of “Business Management”, in which is specified the activity of “Strategic Planning”, where is found the task of “Define or update the processes and projects, and consider whether there are proposals for improvement” that has as purpose “Identify the Required Processes” of the organization. The MoProSoft model specifies that the task mentioned above must be performed by the “Responsible of Business Management” and by the “Management Group”. In the other hand, the “Identify” phase of IDOV specifies the establishment of a “Business Case”, the creation of a “Team”, development of a “Team Charter”, and to obtain the requirements of the customer through workshops. In Six Sigma the term known as the “Voice Of Customer” refers to the customer requirements, which determine the elements that are Critical To Quality (CTQ’s).

As result of the analysis of the described above, it was found that the task of “Define or update the processes and projects, and consider whether there are proposals for improvement” of MoProSoft has a relation with the phase “Identify” of IDOV. This because both specify that it must be created a “Team” and a “Team Charter”, the latter is used to obtain the VOC in which are specified the “Required Processes” of the organization, and based on these determine the CTQ's, which will be the essential elements that must have the "Required Processes" of the organization.

Relationship 2: Design – Planning

In the category of "Management" of the MoProSoft model is found the process of "Process Management", in which is specified the activity of "Planning", in this are found the following tasks:

- "Definition of the Processes Elements". Specifies "Define or update the elements and structure of the process models" of the organization that were identified as "Required Processes" in the "Strategic Plan".
- "Procurement Plan and Training". Indicates that must be created a plan to search trained personnel, suppliers, infrastructure, tools and training requirements.
- "Risk Management Plan". Establishes identify and evaluate risks, as well as develop plans of contention and mitigation.

The methodology IDOV in its phase of "Design" is focused in the CTQ´s in order to:

- Identify the Functional Requirements to "Develop Conceptual Designs", evaluate them and select the one that best fits the requirements.
- Create a "Manufacturing Plan and Procurement Plan".
- "Identify Potential Risks" through the technique of Failure Mode and Effect Analysis (FMEA).

Based on the analysis of the described above, it was determined that the task of "Planning" of the MAN.1 process of MoProSoft has a relation with the "Design" phase of IDOV. This because the task of "Definition of the Processes Elements" of the "Planning" activity of MoProSoft is common with the activity of "Develop a Conceptual Design" of the phase "Identify" of IDOV. The latter has as objective design alternative solutions, with it is possible determine the elements and structure of the "Required Processes" identified in the "Strategic Plan" of TM.1.

The task of "Procurement Plan and Training" of the "Planning" activity of the process MAN.1 has a relation with the activity of create a "Manufacturing Plan and Procurement Plan" of the phase "Design" of IDOV. This because both specify create a plan to search and obtain human resources, material resources, infrastructure, and to establish the training requirements.

Lastly the task of create a “Risk Management Plan” of the “Planning” activity of the process MAN.1 of MoProSoft has a relation with the activity of “Identify Potential Risks” of the phase “Design” of IDOV. This because both have the same objective, which is to detect potential risks and develop a plan to its prevention and mitigation.

Relationship 3: Optimize – Planning

In the phase “Optimize” of IDOV is measured, is optimized, and are applied error tests to the selected design that was conceived in the phase of “Design” of IDOV. The latter with the purpose of evaluate his capability to meet with the CTQ’s.

Based on the analysis of the described above, it was determined that the phase of “Optimize” of IDOV has a relation with the task of “Definition of the Processes Elements” of the “Planning” activity. This because exist the need to ensure that the design that was done for the elements and structure of the task “Definition of the Processes Elements” has the ability to meet the requirements and objectives of the activity of “Planning”. For this, is required to review such design, and if necessary detail its elements and structure, in order to optimize the process through the identification and elimination of the errors that do not allow meeting the CTQ’s.

Relationship 4: Validate – Planning

In the phase “Validate” of IDOV is tested the selected design through the evaluation of his performance, failure modes, reliability and risks to assure that it meets the CTQ’s.

As product of the analysis, it was determined that the task of “Definition of the Processes Elements” of the activity “Planning” has a relation with the phase “Verification” of IDOV. This because through the latter is tested and validated the performance, failure modes, reliability and risks of the design, elements and structure of the process.

Relationship 5: Measure – Planning

The phase of “Measure” of DMAIC focuses on measure the performance of a process. For which has to “Develop a Data Recollection Plan”. “Identify the Sources of Data Collection”, and “Collect the data”.

In the activity of “Planning” of the MAN.1 process is found the task of “Establish or Update the Plan of Measurements of Processes”, in which are specified the types of measurements, periodicity, and responsibility.

From the analysis that was carried out as described above, it was found that the task of “Establish or Update the Plan of Measurements of Processes” of the “Planning” activity has a relation with the phase “Measure” of DMAIC. This because both specify that it must be created a plan to define the sources of data collection, recollect the data, establish the periodicity of the measurements and determine the responsible to carry out such measurements.

Relationship 6: Analyze – Evaluation and Control

The phase of “Analyze” of DMAIC examines the collected information to identify any chance of improvement and the origin of the variation of the process.

In the process of MAN.1 is found the activity of “Evaluation and Control”, in which are specified the tasks of:

- “Generate a Report of Measurements and Improvement Suggestions” according to the “Process Measurement Plan”.
- “Generate a Quantitative and Qualitative Report” from the “Report of Measurements and Improvement Suggestions”.

Based on the analysis that was carried out, it was determined that the “Analysis” phase of DMAIC has a relation with the activity of “Evaluation and Control”. This because the first focuses on analyze the collected information, with that can generate “Reports of Measurements and Improvement Suggestions” as well as “Quantitative and Qualitative Reports”.

Relationship 7: Control – Evaluation and Control

The phase "Control" of DMAIC monitors and documents the behaviour of a process to ensure that it maintains its current course and its level of performance. In the process of MAN.1 is found the activity of “Evaluation and Control”, in which is established the task of give “Monitoring to the Activities of the Process Plan”. The purpose of the latter is to verify that the activities of implantation and measurement of processes are carried out.

As product of the analysis that was carried out, it was determined that the phase “Control” of DMAIC has a relation with the activity of “Evaluation and Control” of the process MAN.1. This because both “Control” and “Evaluation and Control”, looks for the stability of a process through the monitoring, measurements, and control.

Relationship 8: Define – Evaluation and Control

The “Define” phase of DMAIC focuses on determine the requirements, i.e. the CTQ’s, understand the process and its capacity of improvement. In this phase a process flow map is elaborated.

Through the activity of “Evaluation and Control” is generated an “Action Plan” in order to determine the actions to be followed when a finding arises during the evaluation of the processes, as well as a “Improvement Plan” to optimize the processes.

As result of the analysis carried out of the described above, it was found that the activity "Evaluation and Control" the process MAN.1 has a relation with the phase "Define" of DMAIC. This because through the phase of "Define" can be determined the requirements (CTQ's) of improvement, the process is understood, and the process improvement limits are determined. Si it’s possible to generate an "Action Plan" and an "Improvement Plan".

Relationship 9: Improve – Design – Optimize – Planning

The phase "Improve" of DMAIC is focused on designing solutions to mitigate the problems that do not allow a process to meet the CTQ's, as well as develop a plan to implement improvements.

Based on the analysis done to the phases "Improve" of DMAIC, "Design" and "Optimize" of IDOV, and to the activity "Planning" of the process MAN.1, it was determined that the mentioned phases have a relationship with the activity "Planning" of MAN.1. This because the phases of "Improve" of DMAIC, "Design" and "Optimize" of IDOV establishes develop designs of processes, improve them, and tests its capabilities, with this is covered the task of "Definition of the Processes Elements", which specifies do an adjustment to the elements and structure of the processes.

5. A GUIDELINE TO IMPLEMENT THE PROCESS MANAGEMENT OF MOPROSOFT

This chapter presents a guideline conformed by recommended steps and templates to implement the activities of the process MAN.1 of the MoProSoft model.

Table 1 presents the literature that was analyzed in order to develop the guideline to implement the process MAN.1 of MoProSoft.

Reference	Description
[23]	MoProSoft model
[6]	CMMi's Verification and Validation Process Areas.
[19]	Application of a diagnostic instrument to the process "Process Management" of MoProSoft.
[24]	COMPETISOFT – Software Process Improvement for Small and Medium Organizations and Projects.
[18]	Interpretation of the Capability Maturity Model for Small Organizations of Software.
[25]	Practical support for lean six sigma software process definition: using IEEE software engineering standards.
[26]	Document Templates for Student Projects in Software Engineering.
[27]	The Certified Six Sigma Green Belt Handbook.
[28]	Process Improvement using Six Sigma, a DMAIC Guide.
[29]	Deployment Package: Project Management - Entry Profile.
[30]	Guideline for the assessment of engineering processes based on the standard ISO/IEC 15504 (SPICE).
[14]	ISO/IEC 15504 part 2: A model for process management.
[31]	ISO/IEC 15504 part 3: Rating Processes.
[32]	ISO/IEC 15504 part 5: Construction, selection and use of assessment instruments and tools.

Table 1. Reviewed literature to develop the guideline.

I. INTRODUCTION

PURPOSE OF THE DOCUMENT

Present a guideline that consists on a set of recommended steps and templates, to help the SMEs to manage their processes through the implementation of the activities defined by the process “Process Management” (MAN.1) of the MoProSoft model.

SCOPE

The guideline presented in this document is addressed to companies or internal areas within an organization having up to 25 staff members.

The guideline presented in this document is not a magical solution to implement the process MAN.1 of the MoProSoft model. Basic process knowledge, training, skills, time, effort and commitment are required for the successful implementation of the process MAN.1 through the guideline presented in this document.

Also the recommended steps and templates presented in this guideline may be modified adding, changing or removing some elements in order to fit the organization needs.

WHEN TO USE THIS GUIDELINE?

Is recommended to use this guideline when an organization:

- Does not have established processes.
- The established processes are not formally executed and/or documented.
- Exceeds the estimated time, effort, resources for the development of a product. the
- The products developed by the organization do not meet the customer expectations.

DEFINITIONS

This section describes the concepts used within this document.

- **MoProSoft**: a processes model for small and medium-size companies devoted to software development and maintenance.
- **Process Management:** a set of activities that have the purpose of establish, control, and improve the processes of an organization.

- **Process:** a set of interrelated or interacting activities carried out by roles and automated elements, which use resources to transform inputs into outputs that allow achieving business objectives through the satisfaction of a customer.
- **Phase:** a tollgate of a process.
- **Activity:** a set of tasks that transforms products of inputs into products of outputs to achieve an objective.
- **Task:** required, recommended, or permissible action, intended to contribute to the achievement of one or more outcomes of a process.
- **Sub-Task:** when a task is complex it is divided into sub-tasks.
- **Step:** a part of a sequence of actions to carry out a task. It may or may not require the usage of a tool. A step may or may not require an input, and may or may not generate a product within a process.
- **Role:** an entity or group of entities responsible for carrying out a set of activities within a process.
- **Product:** any element that is generated within and by a process. It might be a tool template or a part of them.
- **Workflow:** sequence of activities of a process.
- **Tool:** a technique, methodology, document or entity that enables the execution of an activity.
- **Verification:** action or set of actions to check if a product meet its requirements.
- **Validation:** action or set of actions to check if a product was developed based on the right requirements or if is capable to handle its intended use.
- **Goal:** something that must be achieved or accomplished.
- **Indicator:** mechanism to evaluate the effectiveness of the compliance of an objective through with evidence and facts.
- **Quantitative goals:** Numerical value or satisfaction range by indicator.
- **Tailoring guide:** modification to practices, input and output of a process, while it does not affect the achievement of the process' goals.
- **Knowledge base:** repository of the products generated or required by a process (e.g. documents such as, lessons learned, plans, and reports, among others.)
- **Peer review:** is an effective engineering method implemented via inspections, structured walkthroughs, active reviews or a number of other collegial review methods, which can be used to perform verifications and validations.

- **Root Cause Analysis:** is a method to identify the causes of defects in a process or product, by using others techniques for its support, such as Brainstorming workshops and 5 Whys technique. For further information about RCA please consult [15] or [16].
- **Failure Mode and Effects Analysis:** is an approach to determine how a process or product could fail and the failure effects. It uses other methods for this purpose, such as brainstorming workshops or designing, evaluating or assessing risks of a product.
- **Process Failure Mode and Effects Analysis:** a variation of FMEA which focuses on processes. It can be used to the design processes and perform risk assessment to them.
- **Brainstorming workshop:** is method of group interaction, which is intended to serve as a tool to generate ideas, identify problems and group them in a structured manner. In the literature have been reported several variations of it, for further information about Brainstorming workshops please refer to [17] and [18].
- **5 whys:** a technique that enables encountering the solution for a problem by asking yourself: why the problem arose? For further information about the 5 Whys technique and implementation, please refer to [19].

ACRONYMS

- **TM.1:** the process called “Business Management” of TM of the MoProSoft model.
- **FMEA:** Failure Mode and Effects Analysis.
- **MAN.1:** is the process called “Process Management” of the category MAN of MoProSoft.
- **MAN:** “Management” category of the MoProSoft model.
- **PFMEA:** Process Failure Mode Effects Analysis.
- **RCA:** Root Cause Analysis.
- **SMEs:** Small and Medium Enterprises.
- **TM:** “Top Management” category of the MoProSoft Model.

STRUCTURE OF THE GUIDELINE

The guideline presented in this document contains four sections organized as follows:

- **Section I.** The Process Management of MoProSoft: describe the elements of the process MAN.1 according to MoProSoft, which includes the purpose, goals, indicators, quantitative goals and measurements, involved roles, responsibility and authority, related processes, training, knowledge base, lessons learned, inputs, outputs, internal products, and a list of the tasks.
- **Section II.** Recommendations to Implement the Tasks of MAN.1: describe recommended steps to implement the tasks of MAN.1, taking into account their maturity level, inputs, outputs, related templates (see the description of section III presented below), responsible, notes, and a basic diagram that shows the relationships between the inputs, task, outputs and responsible role.
- **Section III.** Templates: presents a set of templates that supports the generated products when executing the recommendations to implement the tasks, of MAN.1 presented in section II.
- **Section IV.** Relationships between templates and activities: presents a matrix that shows the relationships between the recommendations to implement activities presented in section II and the proposed templates to implement the activities presented in section III.

According to ISO 9001:2000 (see page 132 of [8]) by answering the questions What is done? Why is it done? How is it done? Who does it? Is it in writing?, is possible to implement organized and successful processes.

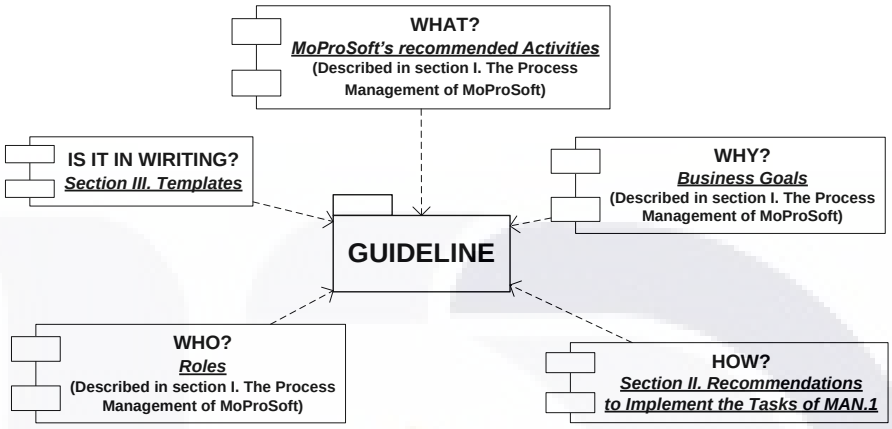


Figure 8. Guideline and process management questions to implement processes.

As depicted in Fig. 8, the four sections of the guideline attempts to enable the successful implementation of the process MAN.1, as they help to answer the questions previously mentioned.

CAPABILITY LEVELS

The capability of a process represents the ability that a process has to meet the business goals. When a process has high capability it means that a process is able to achieve the business goals associated to it through its optimization and continuous improvement. As presented in Table 2, the capability of a process is rated with a scale with a range between 0 and 5, where zero represents the lowest capability level and five the highest.

Level	Capability
1	Realized
2	Managed
3	Established
4	Predictable
5	Optimized

Table 2. Capability levels.

This guideline specifies the capability levels for each task of the process MAN.1. For further references on how to perform an evaluation to determine the capability of a process contained into the MoProSoft model, please refer to the Evalprosoft model [33].

II. THE PROCESS MANAGEMENT OF MOPROSOFT (MAN.1)

CATEGORY

Management (MAN)

PURPOSE

The purpose of Process Management is to establish the organization processes based on Required Processes identified in the Strategic Plan, as well as defining, planning and implementing the corresponding improvement activities.

DESCRIPTION

Process Management comprises the following activities: process planning, preparation for implementation, and process evaluation and control.

- Planning. Based on Required Processes identified in the Strategic Plan, in the Improvement Plan and in the Actions Plan, the process planning establishes or updates a Processes Plan that contains:
  - Process Elements Definition; consider reference process models, and adjust them to organization's needs.
  - Schedule for establishing or improving processes by linking activities and responsible parties.
  - Acquisition and Training Plan, requests for trained personnel, suppliers, infrastructure and tools, as well as training requirements.
  - Processes Assessment Plan, including internal and external evaluations.
  - Processes Measurement Plan, contains measurement types, periodicity and responsibility.
  - Processes Risk Management Plan contains risk identification and evaluation, as well as the corresponding contention and contingency plans.
- Preparation for the Implementation. Perform the following tasks:
  - Designate persons responsible for processes.
  - Documentation or updating of the organization's Processes Documentation as per the established Process Elements Definition.
  - Train the organization's members in the processes, as per Acquisition and Training Plan.
  - Implement pilots project of processes, where deemed convenient.
- Evaluation and Control. Perform the following tasks:
  - Follow up of Processes Plan activities.
  - Gathering of Measurement and Improvement Suggestion Reports, generating the Quantitative

and Qualitative Report to be submitted to the Responsible for Business Management. Analysis of improvement suggestions contributes to the generation of the Improvement Plan.

- Execution of the Assessment Plan, in order to verify the implementation of processes, gathering findings and improvement opportunities. As a result, the Assessment Report and the Actions Plan responding the findings, will be documented, and will be complemented by the Improvement Plan as per opportunities.
- Follow up to Actions Plan.
- Supervision of risks identified in Processes Risk Management Plan.
- Identification and documentation of Lessons Learned.

GOALS

ID	Goal
G1	Planning of the process definition, implementation and improvement activities based on Strategic Plan.
G2	Following-up on process definition, implementation and improvement activities by complying with Processes Plan.
G3	Improving process performance by complying with Improvement Plan.
G4	Keeping Business Management informed on the performance of processes through of the Quantitative and Qualitative Report.

INDICATORS

ID	Indicator	Related Goal
I1	The Processes Plan covers the Required Processes, identified in the Strategic Plan.	G1
I2	The process definition, implementation and improvement activities are carried out as set forth in the Processes Plan.	G2
I3	Members of the organization know their corresponding processes and work based on them.	G2
I4	The organization's processes are documented and updated.	G2
I5	Improvement Plan is defined based on improvement suggestions and opportunities.	G3
I6	Process performance complies with quantitative goals.	G3
I7	Quantitative and Qualitative Report is submitted periodically to Business Management.	G4

QUANTITATIVE GOALS AND MEASUREMENTS

Indicator	Quantitative Goals		Measurement	
	ID	*Value or satisfaction range*	*ID*	*Description*
I1	G1		M1	Compare the information contained in the *Processes Plan*, with the processes required in the *Strategic Plan* to verify their correspondence.
I2	G2		M2	Compare the *Processes Plan* with the *Quantitative and Qualitative Report* in its section corresponding to compliance of this plan to verify compliance.
I3	G2		M3	Perform surveys on the organization's members to verify knowledge of corresponding processes in their application to their activities.
I4	G2	To be defined by the RPM in charge	M4	Verify that *Processes Documentation* is available and updated in the Knowledge Base.
I5	G3		M5	Review if the *Improvement Plan* is defined based on the suggestions and improvement opportunities contained in the *Evaluation Report*.
I6	G3		M6	Compare qualitative goals with measurements reported in *Measurement and Improvement Suggestion Reports* to verify their achievement.
I7	G4		M7	Verify the submission of the *Quantitative and Qualitative Report* according to the periodicity set forth in the *Strategic Plan*.

To define measurements see A1.5 Establish or update the *Processes Measurement Plan*.

ROLES INVOLVED AND REQUIRED SKILLS

Role	Abbreviation	Skills	Process	Category
Responsible for Process Management	RPM	Knowledge of all the activities necessary to define and successfully implement the Process Management process	MAN.1	MAN
Assessor	ASR	Knowledge of methodology and application of the evaluation (see A1.4 Establish or update the Assessment Plan).	MAN.1	MAN
Responsible of Process	RP	Knowledge of process under charge	ALL	ALL
Responsible for Business Management	RBM	Knowledge of the effort required to carry out Process Management and, above all, to be committed to it	TM.1	TM

RESPONSIBILITY AND AUTHORITY

Responsible	Responsible for Process Management
Authority	Responsible for Business Management

TRAINING

RPM Shall offer the required facilities so the personnel involved in the process MAN.1 participates in the training activities defined in the *Training Plan*.

KNOWLEDGE BASE

The knowledge base is a repository of documents that helps the organization to keep evidence and a history of the execution of its processes. Products must be free of defects and errors in order to be incorporated to the Knowledge Base. To assure it, they have to be verified and validated first.

ID	Product	Approval guideline	Capability Level
	Processes plan	Ver1, Val1	2
	Processes documentation	Ver2	2
	Actions plan	Ver3, Val2	3
	Improvement plan	Ver4, Val3	3
	Quantitative and qualitative report	None	3
	Evaluation report	None	3
	Lessons learned	None	3
	Verification report(s)	None	2
	Validation report(s)	None	2

LESSONS LEARNED

Before executing assigned activities, the roles involved in the process MAN.1 shall consult the document *Lessons Learned* to leverage the organization's experience and reduce the possibility of cause problems.

EXCEPTIONAL SITUATIONS

- Roles involved in MAN.1 must notify RPM, in a timely manner, the situations that prevent the execution of the assigned activities.
- RPM must respond to these situations, and if it is not able to solve them or they do not fall on his or her responsibility, he or she, must escalate them to the RBM.

INFRASTRUCTURE RESOURCES

No	Activity	Resource
1	A1. Planning.	Tools that enable documenting, handling and controlling the *Processes Plan*.
2	A2. Preparation for the implementation.	Tools that allow documenting and disseminating processes.
3	A3. Evaluation and control.	Tools that support the execution of the evaluation.

RELATED PROCESSES

All Processes:

- **Category of Top Management (TM**)
  - Business Management (TM.1)
- **Category of Management (MAN)**
  - **Process Management (MAN.1).**
  - Project Portfolio Management (MAN.2)
  - Resource Management (MAN.3)
    - Human Resources and Work Environment (MAN.3.1)
    - Goods, Services and Infrastructure (MAN.3.2)
    - Organization's Knowledge (MAN.3.3
- **Category of Operations (OPE)**
  - Specific Projects Management (OPE.1)
  - Software Development and Maintenance (OPE.2)

INPUTS, OUTPUTS AND INTERNAL PRODUCTS

Inputs	**Resource**		**Source**
	Required processes of the organization		Business Management
	Required processes of the organization		Business Management Project Portfolio Management Resource Management Human Resources and Work Environment Goods, Services and Infrastructure Organization's Knowledge Specific Project Management
	Measurement and Improvement Suggestions Report		Human Resources and Work Environment
Outputs	**Resource**		**Destination**
	Processes Plan	Process Elements Definition	Business Management Process Management Project Portfolio Management Resource Management Specific Projects Management
		Schedule	
		Acquisition and Training Plan	
		Assessment Plan	
		Processes Measurement Plan	
		Process Risk Management Plan	
	Processes Documentation		All Processes
	Quantitative and Qualitative Report		Business Management
	Lessons Learned		Organization´s Knowledge
Internal products	Measurements and Improvement Suggestions Report		Process Management
	Actions Plan		
	Improvement Plan		
	Assessment Report		
	Verification Report(s)		
	Validation Report(s)		

Table 3. Inputs, outputs and internal products.

ACTIVITIES

Activity	Role	Tasks	Level
A1 Planning (G1)	RPM	A1.1 Establish or update the *Process Elements Definition.*	1
	RPM	A1.2 Establish *Schedule* to keep and improve processes.	1
	RPM	A1.3 Establish or update the *Acquisition and Training Plan.*	1
	RPM	A1.4 Establish or update the *Assessment Plan.*	1
	RPM	A1.5 Establish or update the *Processes Measurement Plan.*	3
	RPM	A1.6 Establish or update the *Risk Management Plan* for Process Management.	1
	RPM	A1.7 Integrate the *Processes Plan.*	1
	RPM	A1.8 Verify the *Processes Plan* **(Ver1)**.	2
	RPM	A1.9 Correct defects found in the *Processes Plan* based on the *Verification Report* and obtain approval for corrections.	2
	RBM	A1.10 Validate the Processes Plan **(Val1)**.	2
	RPM	A1.11 Correct defects found in the *Processes Plan* based on the *Validation Report* and obtain the approval of corrections.	2
A2. Preparation for the implementation (G2)	RPM	A2.1 Manage the *Acquisition and Training Plan* identified in the *Processes Plan*.	1
	RPM	A2.2 Assign and notify those Responsible for Processes.	1
	RP	A2.3 Prepare and update *Process Documentation* as per *Processes Plan*.	1
	RPM	A2.4 Verify *Process Documentation* **(Ver2)**.	2
	RPM	A2.5 Correct defects found in *Process Documentation* based on *Verification Report* and obtain approval of corrections.	2
	RPM RP	A2.6 Train the organization on the processes.	1
	RPM	A2.7 Implement processes in pilot projects, if deemed necessary.	1
A3. Evaluation and Control (G2, G3, G4)	RPM	A3.1 Follow up process implementation activities on *Schedule* established in *Processes Plan*.	2
	RPM	A3.2 Generate *Measurements and Improvement Suggestions Report* for this process, as per *Processes Measurement Plan*.	3
	RPM	A3.3 Generate *Quantitative and Qualitative Report* based on *Measurement and Improvement Suggestions Reports* gathered, to be submitted to the Responsible for Business Management.	3
	ASR	A3.4 Perform the evaluations set forth in the *Assessment Plan*.	3
	RPM	A3.5 Verify the *Actions Plan* **(Ver3)**.	3
	RPM	A3.6 Correct defects found in *Actions Plan* based on *Verification Report* and obtain approval of corrections	3
	RBM	A3.7 Validate the *Actions Plan* **(Val2)**.	3
	RPM	A3.8 Correct defects found in *Actions Plan* based on *Validation Report* and obtain approval of corrections.	3
	ASR RPM	A3.9 Generate *Improvement Plan* based on improvement suggestion analysis and on the improvement opportunities detected during the evaluation.	3
	RPM	A3.10 Verify *Improvement Plan* **(Ver4)**.	3
	RPM	A3.11 Correct defects found in *Improvement Plan* based on *Verification Report* and obtain approval of corrections.	3
	RBM	A3.12 Validate *Improvement Plan* **(Val3)**.	3
	RPM	A3.13 Correct defects found in the *Improvement Plan* based on *Validation Report* and obtain approval of corrections.	3
	RPM	A3.14 Follow up on *Actions Plan* and *Improvement Plan*.	3
	RPM	A3.15 Supervise risk control as per *Processes Risk Management Plan*.	2
	RPM	A3.16 Identify *Lessons Learned* on processes and integrate them into the *Knowledge Base*.	3

Table 4. Activities by capability level.

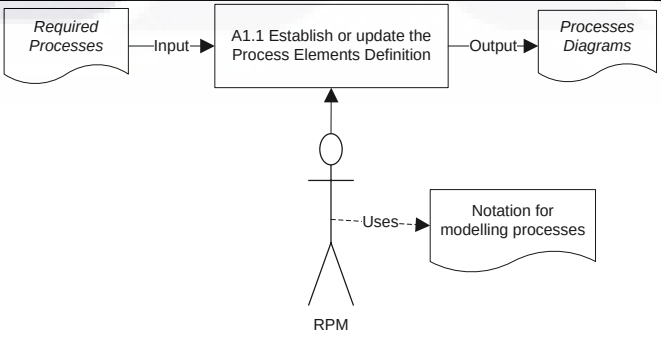
III. RECOMMENDATIONS TO IMPLEMENT THE ACTIVITIES OF MAN.1

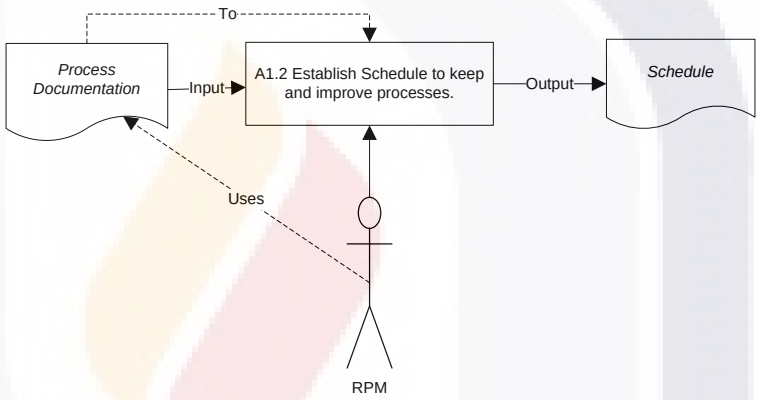
This section presents a set of recommended steps to implement the activities of MAN.1. For this purpose the tasks of MAN.1 are described in more detail considering the following:

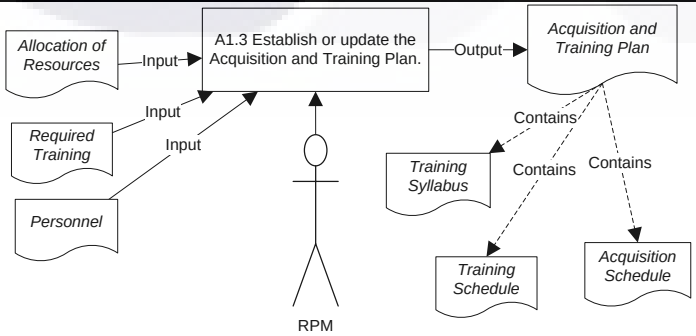
- Task name and level.
- Inputs.
- Outputs.
- Related templates.
- Responsible.
- Recommended steps to implement the activity.
- Notes.
- Diagram to describe the relationships between the inputs, outputs and responsible.

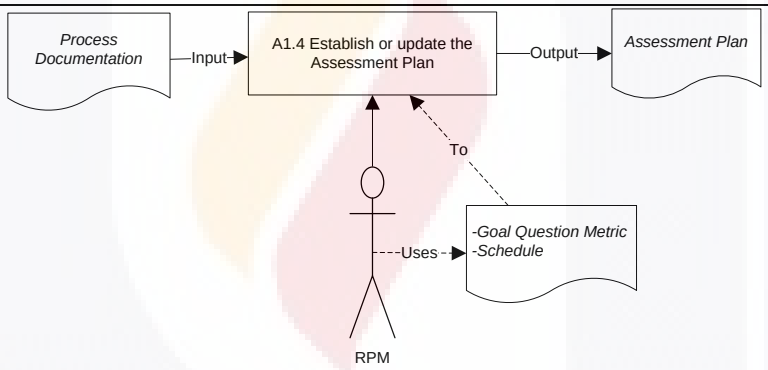
ACTIVITY: A.1 PLANNING

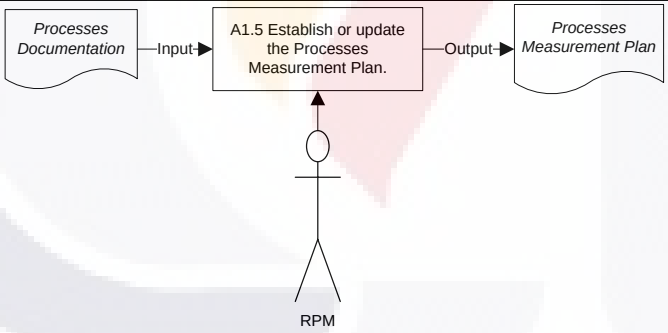
G1.	To plan the activities to define, implement, and improve the processes as per *Strategic Plan*.

TASK / Level 1	*A1.1 Establish or update the Process Elements Definition.*
Inputs	*Required processes of the organization*
Outputs	*Processes diagrams*
Related templates	*Processes Documentation*
Responsible	RPM
Recommended steps	1. Define a pattern to describe the processes taking into account the elements that are specified in A2.3 Prepare or update the *Processes Documentation* as per *Processes Plan*. Please be aware that the goals, indicators and quantitative objectives are mandatory elements that must be part of a *Process Elements Definition*. 2. Based on the reference processes of MoProSoft, define the elements specified in the document of *Required Processes* of the processes with all the defined elements of the pattern of the step presented above. For this purpose start developing the process diagram using a *processes modelling notation* such as BPMN [34], ICAM DEFinition (IDEF0) [35], SIPOC diagrams [36], and UML activity diagrams [37], among others. For such purpose consider the following steps: a. Define the starting point of the process. b. Identify and define activities. c. Identify the sequence of activities. d. Define the ending point of the process. e. Identify the inputs and the suppliers. f. Identify the outputs and the customers. g. Identify the associated roles for each activity. 3. Consider the following for the steps presented above: a. Make sure that the identified activities are congruent in capability level. If not, then make sure they are achievable and can be sequenced by other activities despite their capability level. b. Make sure that the activities allow achieving the business objectives. c. It is suggested to involve the RP and carry out workshops to define and improve the design of the process. 4. If desired or required, perform an assessment to the process using the tool Failure Mode Effect Analysis [27] (*PFMEA*, please see template *PFMEA-RMP-RC.xlsx*), so the process can be optimized by detecting flaws or risks. The *PFMEA* consists on review and analyze each activity of the process to identify possible failure modes, their impact and define actions to prevent them or mitigate them. Performing a *PFMEA* at this point will allow you to be one step forward for the Risk Management Plan (please see *A1.6 Establish or update the Risk Management Plan for Process Management*).
Notes	• None.
Diagram	

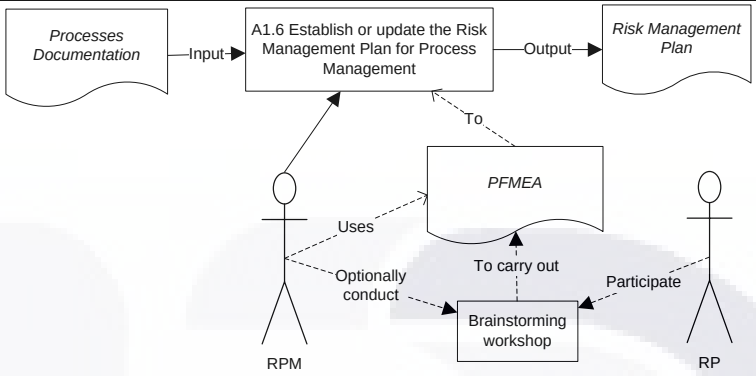
TASK Level 1	*A1.2 Establish Schedule to keep and improve processes.*
Inputs	*Processes Documentation*.
Outputs	*Schedule*
Related templates	*Schedule*
Responsible	RPM
Recommended steps	In order to develop a *Schedule*¦:to keep and improve processes please consider the following steps: 1. Define activities taking into account the level of maturity and make a description of them. Is suggested to include at least all the activities of level 1. 2. Assign activities to the responsible and dates. 3. Develop or identify existing procedures and tools to execute each activity.
Notes	• None
Diagram	

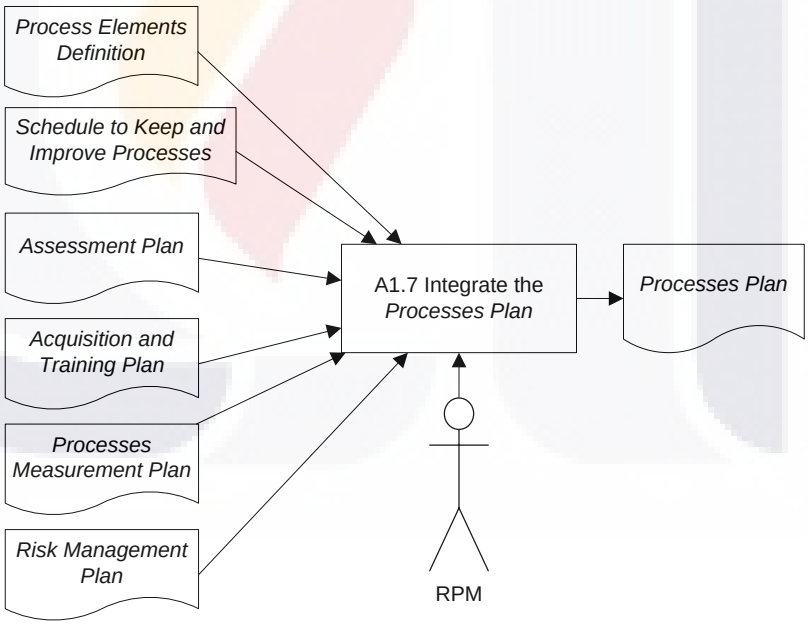
TASK / Level 1	*A1.3 Establish or update the Acquisition and Training Plan.*
Inputs	*Allocation of resources.*
Outputs	*Acquisition and Training Plan*
Related templates	*Acquisition and Training Plan* *Training Syllabus* *Schedule*
Responsible	RPM
Recommended steps	Regarding to the training plan consider the following steps: 1. Make a list with the role and name of personnel to be trained. 2. Describe the required training for each role involved. 3. Develop a *Training Syllabus* for the training courses based on the required skills. 4. Develop a *Schedule* to carry out the training. Regarding to the acquisition plan consider the steps presented below: 1. Identify and list the required resources, then make a description of and justify why the resource is required. 2. Identify the available resources and make a list of them. 3. In basis of the lists of required and available resources develop a list of missing resources. 4. If there is any process to select the supplier and make the purchases, include a diagram of such process. The following activities are recommended as part of an acquisition process. a. Taking into account the supplier selection criteria, identify and list with the information of the possible suppliers (name and contact information). b. Request quotations to each supplier of the missing resources. c. If required perform a cost-benefit analysis to select the supplier. d. Select the supplier and make the purchases. 5. Define the supplier selection criteria. 6. Taking into account the supplier selection criteria, look for possible suppliers and make a list of them including their data, e.g. name, resource that will provide, email, phone and address. 7. Based on the acquisition process, develop a schedule to purchase de missing resources.
Notes	• If desired, a risk analysis may be conducted to increase the possibility of successful implementation of the *Acquisition and Training Plan* (see A1.6 Establish or update the *Risk Management Plan* for Process Management). • Other calculations could be made to manage the acquisition plan such as "*planned budget* minus *expenses*" in order to know if our planned budget is enough to buy the required resources, or if is necessary to take actions to solve arising problems.
Diagram	

TASK Level 1	*A1.4 Establish or update the Assessment Plan*
Inputs	*Process Documentation*
Outputs	*Assessment Plan*
Related templates	*Assessment Plan*
Responsible	RPM
Recommended steps	To establish the *Assessment Plan* define: 4. The type of evaluations (internal or external). 5. Purpose. 6. Goals. 7. Scope. 8. Required resources, such as inputs, outputs, and tools required for the assessment. 9. The evaluation criteria. The Goal Question Metric (GQM) [38] may be used for this purpose. 10. Methods of evaluation. 11. Develop a schedule to carry out the evaluation (see *Schedule*) by. a. Defining and describing activities. b. Assigning activities to the responsible and dates. c. Developing procedures and tools to execute each activity.
Notes	• None
Diagram	

TASK Level 3	*A1.5 Establish or update the Processes Measurement Plan.*
Inputs	*Processes Documentation*
Outputs	*Processes Measurement Plan*
Related templates	*Processes Measurement Plan* *Schedule*
Responsible	RPM
Recommended steps	To develop a *Processes Measurement Plan*, consider the following steps and define for each process: 1. The related indicator for each measurement 2. What will be a defect, so it is possible to know whether the goals or objectives of the organization are being achieved or not. When a defect arises, indicates that the process is not performing into the maximum or minimum levels of tolerance, which means that the organization's goals, objectives are not being met. 3. Define and describe the formulae that will be used as metrics to measure the performance of the process. The metrics must be defined keeping in mind that they must reflect the achievement of an organizational goal or objective through the indicators. 4. The target, maximum and minimum values in which the process is expected to perform. 5. The procedures that must be carried out to generate the measurements. 6. Required tools to generate the measurements (e.g. data collection sheets, statistical tests, among others). 7. Responsible to perform the measurements, including the role and name. 8. Start date for each measurement. 9. Periodicity of each measurement.
Notes	• Further references on how to perform a measurement according to the six sigma philosophy can be found in [27].
Diagram	

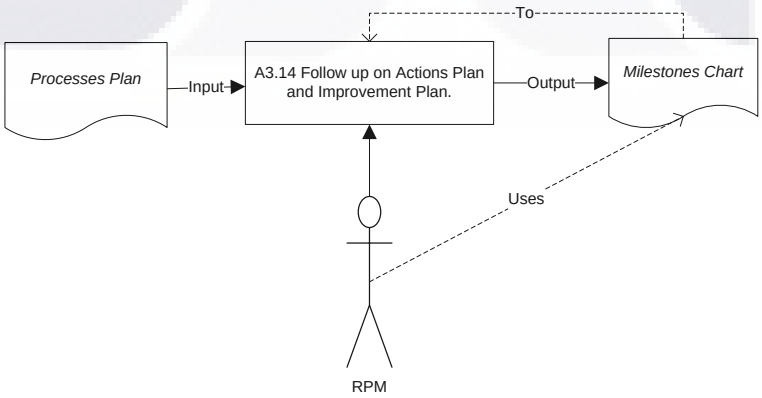
TASK Level 1	*A1.6 Establish or update the Risk Management Plan for Process Management.*
Inputs	*Process Documentation*
Outputs	*Risk Management Plan*
Related templates	*PFMEA*/*PFMEA-RMP-RC.xlsx* *RCA*/*RCA 5Whys.xlsx* *Schedule*
Responsible	RPM
Recommended steps	To develop a risk management plan consider the following steps: 1. Assemble a team considering any stakeholder that has knowledge about the process that is going to be evaluated. The RPM and RP always must be part of the team. 2. List the steps of the process under assessment (columns "Process step", "Input" and "Output" of *PFMEA*/*PFMEA-RMP-RC.xlsx*) and the date they were evaluated. The latter serve when new risks arise or are identified. 3. Identify potential failure modes in process steps (column "Potential Failure Mode" of *PFMEA*/*PFMEA-RMP-RC.xlsx*). A failure mode is any manner in which the process step could fail to perform its intended function or functions. Take into account that the output depends on the process step and the process step on the input, so if the input goes wrong then the process step and the output will go wrong for sure. Typical failure redaction can start off with: Insufficient, Improper, Deformation, Erratic, etc. It is recommended to carry out a *Brainstorming workshop* to identify the failure modes. 4. Identify the potential effects of the failure modes (column "Potential Failure Mode" of *PFMEA*/*PFMEA-RMP-RC.xlsx*). This refers to the impact the failure mode has in the outcome of the process step. 5. Assign severity rating (column "SEV" of *PFMEA*/*PFMEA-RMP-RC.xlsx*) preferably using a scale from 1 to 10 to each effect the failure mode can cause. In the scale the higher severity the higher the number, for example if the severity is the highest then assign a value of "10". 6. Identify potential causes for every failure mode. Use tools like brainstorming workshops and *RCA* using the *5 Whys* technique (see *RCA 5Whys.xlsx*). 7. Assign occurrence rating (column "OCC" of *PFMEA-RMP-RC.xlsx*) using the same scale than severity "SEV". Occurrence refers to the likelihood or frequency at which a cause of a failure mode could occur. 8. Identify controls in order to detect and prevent the causes of the failure modes, so it is possible to avoid them or mitigate them. 9. Assign detection rating (column "DET" of *PFMEA-RMP-RC.xlsx*) regarding the probability that an occurrence of a failure mode could happen. 10. Calculate the Risk Priority Number (RPN) for each step that is being analyzed. The RPN is calculated as follows: SEV x OCC x DET = RPN. The higher the value of the RPN is the more risk has. When two risks have the same overall score, is suggested to escalate the one with the higher severity rating. 11. Define actions (column "Actions Recommended" of *PFMEA*/*PFMEA-RMP-RC.xlsx*) to improve controls or reduce the occurrence of a cause of a failure mode. If required the process must be redesigned in order to eliminate the cause and failure mode or reduce the severity. 12. Assign action's responsible (column "Responsible" of *PFMEA*/*PFMEA-RMP-RC.xlsx*). 13. Carry out the actions and register the dates. (columns "Actions taken" and "date" of *PFMEA*/*PFMEA-RMP-RC.xlsx*) 14. Recalculate the RPN after the actions has been taken in order to know if the risk fell. 15. Develop a *Schedule* to periodically review and update new risks (see A3.15 Supervise risk control as per *Processes Risk Management Plan*) taking into account the *Improvement Suggestions Report*, the Assessment *Report* and any feedback of the RP and the personnel related to the process under analysis. It is recommended that keep the *PFMEA* as a "living document" updating it periodically to identify and register arising risks.

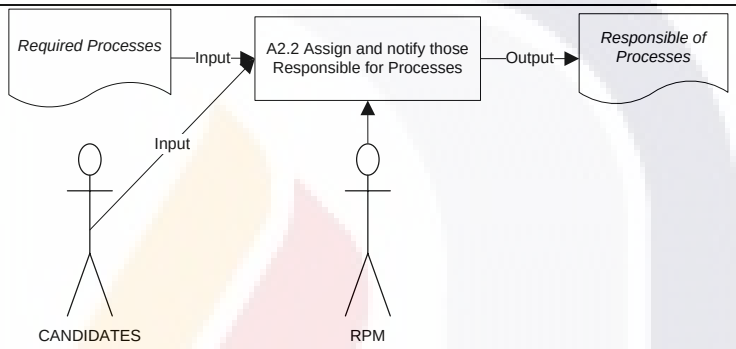
Notes	• The scales of the columns “severity” (SEV), “occurrence” (OCC) and “detection rating” (DET) of the columns must be the same. • The procedures presented in this activity to develop a risk management plan are those of the Six Sigma’s Process Failure Mode Effects and Analysis (see *PFMEA/PFMEA-RMP-RC.xlsx*), which allows to identify risks, procedures of mitigation, prevention and responsible, as well as prioritize them to create a risk management plan.
Diagram	

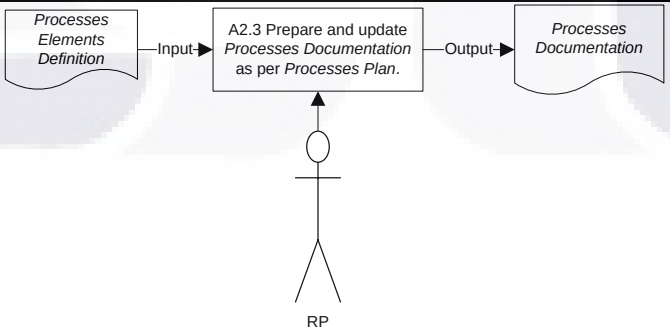
TASK Level 1	*A1.7 Integrate the Processes Plan.*
Inputs	*Schedule to Keep and Improve Processes.* *Acquisition and Training Plan.* *Training Syllabus.* *Assessment Plan.* *Processes Measurement Plan.* *Risk Management Plan*.
Outputs	*Processes Plan.*
Related templates	*Schedule.* *Acquisition and Training Plan.* *Training Syllabus.* *Assessment Plan.* *Processes Measurement Plan.* *PFMEA/PFMEA-RMP-RC.xlsx.*
Responsible	RPM
Recommended steps	1. Once all the documents listed as inputs are complete, integrate them in a unique document and name it *Processes Plan*.
Notes	None
Diagram	

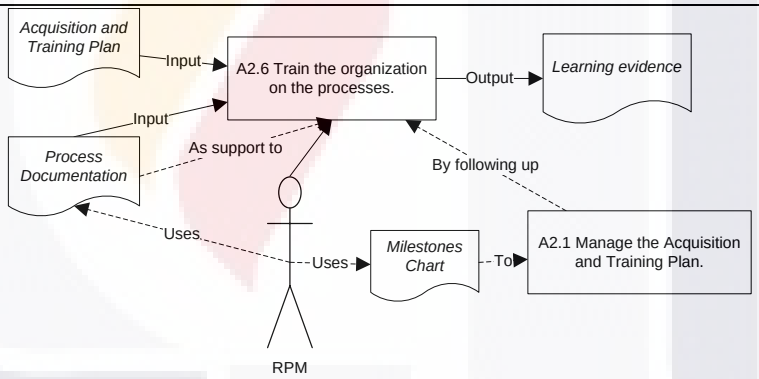
ACTIVITY A.2 PREPARATION FOR THE IMPLEMENTATION

G2.	Follow up the process definition, implementation and improvement activities according to the *Processes Plan*.

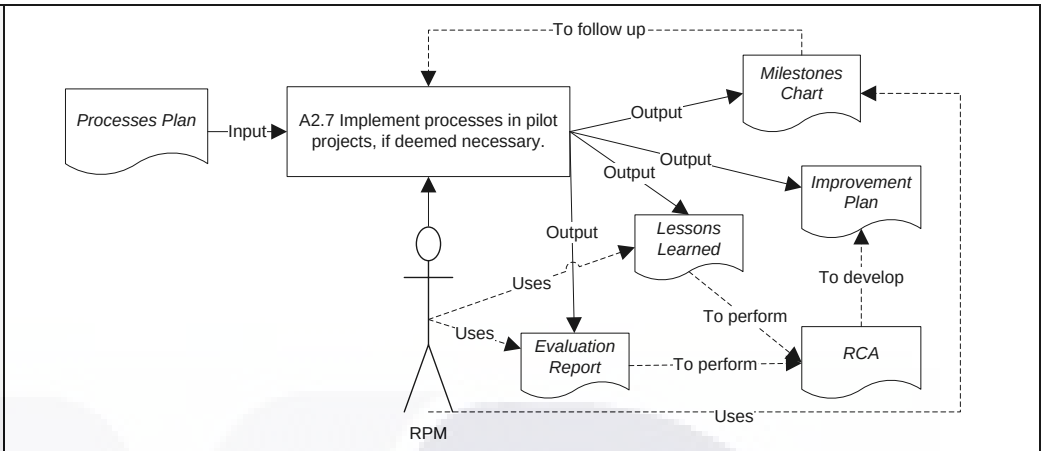
TASK **Level 1**	*A2.1 Manage the Acquisition and Training Plan identified in the Processes Plan.*
Inputs	*Acquisition and Training Plan*
Outputs	*Milestones Chart*
Related templates	*MC/Milestones Chart.xlsx*
Responsible	RPM
Recommended steps	Monitor activities defined in the *Acquisition and Training Plan* consider the following steps: 1. Use a *MC/Milestones Chart* to define: a. The milestones. b. The related activities related to each milestone. c. The start, end and current date of the activities. d. Calculate the time left to accomplish an activity by subtracting the end date from the current date. e. Calculate the estimated time to accomplish the activity by subtracting the start date from the current date. f. Calculate the accumulated days since the activity started, by subtracting the current date from the start date. g. Calculate the time lag by subtracting the current date from the end date. h. Register the percentage of progress for each activity. i. If any, register a note. 2. If using a *Gantt Chart,* update it. 3. If a problem arises, perform risk analysis activities (see A1.6 Establish or update the *Risk Management Plan* for Process Management and A1.15 Supervise risk control as per *Processes Risk Management Plan*).
Notes	• As the purpose of this activity the same than A3.1 Follow up process implementation activities on the *Schedule* established in *Processes Plan* and *A3.14 Follow up on Actions Plan and Improvement Plan*, the same steps and tools apply. • If a risk analysis was performed, execute activities of risk control (see A1.15 Supervise risk control as per *Processes Risk Management Plan*).
Diagram	

TASK / Level 1	*A2.2 Assign and notify those Responsible for Processes.*
Inputs	*Required Processes*
Outputs	*Notification of assignation*
Related templates	*Responsible of Processes*
Responsible	RPM
Recommended steps	1. Make a list of the candidates to be responsible of processes. 2. Assign responsible to each process considering skills, knowledge, experience, and training. 3. Notify the responsible of processes and register his acknowledgement (e.g. the signature of the responsible in the assignation document, please see column "Signature of acknowledgement" of the template *Responsible of Processes*).
Notes	The Process Documentation must be delivered to each responsible.
Diagram	

TASK Level 1	*A2.3 Prepare and update Processes Documentation as per Processes Plan.*
Inputs	*Required Processes* *Process Elements Definition*
Outputs	*Processes Documentation*
Related templates	*Processes Documentation*
Responsible	RP (Owner) RPM (Optional)
Recommended steps	Document the processes of the organization according to the elements and pattern defined in: *A1.1 Establish or update the Processes Elements Definition*. Be aware that the *Processes Documentation* must contain the following elements and structure regardless the pattern that is used to describe the process: • Process name. • Purpose. • Description. • Goals. • Indicators. • Quantitative goals. • Responsibility and authority. • Related processes. • Inputs, outputs, and internal products. • Roles Involved and required training. • Activities and its descriptions. • Verification and validation. • Incorporation to Knowledge Base. • Infrastructure resources. • Measurements. • Exceptional situations. • Lessons learned. • Tailoring guide.
Notes	• None
Diagram	

TASK Level 1	*A2.6 Train the organization on the processes.*
Inputs	*Processes Documentation*. *Acquisition and Training Plan*.
Outputs	*Learning evidence (reports of assignments, exams, etc.).*
Related templates	*Acquisition and Training Plan* *Training Syllabus* *Schedule* *MC/Milestones Chart.xlsx*
Responsible	RPM RP
Recommended steps	1. Execute the *Training Plan* (see *Personnel*, *Required Training*, *Training Syllabus* and *Training Schedule* subsections of the *Acquisition and Training Plan*) and manage it as defined in *A2.1 Manage the Acquisition and Training Plan identified in the Processes Plan*.
Notes	• During the training process, evidence of learning must be generated (e.g. reports of assignments and exams). Such evidence must be considered and described in the *Training Syllabus*. • General training that could apply for all the areas of the organization must be considered (e.g. security awareness), and a *Training Plan* and a *Training Syllabus* must be developed for this purpose. • *Processes Documentation* could be used as support to teach the learners the process they are involved with.
Diagram	

TASK Level 1	*A2.7 Implement processes in pilot projects, if deemed necessary.*
Inputs	*Processes Plan*
Outputs	*Milestones Chart* *PFMEA* *Lessons Learned* *Evaluation Report* *Improvement Plan*
Related templates	*MC/Milestones Chart.xlsx* *PFMEA/PFMEA-RMP-RC.xlsx* *Lessons Learned* *Evaluation Report* *Improvement Plan* *RCA/RCA 5Whys.xlsx*
Responsible	RPM
Recommended steps	Depending of the level of maturity level, different activities may be executed and different steps may apply. The following are the basic steps that are recommended for a pilot implementation of a process: 1. Execute the *Processes Plan*. 2. During the execution of the *Processes Plan* to implement the pilot process: a. Follow up the activities using the *Milestones Chart*. b. Identify and register arising *risks* (see *PFMEA/PFMEA-RMP-RC.xlsx*). c. For level 3, is recommended to identify *Lessons Learned* (see A3.16 Identify *Lessons Learned* on processes and integrate them into the *Knowledge Base*) and to perform an *Assessment* (see A1.4 Establish or update the *Assessment Plan* and A3.4 Perform the evaluations set forth in the *Assessment Plan*) to generate an *Evaluation Report* with findings, actions plan, and process improvement opportunities. 3. Taking into account the *risks*, and for level 3 the *Lessons Learned* and *Evaluation Report*, *Suggest Improvements* and implement them (for level 3, develop an *Improvement Plan* and execute it, see A3.9 Generate *Improvement Plan* based on improvement suggestion analysis and on the improvement opportunities detected during the evaluation).
Notes	• Carrying out a *RCA* within (see *RCA 5Whys.xlsx*) a *PFMEA* (see *PFMEA-RMP-RC.xlsx*) is possible to identify the cause of the findings and therefore develop actions and improvement plan to improve processes. • Although the products *Lessons Learned*, *Evaluation Report*, and *Improvement Plan* require the execution of task of level 3, it is recommended for those organisations with level 1, to make an effort to implement them at least in an informal manner.

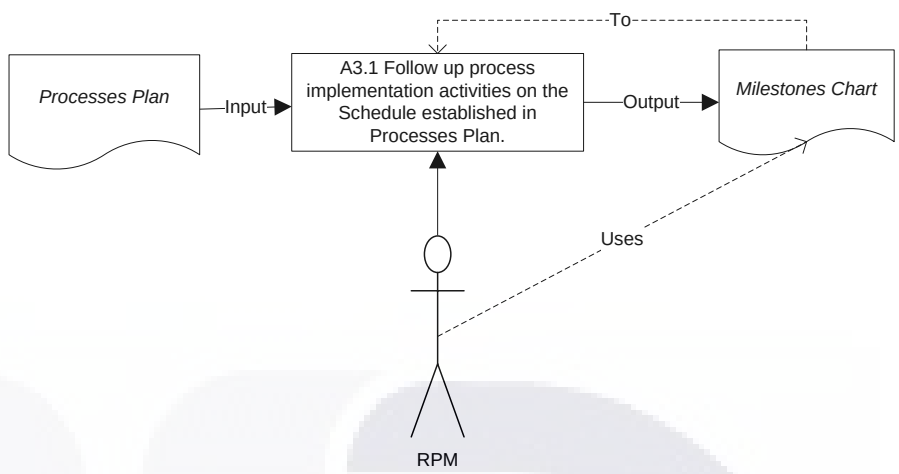
Diagram	

To follow up
Processes Plan
Input
A2.7 Implement processes in pilot projects, if deemed necessary.
Output
Milestones Chart
Output
Output
Improvement Plan
Output
Lessons Learned
Uses
To develop
To perform
Uses
Evaluation Report
To perform
RCA
RPM
Uses

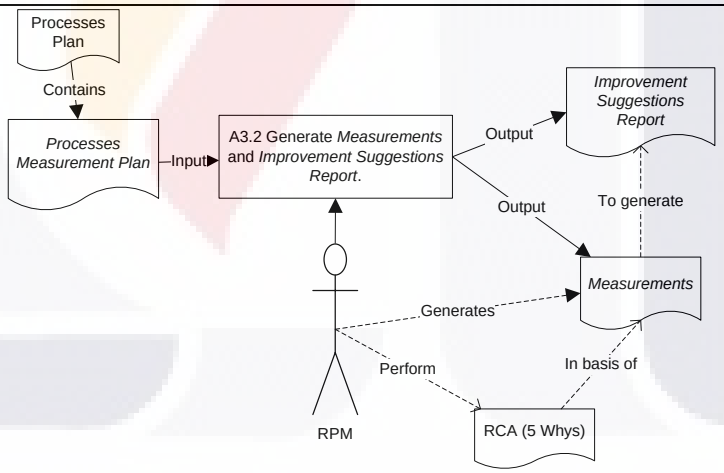
ACTIVITY A.3 EVALUATION AND CONTROL

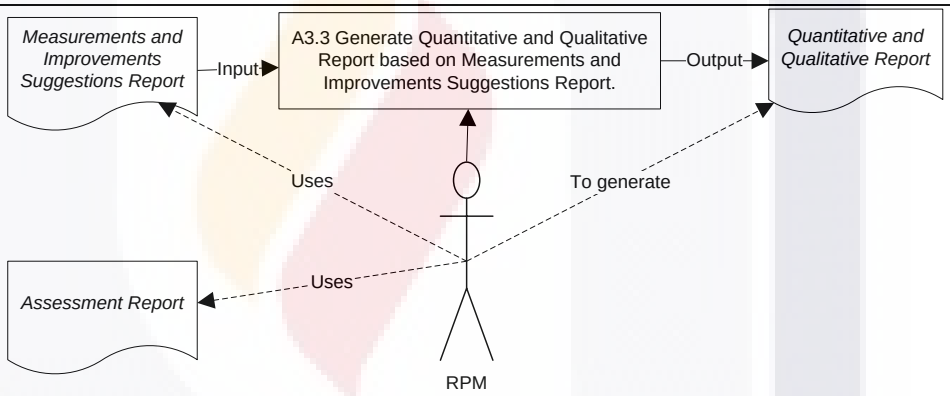
G2.	Follow up the process definition, implementation and improvement activities according to the *Processes Plan*.
G3.	Improving processes performance by complying with the *Improvement Plan*.
G4.	Keep Business Management informed of the processes performance through the *Quantitative and Qualitative Report*.

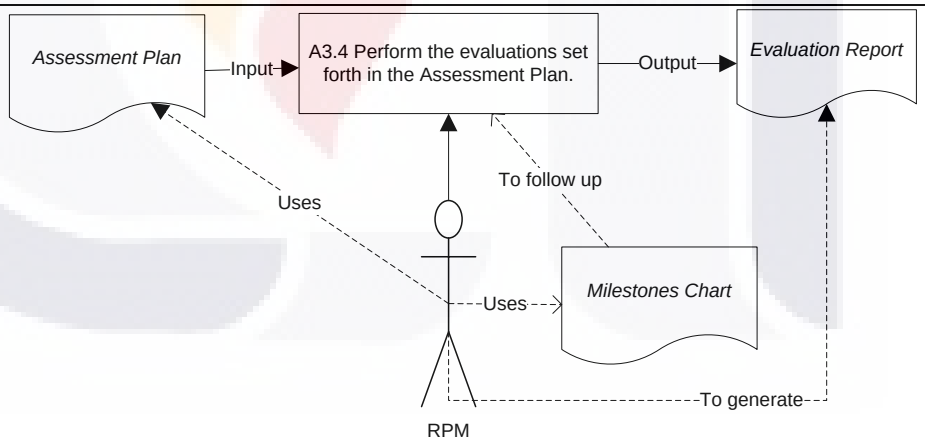
TASK / **Level 2**	*A3.1 Follow up process implementation activities on the Schedule established in Processes Plan.*
Inputs	*Processes Plan*
Outputs	*Milestones Chart*
Related templates	*MC/Milestones Chart.xlsx*
Responsible	RPM
Recommended steps	During the execution of the activities: 1. Using a *Milestones Chart*, define: a. The milestones. b. The related activities related to each milestone. c. The start, end and current date of the activities. d. Calculate the time left to accomplish an activity by subtracting the end date from the current date. e. Calculate the estimated time to accomplish the activity by subtracting the start date from the current date. f. Calculate the accumulated days since the activity started, by subtracting the current date from the start date. g. Calculate the time lag by subtracting the current date from the end date. h. Register the percentage of progress for each activity. i. If any, register a note. 2. If using a *Gantt Chart,* update it. 3. If a problem arises, perform risk analysis activities (see A1.6 Establish or update the *Risk Management Plan* for Process Management and A1.15 Supervise risk control as per *Processes Risk Management Plan*).
Notes	• A *milestone* is a stage that marks the end of something important, e.g. the completion of an activity, a phase, a period of time, a product, a component or sub product. • The value of dates is given in time so the units of days, hours, minutes, etc., could be used. • Time lag is the inverse of the time left. A positive number in the time lag indicates the extra time to the moment in the execution of an activity.

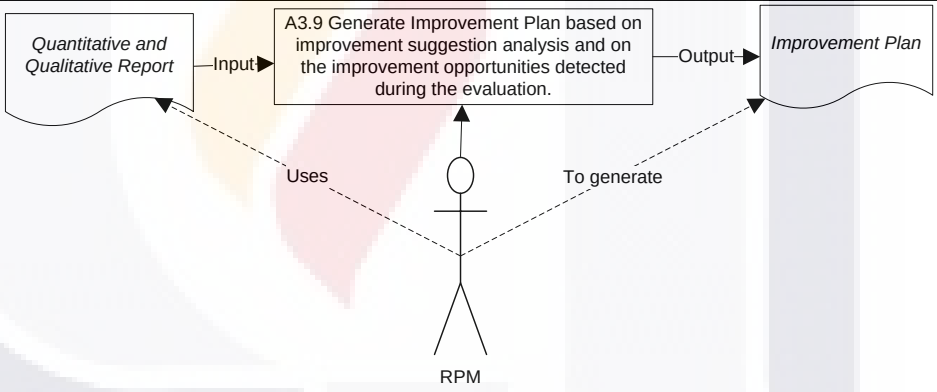
Diagram	

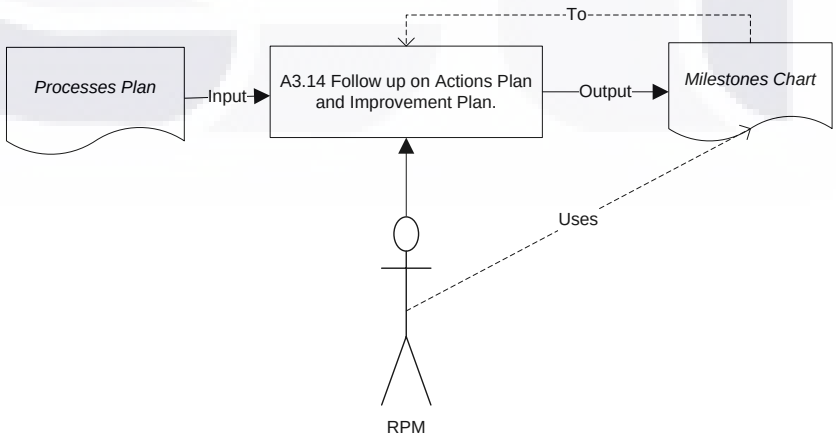
To
Processes Plan
Input
A3.1 Follow up process implementation activities on the Schedule established in Processes Plan.
Output
Milestones Chart
Uses
RPM

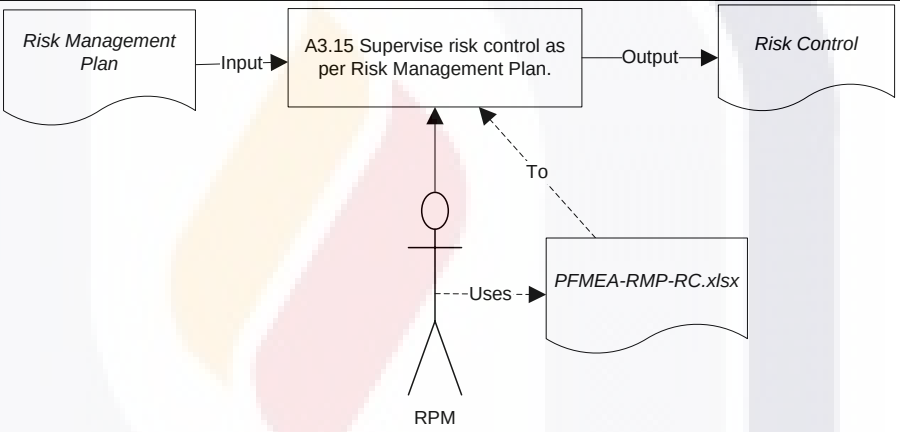
TASK Level 3	*A3.2 Generate Measurements and Improvements Suggestions Report for this process, as per Processes Measurements Plan.*
Inputs	*Process Measurements Plan*
Outputs	*Measurements and Improvement Suggestions Report*
Related templates	*Measurements and Improvement Suggestions Report* *RCA*/*RCA 5Whys.xlsx*
Responsible	RPM
Recommended steps	1. Execute the *Processes Measurements Plan* (see A1.5 Establish or update the *Processes Measurement Plan*) considering: a. To generate the measurements follow the procedures defined in the *Processes Measurements Plan* to collect data, and then use the formulae to determine the process' measurement value. b. Register the process and unit that were measured and they related indicator, as well as the max, min, expected and measured value in order to know if the measured process or unit performs into the specified limits, moreover if it is near to reach the target value (ideal value) and be aware if the organization's goals are being achieved through the indicators. 2. To generate the improvements suggestions report: a. Taking into account the measurements, identify cause of defects by perform a *RCA* (please see *RCA 5Whys.xlsx*), for each defect or process that is not complying with the maximum of defects allowed. b. After the cause is determined ask yourself "HOW to solve the problem?" in order to identify improvement suggestions and solutions to eliminate defects. c. Register the suggested improvements for each process and the element of the related process.
Notes	• None
Diagram	

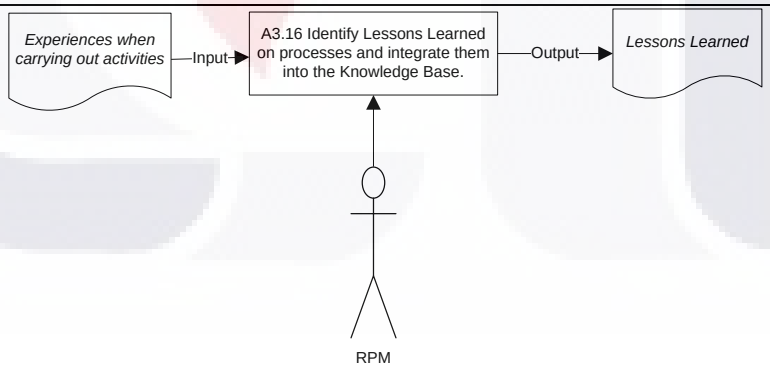
TASK Level 3	*A3.3 Generate Quantitative and Qualitative Report based on Measurements and Improvements Suggestions Report gathered, to be submitted to the Responsible for Business Management.*
Inputs	*Measurements and Improvements Suggestions Report*
Outputs	*Quantitative and Qualitative Report*
Related templates	*Quantitative and Qualitative Report*
Responsible	RPM
Recommended steps	Based on the *Measurements and Improvements Suggestions Report*, develop a *Summary of Findings* considering the following steps: 1. List the processes or products that were measured. 2. List the findings and describe them. 3. Describe the recommended actions for each finding. 4. Describe the suggested improvements for each finding. 5. Count the findings per product to calculate the subtotal of findings, and then make the summation of the subtotals in order to calculate the total of findings for all the products. 6. Submit the report to the RBM.
Notes	• Other source of that may findings may be considered is the *Evaluation Report*.
Diagram	

TASK Level 3	*A3.4 Perform the evaluations set forth in the Assessment Plan.*
Inputs	*Assessment Plan*
Outputs	*Evaluation Report*
Related templates	*Evaluation Report*
Responsible	ASR
Recommended steps	1. Carry the evaluations as defined in the *Assessment Plan*. 2. Describe the findings found during the evaluation considering the following: a. Specify the process or product that was measured. b. List the findings, assign an identifier (ID) and make a description. c. Describe the recommended actions for each finding. d. Describe the suggested improvements for each finding. e. Count the number of findings. 3. Develop an *Actions Plan*: a. Define activities to perform actions so the findings can be corrected. b. Define actions to be executed within an activity to correct a finding. c. List the affected process or product to be affected by executing the action. d. List the related finding to be corrected when executing the action. e. If required, make a list of required tools to execute the actions. f. Define start and end dates. g. Assign responsible. 4. Describe process improvement opportunities identified during the evaluation: a. List the processes with improvement opportunities. b. Make a description of the improvement opportunities. c. Justify the improvement opportunities.
Notes	Optionally, a *Milestones Chart* could be used to follow up the activities defined in the *Assessment Plan* during the evaluation.
Diagram	

TASK Level 3	*A3.9 Generate Improvement Plan based on improvement suggestion analysis and on the improvement opportunities detected during the evaluation.*
Inputs	*Quantitative and Qualitative Report*
Outputs	*Improvement Plan*
Related templates	*Improvement Plan*
Responsible	ASR RPM
Recommended steps	When the *Improvements Suggestions Report* identified during the evaluation is received, develop an *Improvement Plan* considering the following steps: 1. List the suggested improvement opportunities from the *Quantitative and Qualitative Report*. 2. Review and analyze the improvements and select those that are feasible, for this a *Brainstorming Workshop* could be carried out between the RPM and ASR. 3. Justify why the improvement is feasible. 4. Define expected results and/or target value. 5. Define a metric to measure the result of the improvement by establishing a formula and making its description. 6. If any, list the required tools to carry out the improvement. 7. Define start and end dates. 8. Assign responsible to carry out the improvements.
Notes	None.
Diagram	

TASK Level 3	*A3.14 Follow up on Actions Plan and Improvement Plan.*
Inputs	*Improvement Plan*.
Outputs	*Milestones Chart*.
Related templates	*MC/Milestones Chart.xlsx*. *Improvement Plan*.
Responsible	RPM
Recommended steps	To follow up the *Schedule* according to the *Actions* defined in the *Improvement Plan* consider the following steps: 1. Use a *Milestones Chart* to define: a. The milestones. b. The related activities related to each milestone. c. The start, end and current date of the activities. d. Calculate the time left to accomplish an activity by subtracting the end date from the current date. e. Calculate the estimated time to accomplish the activity by subtracting the start date from the current date. f. Calculate the accumulated days since the activity started, by subtracting the current date from the start date. g. Calculate the time lag by subtracting the current date from the end date. h. Register the percentage of progress for each activity. i. If any, register a note. 2. If using a *Gantt Chart,* update it. 3. If a problem arises, perform risk analysis activities (see A1.6 Establish or update the *Risk Management Plan* for Process Management and A1.15 Supervise risk control as per *Processes Risk Management Plan*).
Notes	A milestone is a stage that marks the end of something important, e.g. the completion of an activity or a phase, a period of time, the completion of a product, a component or sub product. The milestones must be defined in the planning stage. • As the purpose of this activity the same than A3.1 Follow up process implementation activities on the *Schedule* established in *Processes Plan* and A2.1 Manage the Acquisition and Training Plan identified in the Processes Plan, the same steps and tools apply. • If a risk analysis was performed, execute activities of risk control (see A1.15 Supervise risk control as per *Processes Risk Management Plan*).
Diagram	

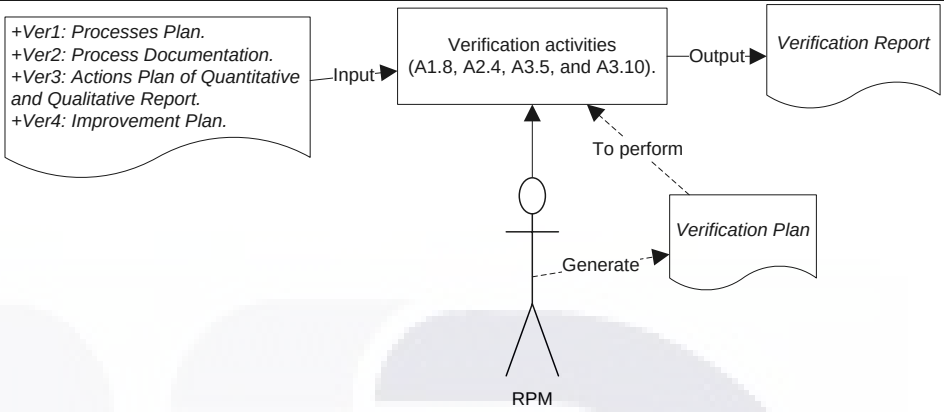
TASK Level 2	*A3.15 Supervise risk control as per Processes Risk Management Plan.*
Inputs	*Risk Management Plan*
Outputs	*Risk Control*
Related templates	*PFMEA-RMP-RC.xlsx*
Responsible	RPM
Recommended steps	1. Execute the Risk Management Plan according to its *Schedule*. 2. Supervise identified risks and identify arising risks and perform a *PFMEA* (if exist, use and update the existing one) in order to define the respective controls. 3. Develop a summary of findings specifying (see sheet *Risk Control* of the template *PFMEA*/*PFMEA-RMP-RC.xlsx*) a. The date of the assessment, the responsible, his role and name. b. Description of the findings, assign an ID, the actions taken, date it was found and the role and person who found it. c. If any, register notes.
Notes	None.
Diagram	

TASK Level 3	*A3.16 Identify Lessons Learned on processes and integrate them into the Knowledge Base.*
Inputs	Experiences when carrying out activities
Outputs	*Lessons Learned*
Related templates	*Lessons Learned*
Responsible	All roles involved, mainly the RPM
Recommended steps	1. Every person may identify and register their lessons learned (see *Lessons Learned*) during the execution of their activities by: a. Identifying lessons learned such as: i. Best practices. ii. Recurring problems and its possible solutions. iii. Successful management experiences. iv. Common mistakes. v. Frequently Asked Questions. b. Registering the lessons learned grouping them in categories such as: i. Lessons learned that lead to success. ii. Dont's: iii. Common mistakes. iv. Be careful with. c. Assigning a number. d. Making a description. e. Specifying the person who found it, with his role and name. f. Specifying the dates that the lessons learned was found. 2. Then, in a team meeting, present them and discuss them. During the meeting new lessons learned may arise when the members of the team express their ideas and they must be registered as well. 3. Once the lessons learned have been defined and approved by the team, concentrate them in a document (see : *Lessons Learned*) that will be part of the *Knowledge Base*. 4. Periodically update the document of *Lessons Learned*.
Notes	• None
Diagram	

VERIFICATIONS

TASK	Level	Inputs	Outputs	Responsible
A1.8 Verify the Processes Plan (Ver1)	2	• *Processes Plan.* • *(Ver1).*	• *Processes Plan*	RPM
A2.4 Verify Process Documentation (Ver2)	2	• *Processes Documentation* • *(Ver2)*	• *Processes Documentation*	RPM
A3.5 Verify the Actions Plan (Ver3)	3	• *Qualitative and Quantitative Report +Actions Plan.* • *(Ver3)*	• *Qualitative and Quantitative Report +Actions Plan.*	RPM
A3.10 Verify Improvement Plan (Ver4)	3	• *Improvement Plan* • *(ver4)*	• *Improvement Plan*	RPM

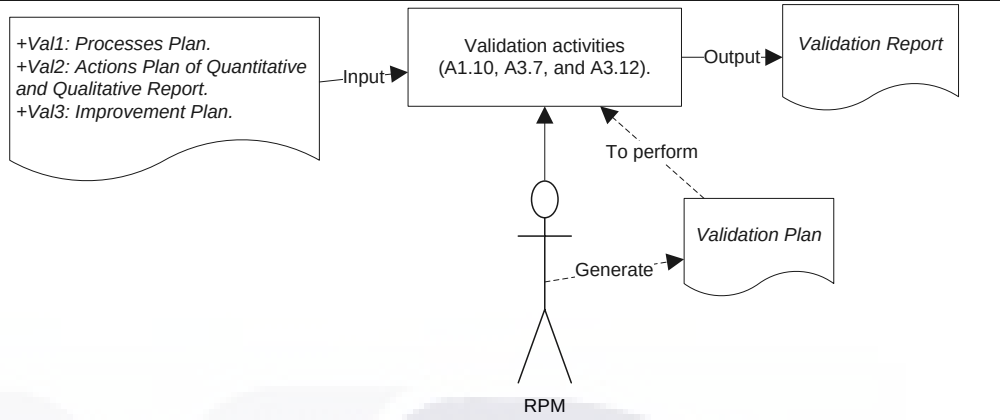
Related templates	*Verification/Validation Plan* *Verification/Validation Report*
Recommended steps	1. Develop a *Verification Plan* considering the following: a. Define product(s) to be verified. b. Define requirements to be satisfied by each product, e.g.: i. Completeness and correctness. ii. Expected when measuring the value(s) of a unit. c. Define verification criteria, e.g.: i. The range of acceptance for each requirement. ii. The absence or presence of something. iii. If a measurement of a unit is required, define expected, maximum and minimum values. d. Define verification procedures, addressing the technical approaches that will be used to evaluate whether a product meets its requirements or not. e. Define the required tools (e.g. peer review checklists including completeness, correctness, design guidelines, rules of construction among others) to carry out the verification. f. Optionally, develop a schedule to perform the verification. 2. Carry out the verification conducting peer reviews checking whether a **product meets its requirements or not**, considering the following: a. For **Ver1:** check the feasibility and consistency of the elements contained in the *Processes Plan* (see A1.7 Integrate the *Processes Plan*). b. For **Ver2:** check that processes identified in the *Processes Plan* are documented as per the *Process Elements Definition* and that they are consistent (see A2.3 Prepare and update *Process Documentation* as per *Processes Plan*). c. For **Ver3:** check that actions are established for all identified findings of the evaluations according to the *Assessment Plan* (see A3.4 Perform evaluations set forth in the *Assessment Plan*). d. For **Ver4:** check that an answer is given to all identified improvement opportunities detected during the evaluation (see A3.9 Generate *Improvement Plan* based on improvement suggestion analysis and on the improvement opportunities detected during the evaluation). 3. Analyze resulting data and develop a *Verification Report*, which may contain the following: a. Date and duration. b. Participants. c. Number of defects found. d. Description of defects found. e. Suggestions of corrections for each finding. Perform a *RCA* (see *RCA 5Whys.xlsx*) to determine the root of defects and develop a solution. f. The person who found the defect. g. Suggestions to correct each defect.

Notes	• Keep in mind that verification focuses on answering the following question: ***Are we building the product correctly?*** • A defect also can be referred as a finding.
Diagram	

VALIDATIONS

TASK	Level	Inputs	Outputs	Responsible
A1.10 Validate the Processes Plan (Val1)	2	• *Processes Plan* • *(Val1)*	*Processes Plan*	RPM
A3.7 Validate the Actions Plan (Val2)	3	• *Qualitative and Quantitative Report. + Actions Plan.* • *(Val2)*	• *Qualitative and Quantitative Report +Actions Plan.*	RPM
A3.12 Validate Improvement Plan (Val3)	3	• *Improvement Plan* • *(Val3)*	*Improvement Plan*	RPM

Related templates	*Verification/Validation Plan* *Verification/Validation Report*
Recommended steps	1. Develop a *Validation Plan* considering the following: a. Define product(s) to be validated. b. Define requirements to be satisfied by each product, e.g. i. Compliance with organizational objectives or goals according to the strategic planning of the organization. c. Define validation criteria. i. The range of acceptance for each requirement. ii. The absence or presence of something. iii. If a measurement of a unit is required, define expected, maximum and minimum values. d. Define validation procedures, addressing the technical approaches that will be used to evaluate whether a product is feasible for the organization by helping to meet they objectives or goals. e. Define the required tools (e.g. peer review checklists including customer acceptance criteria, completeness, correctness, among others) to carry out the validation. f. Optionally, develop a schedule to perform the validation. 2. Carry out the validation conducting peer reviews checking whether a **product is useful for its intended use**, considering the following: a. For **Val1:** check that the *Process Plan* is consistent and in accordance with the *Strategic Plan* (see A1.7 Integrate the *Processes Plan*). b. For **Val2:** check that the *Actions* specified in the *Actions Plan* (and the other elements of the *Evaluation Report*), which are identified when an assessment is performed, are feasible to meet the organization's objectives or goals (see A3.4 Perform the evaluations set forth in the *Assessment Plan*). c. For **Val3:** check that the *Improvements* specified in the *Improvement Plan* are feasible to meet the organization's objectives or goals (see A3.9 Generate *Improvement Plan* based on improvement suggestions analysis and on the improvement opportunities detected during the evaluation). 3. Analyze resulting data and develop a *Validation Report*, which may contain the following: a. Date and duration. b. Participants. c. Number of defects found. d. Description of defects found. e. Suggestions of corrections for each defect. If required perform a *RCA* (see *RCA 5Whys.xlsx*) to determine the root of the findings and develop a solution. f. The person who found the defect. g. Suggestions to correct each defect.
Notes	• Keep in mind that verification focuses on answering the following question: ***is the right product?*** • A defect can also be referred as a finding.

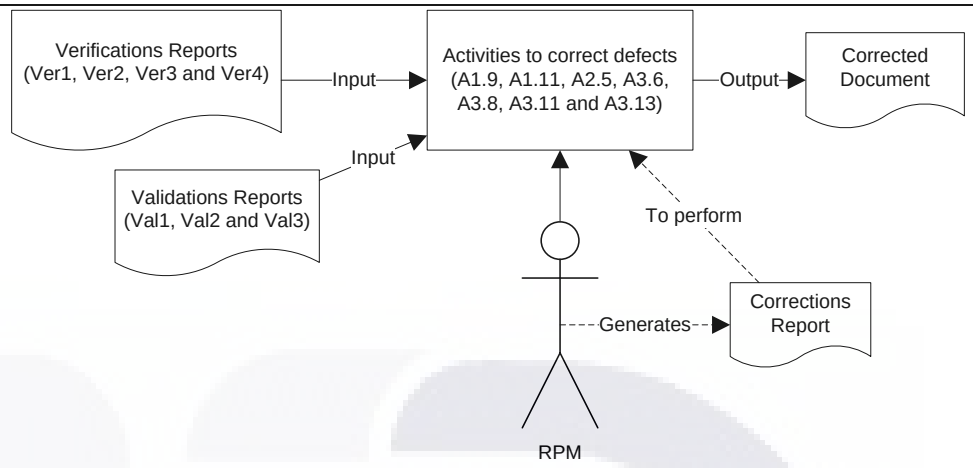
Diagram	

+Val1: Processes Plan.
+Val2: Actions Plan of Quantitative and Qualitative Report.
+Val3: Improvement Plan.
Input
Validation activities
(A1.10, A3.7, and A3.12).
Output
Validation Report
To perform
Validation Plan
Generate
RPM

CORRECTION OF DEFECTS

TASK	Level	Inputs	Outputs	Responsible
A1.9 Correct defects found in the Processes Plan based on the Verification Report and obtain approval for corrections.	2	*Processes Plan* *Verification report* ***(Ver1)***	*Processes Plan* *Corrections Report*	RPM
A1.11 Correct defects found in the Processes Plan based on the Validation Report and obtain approval for corrections.	2	*Processes Plan* *Validation Report* ***(Val1)***	*Processes Plan* *Corrections Report*	RPM
A2.5 Correct defects found in Process Documentation based on Verification Report and obtain approval for corrections.	2	*Processes Documentation Verification Report* ***(Ver2)***	*Processes Documentation Corrections Report*	RPM
A3.6 Correct defects found in Actions Plan based on Verification Report and obtain approval for corrections.	3	*Actions Plan Verification Report* ***(Ver3)***	*Actions Plan Corrections Report*	RPM
A3.8 Correct defects found in Actions Plan based on Validation Report and obtain approval for corrections.	3	*Actions Plan Validation Report* ***(Val2)***	*Actions Plan Corrections Report*	RPM
A3.11 Correct defects found in Improvement Plan based on Verification Report and obtain approval for corrections.	3	*Improvement Plan Verification Report* ***(Ver4)***	*Improvement Plan Corrections Report*	RPM
A3.13 Correct defects found in Improvement Plan based on Validation Report and obtain approval for corrections.	3	*Improvement Plan Verification Report* ***(Ver4)***	*Improvement Plan Corrections Report*	RPM

Related templates	*Corrections Report*
Recommended steps	As can be seen in the activities presented above, all of them are about correcting defects, so the same procedures apply for all of them. 1. Generate a *Corrections Report* for each validation document with a summary of the corrections specifying: a. An ID and the name of the document where the error is. b. The error. c. The section where the error is. d. The correction to be made to eliminate the error. e. The rationale to justify why that correction is appropriate to eliminate the error. f. The role and name of the responsible that is going to make the corrections. g. Whether the correction is approved or not. h. The role and name of the responsible that approve or disapprove the correction. 2. Carry out the corrections and then, update the document registering the dates when the corrections were done. 3. The responsible of the approbations must sign to provide evidence that acknowledges with the acceptation or revocation of the corrections, as well as the dates when the corrections were made.

Notes	None.
Diagram	

IV. TEMPLATES

This section presents a set of nineteen (19) templates (see Table 6) to support the resulting products when executing the *Recommendations to Implement the Tasks of MAN.1*.

No	Template
1	*Cover Page*
2	*Acquisition and Training Plan*
3	*Assessment Plan*
4	*Corrections Report*
5	*Evaluation Report*
6	*Improvement Plan*
7	*Lessons Learned*
8	*Measurements and Improvements Suggestions Report*
9	*MC/Milestones Chart.xlsx*
10	*PFMEA/PFMEA-RMP-RC.xlsx*
11	*Processes Documentation*
12	*Processes Measurements Plan*
13	*Qualitative and Quantitative Report*
14	*RCA/RCA 5Whys.xlsx*
15	*Responsible of Processes*
16	*Schedule*
17	*Training Syllabus*
18	*Verification/Validation Plan*
19	*Verification/Validation Report*

Table 5. List of proposed templates.

Note: Documents could be composed of one or more templates, but all of them must have a cover page. The template *Cover Page*, must be included in every document generated from the templates presented in this guideline, as it presents the following commons characteristics or sections applicable to them:

- Title and ID of the document.
- Version of the document.
- Title and ID of the project.
- Department.
- Name of the Process.
- The date the document saved or printed as a final version.
- The classification of the document.
- The location, physical or logical, of the document.

COVER PAGE (TITLE OF THE DOCUMENT) /(ID)

Version of the Document

Project Title /(ID)

Department

Process

Printing Date

Classification (Public/Internal/Confidential/Restricted)

Location of electronic version of file

OVERVIEW

TARGET AUDIENCE

VERSION CONTROL HISTORY

ID	Document	Version	Changes	Date completed	Responsible

DOCUMENT APPROVAL

The following stakeholders have reviewed the information contained in this document and agree with its content.			
Name	**Role/Owner**	**Signature**	**Date**

* DEFINITIONS, ACRONYMS, AND ABBREVIATIONS.

TABLE OF CONTENTS

DESCRIPTION/ORGANIZATION OF THE DOCUMENT

CONTENT OF THE DOCUMENT

REFERENCES

APPENDICES

* Where applicable.

ACQUISITION AND TRAINING PLAN

PERSONNEL

No	Role	Name

REQUIRED TRAINING

No	Role	Training

TRAINING SYLLABUS

Attach the training syllabus that was developed according to the required training (see *Training Syllabus*).

TRAINING SCHEDULE

Attach the schedule for the activities of the training (see *Schedule*).

REQUIRED RESOURCES

No	Resource	Description	Justification

AVAILABLE RESOURCES

No	Resource

MISSING RESOURCES

No	Resource

ACQUISITION PROCESS

Insert and describe the diagram for the process of acquisition.

SUPPLIER SELECTION CRITERIA

No	Criteria

POSSIBLE SUPPLIERS OF MISSING RESOURCES

No	Supplier	Resource	Email	Phone	Address

ACQUISITION SCHEDULE

Attach the schedule for the activities of acquisition of required resources (see *Schedule*).

ASSESSMENT PLAN

TYPE OF EVALUATION

Select (mark) one of the above:

Internal		External	

PURPOSE

SCOPE

REQUIRED RESOURCES

ID	Resource	Description

EVALUATION CRITERIA

ID	Goal	Question	Rating scale	
			ID	*Description*
EC1	Evaluate the existence of base practices.	The practice is implemented and produces identifiable work products?	**N**	**Non-Existent:** The practice is either not implemented or does not produce any identifiable work products.
			Y	**Existent:** The practice is implemented and produces identifiable work products
EC2	Evaluate the adequacy of existing practices.	The practice satisfies its purpose?	**N**	**Not adequate:** The practice is either not implemented or does not to any degree satisfy its purpose.
			P	**Partially adequate:** The implemented practice does little to satisfy its purpose.
			L	**Largely adequate:** The implemented practice largely satisfies its purpose.
			F	**Fully adequate:** The implemented practice fully satisfies its purpose.

EC3	Evaluate the completion of activities.	The activities are completed on time and with the resources planned?	**N**	**Non-Existent:** The practice is either not implemented or does not produce any identifiable work products;
			Y	**Existent:** The implemented practice produces identifiable work products.

METHODS

Evaluation ID	Description

SCHEDULE

Attach a schedule (please see the template of *Schedule*).

CORRECTIONS REPORT

SUMMARY OF CORRECTIONS

ID	Document	Error	Section	Correction	Rationale	Responsible	
						Role	*Name*

APPROVAL

ID	Approval of correction			Date corrected		Responsible of approval	
	Yes	*No*	*Signature*	*Date*	*Signature*	*Role*	*Name*

EVALUATION REPORT

FINDINGS

Product/Process					
Finding		Recommended Actions	Suggested Improvements		Notes
ID	*Description*		*ID*	*Description*	
Total					

ACTIONS PLAN

Activity	Action	Affected process/product	Related finding (ID)	Tool	Date		Responsible
					Start	*End*	

PROCESS IMPROVEMENT OPPORTUNITIES

Process	Improvement opportunity	Rationale	Suggested by	
			Role	*Name*

IMPROVEMENT PLAN

IMPROVEMENTS

Process/Product 1										
ID	**Improvement**	**Rationale**	**Expected results and/or target value**	**Metric**		**Tools**	**Dates**		**Responsible**	
				Formula	*Description*		*Start*	*End*	*Role*	*Name*

Process/Product 1										
ID	**Improvement**	**Rationale**	**Expected results and/or target value**	**Metric**		**Tools**	**Dates**		**Responsible**	
				Formula	*Description*		*Start*	*End*	*Role*	*Name*

SCHEDULE

This part is to be covered using the template of *Schedule*.

LESSONS LEARNED

LESSONS LEARNED THAT LEAD TO SUCCESS

No	Name	Description	Found by		Date
			Role	*Name*	

DONT'S

No	Name	Description	Found by		Date
			Role	*Name*	

COMMON MISTAKES

No	Name	Description	Found by		Date
			Role	*Name*	

BE CAREFUL WITH

No	Name	Description	Found by		Date
			Role	*Name*	

MEASUREMENTS AND IMPROVEMENT SUGGESTIONS REPORT

SUMMARY OF MEASUREMENTS

Process	Unit	Related indicator (ID)	Max value	Min value	Target value	Measured value

IMPROVEMENT SUGGESTIONS

ID	Improvement	Related process	Element of the related process

MILESTONES CHART

Process										
Event	Related activity	Start date	End date	Current date	Time left (days)	Estimated time (days)	Accumulated time (days)	Time lag (days)	Progress	Notes

PROCESSES DOCUMENTATION

PROCESSES

No	ID	Name	Category	Responsible	
				Role	*Name*

DESCRIPTION

Process name	See section *II. THE PROCESS MANAGEMENT OF MOPROSOFT (MAN.1)*.
Category	See subsection *Category* of section I.
Purpose	See subsection *Purpose* of section I.
Description	See subsection *Description* of section I.
Quantitative Goals	See subsection *Quantitative Goals and Measurements* of section I.
Qualitative Goals	See subsection *Goals* of section I.
Indicators	See subsection *Indicators* of section I.
Responsibility and Authority	See subsection *Responsibility and Authority* of section I.
Related Processes	See subsection *Related Processes* of section I.
High Level Process Diagram	----------
Detailed Process Diagrams	----------
Inputs **Outputs** **Internal Products**	See subsection *Inputs, Outputs and Internal Products* of section I.
Roles Involved	See subsection *Roles Involved* of section I.
Training	See subsection *Training* of section I.
Activities	See subsection *Activities* of section I.
Activities description	See SECTION II. RECOMMENDATIONS TO IMPLEMENT THE ACTIVITIES OF MAN.1.
Verifications and validations	See subsections *Verifications* and *Validations* of section II.
Incorporation to the Knowledge Base	See subsection *Knowledge Base* of section I.
Infrastructure Resources	See subsection *Infrastructure Resources* of section I.
Measurements	See subsection *Quantitative Goals and Measurements* of section I.
Exceptional situations	See subsection *Exceptional Situations* of section I.
Lessons Learned	See subsection *Lessons Learned* of section I.
Tailoring Guide	----------

PROCESSES MEASUREMENTS PLAN

PROCESSES MEASUREMENTS

Process 1												
Related indicator (ID)	Defect	Metric		Values			Procedures	Tool	Responsible		Start date	Periodicity
		Formula	Description	Target	Max	Min			*Role*	*Name*		

Process 2												
Related indicator (ID)	Defect	Metric		Values			Procedures	Tool	Responsible		Start date	Periodicity
		Formula	Description	Target	Max	Min			*Role*	*Name*		

*SCHEDULE

This part is to be covered using the template of *Schedule*.

* If necessary

QUALITATIVE AND QUANTITATIVE REPORT

SUMMARY OF FINDINGS

Product/Process	Finding *Description*	Recommended Actions	Suggested Improvements
Subtotal			
Subtotal			
Total			

RESPONSIBLE OF PROCESSES

ASSIGNATION MATRIX

Name	Process	Date of notification	Signature of acknowledgment

RISK MANAGEMENT PLAN (PFMEA)

Part 1:

Date	ID	Process activity/task/step	Input	Output	Potential Failure Mode	Potential Failure Effects	SEV	Potential Causes	OCC	Current Controls	DET	RPN
		What is the process step	What is the input of the step?	What is the outcome of the step?	In what ways does the Key Input go wrong?	What is the impact on the Key Output Variables (Customer Requirements) or internal requirements?	How Severe is the effect to the customer?	What causes the Key Input to go wrong?	How often does cause or FM occur?	What are the existing controls and procedures (inspection and test) that prevent eith the cause or the Failure Mode?	How well can you detect cause or FM?	What is the highest risk?

Part 2:

Actions Recommended	Responsible person	Actions Taken	Date	Recalculated SEV	Recalculated OCC	Recalculated DET	Recalculated RPN
What are the actions for reducing the occurrence of the Cause, or improving detection? Should have actions only on high RPN's or easy fixes.	Whose Responsible for the recommended action?	What are the completed actions taken with the recalculated RPN? Be sure to include completion month/year	What was the date when the actions were executed?				
							0

ROOT CAUSE ANALYSIS (RCA) – 5 WHYS?

Problem:	

Categories	Root Causes	Why? 1	Why? 2	Why? 3	Why? 4	Why? 5	Why? 6
People							
Materials							
Measurements							
Environment							
Methods							
Infrastructure							

SCHEDULE

ACTIVITIES

No	Activity	Description

ASSIGNATION OF ACTIVITIES

No	Activity	Responsible		Date		
		Role	*Name*	*Start*	*End*	*Periodicity**

PROCEDURES AND TOOLS

No	Activity	Procedure	Tool	
			Name	*Description*

**GANTT CHART

Develop and attach a Gantt chart with the identified activities. It is important to take into account the sequence of the activities.

* Where applicable.

** Optional.

TRAINING SYLLABUS

COURSE DESCRIPTION

COURSE DATES

- Start date:
- End date:

COURSE MATERIAL

1. Book 1
2. Book 2

GOALS

- General goal: a goal is the overall results or capabilities you hope to attain by implementing your training plan.
- Specific goals
    - Specific goal x: pass supervision qualification test.

LEARNING OBJECTIVES

- General objective: an objective is what you will be able to do as a result of the learning activities in this plan.
- Specific objectives:
    - Specific objective x: exhibit required skills problem solving and decision making.

EVALUATION

Evaluations refer to the assessment and judgement to conclude whether a student achieved the learning objectives or not.

ASSIGNMENTS

Tasks that will allow the student acquire knowledge to achieve the learning objectives.

TOPICS

Unit	Content	Date

POLICIES

VERIFICATION/VALIDATION PLAN

PRODUCTS

ID	Product

DESCRIPTION

Product									
ID									
Requirement	Procedure	Criteria				Tool	Responsible		
		Description	*Value**				*Role*	*Name*	
			Expected	Max	Min				

**SCHEDULE

This part is to be covered using the template of *Schedule*.

* Where applicable.

** Optional.

VERIFICATION/VALIDATION REPORT

Date		Duration	

PARTICIPANTS

Name	Role

FINDINGS

Product		Defect			Found by	Suggested corrections
ID	*Name*	*Description*	*Actual value**	*Expected Value**		
Total defects:						

* Where applicable.

RELATIONSHIPS BETWEEN ACTIVITIES AND TEMPLATES

This subsection presents in tables 3 and 4, the relationships between activities and templates of products through a matrix, in which the rows contain the activities and the columns the templates of products. This matrix is useful to identify the products that are generated through each activity.

Activity	A1. Planning (G1)											A2. Preparation for the Implementation (G2)						
Responsible	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RPM	RBM	RPM	RPM	RPM	RP	RPM	RPM	RPM RP	RPM
Level	1	1	1	1	3	1	1	2	2	2	2	1	1	1	2	2	1	1
Task→ ---------- Template ↓	A1.1 Establish or update the *Process Elements Definition*.	A1.2 Establish *Schedule* to keep and improve processes.	A1.3 Establish or update the *Acquisition and Training Plan*.	A1.4 Establish or update the *Assessment Plan*.	A1.5 Establish or update the *Processes Measurement Plan*.	A1.6 Establish or update the *Risk Management Plan* for Process Management.	A1.7 Integrate the *Processes Plan*.	A1.8 Verify the *Processes Plan* **(Ver1)**.	A1.9 Correct defects found in the *Processes Plan* based on the *Verification Report* and obtain approval for corrections.	A1.10 Validate the Processes Plan **(Val1)**.	A1.11 Correct defects found in the *Processes Plan* based on the *Validation Report* and obtain the approval of corrections.	A2.1 Manage the *Acquisition and Training Plan* identified in the *Processes Plan*.	A2.2 Assign and notify those Responsible for Processes.	A2.3 Prepare and update *Process Documentation* as per *Processes Plan*.	A2.4 Verify *Process Documentation* **(Ver2)**.	A2.5 Correct defects found in *Process Documentation* based on *Verification Report* and obtain approval of corrections.	A2.6 Train the organization on the processes.	A2.7 Implement processes in pilot projects, if deemed necessary.
Cover Page	All documents generated conformed by one or more templates.																	
Acquisition and Training Plan			X				X										X	
Assessment Plan				X			X											
Corrections Report									X		X					X		
Evaluation Report																		X
Improvement Plan																		X
Lessons Learned																		X
Measurements and Improvements Suggestions Report																		
MC/Milestones Chart.xlsx												X				X		X
PFMEA/PFMEA-RMP-RC.xlsx						X	X											X
Processes Documentation	X													X				
Processes Measurements Plan					X		X											
Qualitative and Quantitative Report																		
RCA/RCA 5Whys.xlsx																		X
Responsible of Processes													X					
Schedule		X	X		X	X	X											
Training Syllabus			X				X										X	
Verification/Validation Plan								X		X					X			
Verification/Validation Report								X		X					X			

Table 6. Relationships between A1. Planning, A2. Preparation for the Implementation and the proposed templates for products.

Activity	A3. Evaluation and Control (G2, G3, G4)															
Responsible	RPM	RPM	RPM	ASR	RPM	RPM	RBM	RPM	ASR RPM	RPM	RPM	RBM	RPM	RPM	RPM	RPM
Level	2	3	3	3	3	3	3	3	3	3	3	3	3	3	2	3
Task→ ---------- **Template ↓**	A3.1 Follow up process implementation activities on *Schedule* established in *Processes Plan*.	A3.2 Generate *Measurements and Improvement Suggestions Report* for this process, as per *Processes Measurement Plan*.	A3.3 Generate *Quantitative and Qualitative Report* based on *Measurement and Improvement Suggestions Reports* gathered, to be submitted to the Responsible for Business Management.	A3.4 Perform the evaluations set forth in the *Assessment Plan*.	A3.5 Verify the *Actions Plan* **(Ver3)**.	A3.6 Correct defects found in *Actions Plan* based on *Verification Report* and obtain approval of corrections.	A3.7 Validate the *Actions Plan* **(Val2)**.	A3.8 Correct defects found in *Actions Plan* based on *Validation Report* and obtain approval of corrections.	A3.9 Generate *Improvement Plan* based on improvement suggestion analysis and on the improvement opportunities detected during the evaluation.	A3.10 Verify *Improvement Plan* **(Ver4)**.	A3.11 Correct defects found in *Improvement Plan* based on *Verification Report* and obtain approval of corrections.	A3.12 Validate *Improvement Plan* **(Val3)**.	A3.13 Correct defects found in the *Improvement Plan* based on *Validation Report* and obtain approval of corrections.	A3.14 Follow up on *Actions Plan* and *Improvement Plan*.	A3.15 Supervise risk control as per *Processes Risk Management Plan*.	A3.16 Identify *Lessons Learned* on processes and integrate them into the *Knowledge Base*.
Cover Page	All documents generated conformed by one or more templates.															
Acquisition and Training Plan																
Assessment Plan																
Corrections Report						X		X			X		X			
Evaluation Report				X												
Improvement Plan									X					X		
Lessons Learned																X
Measurements and Improvements Suggestions Report		X														
MC/Milestones Chart.xlsx	X													X		
PFMEA/PFMEA-RMP-RC.xlsx															X	
Processes Documentation																
Processes Measurements Plan																
Qualitative and Quantitative Report			X													
RCA/RCA 5Whys.xlsx		X														
Responsible of Processes																
Schedule																
Training Syllabus																
Verification/Validation Plan					X	X	X			X		X				
Verification/Validation Report						X	X			X		X				

Table 7. Relationships between A3. Evaluation and Control and the proposed templates for products.

6. VALIDATION OF THE RESEARCH

INSTRUMENT FOR THE CONCEPTUAL VALIDATION

The validation of this research was made through the instrument of conceptual validation proposed by Mora in [39], which is the questionnaire presented in Table 8, and consists of 8 questions that can be rated with a range of values between 1 and 5, where 1 represents the worst score and 5 the best.

P.1 The conceptual model is supported by strong theoretical principles.						
Totally disagree	*1*	*2*	*3*	*4*	*5*	*Totally agree*
Recommendations						
P.2 The theoretical principles that were used to develop the conceptual model are relevant to the addressed topic.						
Totally disagree	*1*	*2*	*3*	*4*	*5*	*Totally agree*
Recommendations						
P.3 The reviewed literature to develop the conceptual model doesn't presents important omissions related to the addressed topic.						
Totally disagree	*1*	*2*	*3*	*4*	*5*	*Totally agree*
Recommendations						
P.4 The conceptual model is logically coherent.						
Totally disagree	*1*	*2*	*3*	*4*	*5*	*Totally agree*
Recommendations						
P.5 The conceptual model is adequate with the purpose for which was created.						
Totally disagree	*1*	*2*	*3*	*4*	*5*	*Totally agree*
Recommendations						
P.6 The resulting conceptual model is congruent with the underlying research paradigm that was used (positivist, interpretive and/or critic).						
Totally disagree	*1*	*2*	*3*	*4*	*5*	*Totally agree*
Recommendations						
P.7 The conceptual model brings something new to the addressed topic and it's not a duplication of an existing model.						
Totally disagree	*1*	*2*	*3*	*4*	*5*	*Totally agree*
Recommendations						
P.8 The style of the presentation of the conceptual model is adequate for a scientific report.						
Totally disagree	*1*	*2*	*3*	*4*	*5*	*Totally agree*
Recommendations						

Table 8. Questionnaire for conceptual validation.

PANEL OF EXPERTS

Also, an expert's panel was conformed including the members shown in Table 9. They were asked to answer the questionnaire to determine whether the guideline presented in Chapter 5 is conceptually valid and feasible.

Evaluator/Résumé
Álvarez Rodríguez Francisco Javier (Dr.) Associate Professor of Software Engineering and Dean of the Center of Basic Science at the Universidad Autónoma de Aguascalientes.
Barajas Saavedra Arturo (M. en C.) Associate Professor of Software Engineering at the Universidad Autónoma de Aguascalientes.
Cardona Salas Juan Pedro (Dr.): Associate Professor of software Engineering at the Universidad Autónoma de Aguascalientes.
Flores Mejía Fernando (Dr.) Associate Professor of Software Engineering at the Instituto Politécnico Nacional, campus Guanajuato. His research interests are service oriented models and architectures.
Hermosillo Escobedo, Alma Edith (M. en C.) Consultant in the project for the pilot implementation of MoProSoft and CEO of the enterprise Medikas Developers S. De R.L. M.I.
Margain Fuentes, María de Lourdes Yolanda. (Dr.) Associate professor and responsible of the bachelors Eng, in Strategic Systems of Information, at the Universidad Politécnica de Aguascalientes.
Mora Tavarez, Manuel (Dr.) Associate Professor of Information Systems at the Autonomous University of Aguascalientes.
Ponce Gallegos, Julio César (Dr.) Associate Professor of Artificial Intelligence and Software Engineering at the Universidad Autónoma de Aguascalientes. His research interests are Evolutionary computation and maturity models.
Reyes Delgado, Paola Yuritzy (M. En C.) Associate Professor of Software Engineering at the Universidad Politécnica de Aguascalientes. Her research interests are maturity models such as CMMi and MoProSoft.

Table 9. Experts panel.

RESULTS

The results of the survey are presented below in Table 10.

Evaluator	P1	P2	P3	P4	P5	P6	P7	P8
Álvarez Rodríguez Francisco Javier (Dr.)	5	5	5	5	5	5	5	5
Barajas Saavedra Arturo (M. en C.)	5	5	4	5	5	5	4	5
Cardona Salas Juan Pedro (Dr.)	4	4	4	4	5	4	5	4
Flores Mejía Fernando (Dr.)	5	4	4	4	4	4	4	4
Hermosillo Escobedo Alma Edith (M. en C.)	5	5	5	5	5	5	5	5
Margain Fuentes María de Lourdes Yolanda. (Dr.)	4	4	4	4	4	4	3	5
Mora Tavarez Manuel (Dr.)	5	5	5	5	5	5	5	5
Ponce Gallegos Julio César (Dr.)	5	5	4	5	5	5	5	5
Reyes Delgado Paola Yuritzy (M. En C.)	5	4	3	5	5	5	5	5
Average per question	4.78	4.56	4.22	4.67	4.78	4.67	4.56	4.78
Overall average rate	**4.625**							

Table 10. Results of the survey.

When the survey was completed, each question was averaged separately to obtain numeric values that identify weaknesses and strengths in the guideline according to each question, finally all questions were averaged in order to obtain an overall rate of the research product, i.e. the guideline presented in Chapter 5. The average per aspect evaluated is presented in Fig. 9.

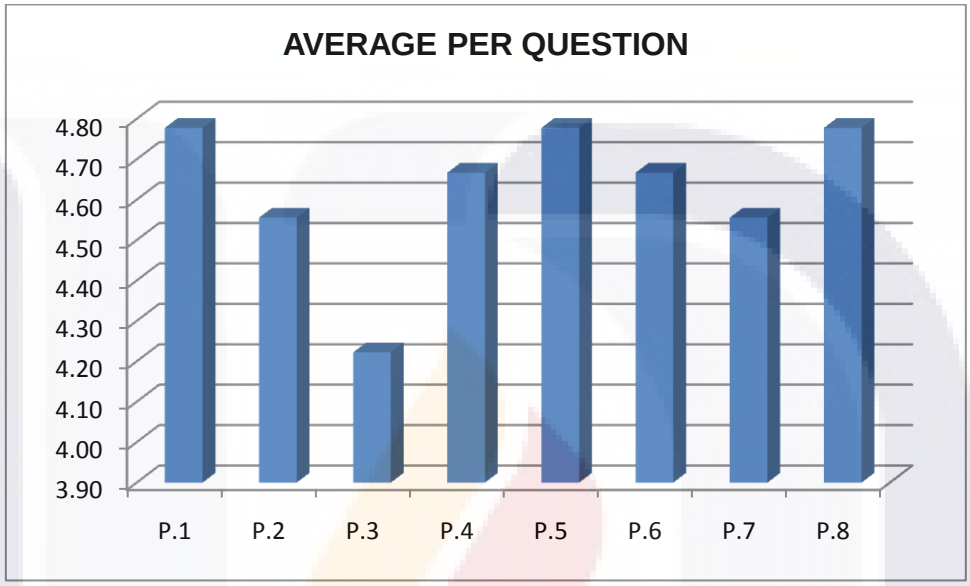


Figure 9. Average value per question of the conceptual validation.

The results presented in Table 10 and Fig. 9 reveals that:

1. The guideline is supported by strong theoretical principles, because an extensive literature review was done. This is reflected in the results of the survey. According to the results of P.1 of the questionnaire, the experts agree in a 95.6% that the guideline has strong theoretical principles, as the averaged value were 4.78, which is a closer to the maximum value, i.e. 5.
2. Evaluators agree in a 91.2% that the principles that were used to develop the conceptual model of the guideline are relevant to the addressed topic. Because average rate per this question scored 4.56, which also is a value near the maximum score (5).

3. The literature that was reviewed covers the more relevant models that have been proved and internationally used (e.g. MoProSoft, Six Sigma, CMMI, ISO/IEC 15504 Part 2, among others). This statement is also supported by the results of P.3, where the experts agree in an 84.4% that there were not important literature omissions in order to develop the guideline. This was the aspect that rated less score which is 4.22 is still positive value.
4. The guideline is logically coherent. 93.4% of evaluators rated this aspect with a good score, the average of it, is 4.67, which also is close to the maximum value (5).
5. The guideline is adequate for the purpose for which was created. 95.6% of evaluators agree on the fact that the implementation of the guideline will be helpful for the SMEs to manage their processes. This aspect was also rated positively as the average value was 4.78, which again is a value near the highest score (5).
6. The guideline is congruent with the underlying research paradigm that was used. 93.4% of evaluators believe that the guideline was developed through an adequate research methodology, taking into account correct interpretative and critic paradigms. The average rate for this aspect was 5.67, which is a close value the maximum rate (5).
7. The guideline brings something new to the addressed topic and it's not a duplication of existing models. 91.2% of evaluators agree that although there are tools in the market to help the implementation of MoProSoft, none of them has the elements of the guideline presented in this research. Evaluators positively rated this aspect with an average value of 4.56, which is good as is closer to the maximum value (5).
8. The style of the presentation of the guideline is adequate for a scientific report. 95.6% of the evaluators agree that the guideline developed in this research should be reported in the literature as it presents an important contribution for SMEs. This aspect was positively rated with an average value of 4.78, almost the maximum value (5).

From the results presented in Table 10 and depicted in Fig. 9, is possible to know that all averaged values per question rated over 4.22, which indicate that for each concept evaluated, there are good values as they are closer to the maximum, which is 5. Furthermore the overall average rate of the guideline scores 4.56, which also is a value closer to 5. Therefore, according to the results previously discussed, is accurate to say that the guideline developed in this research is valid and feasible.

Finally, **Table** presents the feedback that was obtained from the panel of experts.

Evaluator/Feedback
Álvarez Rodríguez Francisco Javier (Dr.) It is a good guideline; however an activity diagram showing the recommended steps of implementation according to the capability levels of the activities is missing.
Barajas Saavedra Arturo (M. en C.) It is interesting that it takes into account Six Sigma and fits concepts and tools to implement the tasks. It is a good proposal, it incorporates strong theoretical basis and is logically coherent.
Cardona Salas Juan Pedro (Dr.) It will be interesting to specify in detail the parts of the literature that was reviewed and map them with the guideline, so it is possible to know the exact theoretical basis for each part of the guideline. It is a good proposal.
Flores Mejía Fernando (Dr.) It is a good, simple and understandable proposal with solid theoretical basis.
Hermosillo Escobedo Alma Edith (M. en C.) The guideline is well structured and developed. The level of abstraction of the recommend steps is just adequate, not too rigid not too flexible. Provide instructions to fill up the templates. There are similar tools in the market however they are not purchased because of its high cost.
Margain Fuentes María de Lourdes Yolanda. (Dr.) The guideline is a good proposal, it is based on strong theoretical basis, however its implementation in the real world will say how good is in reality. A case study is suggested to prove it and improve it.
Mora Tavarez Manuel (Dr.) Missing Items • A general flow diagram or activity diagram of the *Process Management* Process Innovations • Activities of verifications are grouped. • Detailed design of activities. • Quantitative goals and measurements. • Templates. Recommendations • Add an ID for inputs and outputs products.
Ponce Gallegos Julio César (Dr.) To carry out a case study in the future, in order to know how useful the guideline is in real enterprises. To expand this guideline to the other processes of MoProSoft.
Reyes Delgado Paola Yuritzy (M. En C.) Review and take into account ISO:9000:2000 and Evalprosoft models to improve the guideline.

Table 11. Feedback of the expert's panel.

7. CONCLUSIONS AND FUTURE WORK

This chapter presents the conclusions of the research entitled “A Guideline to Implement the Process Management of MoProSoft”, taking into account the objectives, hypothesis and research question defined in Chapter 2. In addition contributions, limitations, and future work are also included.

CONCLUSIONS

This research work presents a guideline to implement the process MAN.1 of MoProSoft. In order to develop the guideline, an extensive review of literature was done, including maturity and capability models (such as CMMI, Competisoft, ISO/IEC 15504 - Part 2, among others), as well as methodologies of Six Sigma, so it was possible to identify existing methods and tools that may facilitate their implementation. Therefore it was possible to acquire strong theoretical basis, which allowed identifying relationships between models, tools and methods (mainly process MAN.1 and Six Sigma’s IDOV and DMAIC), as well as the development of new ones for the development of the guideline.

The main contribution of this research is presented in Chapter 5, which is a guideline conformed by a set of recommendations and nineteen templates to implement the sixteen tasks of the process MAN.1 of MoProSoft. The validation of the guideline was made through a questionnaire to perform a conceptual validation proposed by Mora in [13], which is composed of eight questions that could be rated within a range of values between 1 and 5, where 1 represents the worst and 5 the best. The questionnaire was used to survey a group conformed by nine experts in the area in order to rate the guideline and provide feedback.

According to the results that were obtained by the expert panel through the validation instrument i.e. questionnaire, is evident that the guideline is supported by strong theoretical principles, is relevant, logically coherent, and that is adequate to meet their creation purpose, as all these questions were rated with values over 4.56, almost the highest rate. However, the results shows that a possible weakness in the guideline could be the slightly omission of some relevant literature, because the result of averaging this question was the lowest, scoring 4.22 out of 5, however it is still a good rate as represents the 84.4% of acceptation. As can be seen according to the results of the evaluation, is accurate to affirm that the guideline is conceptually valid and feasible, as the rating value

for each criteria of the validation instrument (questionnaire) were over 4.22, and the overall rate scores 4.56, which is a value near the highest rate. Therefore is possible to affirm that the general objective of the research was successfully covered.

RESEARCH OBJECTIVES COVERED

The following conclusions are presented according to the objectives, hypotheses and research question, as defined in Chapter 2.

General objective: Develop a guideline to facilitate the implementation of the process MAN.1 of MoProSoft.

General objective was covered. Chapter 5 presents the guideline that includes a detailed description of the activities of MAN.1 with recommended steps and a set of related templates to facilitate its implementation.

Specific objective 1: Verify whether there are relationships between the process MAN.1 of MoProSoft, and the methodologies IDOV and DMAIC of Six Sigma, in order to identify Six Sigma elements that could be useful to develop the guideline.

Specific objective **O1** was covered as its related hypothesis **H1**was confirmed through the response given to the associated question **Q1**.

H1. There are relationships between the process MAN.1 of MoProSoft and the methodologies IDOV and DMAIC of Six Sigma that could help the development of the guideline to implement the process MAN.1 of MoProSoft.

Q1. What are the relationships between the process MAN.1 of MoProSoft and the methodologies IDOV and DMAIC of Six Sigma?

In order to answer the question **Q1** to confirm **H1**, and therefore cover specific objective 1. The process MAN.1 and to the IDOV and DMAIC methodologies of Six Sigma where analyzed, as result nine relationships between them were identified, their description can be found in Chapter 4 and also in the paper [40], entitled “Relationships between MoProSoft and Six Sigma: A Path Towards the Development of an Interpretation Model to Implant the "Process Management" in Small and Medium Businesses,” which was published in the vol. 43 of the journal “Research In Computing Science”.

Specific objective 2: Develop a set of recommended steps and templates as part of the guideline to implement the process MAN.1 of MoProSoft.

This objective was also covered, the guideline presented in Chapter 5 describe a set of recommended steps with their associated templates, roles, and diagram to facilitate the understanding of the process MAN.1, and therefore facilitate its implementation. Some flaws were identified in the process MAN.1 specified by MoProSoft, such as the inconsistency on the sequence of some activities, and the need to make a specialization to divide them in a more consistent manner.

Specific objective 3: Verify the conceptual validity and feasibility of the guideline.

Specific objective 3 was covered. As presented in Chapter 6, the research was evaluated using the instrument of conceptual validation proposed by Mora in [13]. According to the results of the evaluation presented in Chapter 6, it was determined that the guideline to implement the process MAN.1 of MoProSoft presented in Chapter 5, is conceptually valid as and feasible.

SUMMARY

The main contributions of this research work are summarized as follows, comments of the evaluators are also considered:

- The main contribution of the research is the development of the guideline to facilitate the implementation of the process MAN.1 of the MoProSoft model, which is presented in Chapter 5.
- The guideline is a valuable instrument for the starting SMEs, and that does not have guidance to manage or even establish their processes.
- The recommended steps to implement tasks have an adequate level of abstraction as they provide specific enough guidance (without being rigid or inflexible) on how to implement the tasks of the process MAN.1.
- The guideline is easy to understand and has solid theoretical basis.

Although the guideline presents important contributions, it also presents some weaknesses, which according to the evaluators are:

- The guideline does not present specific guidance on how to implement activities taking into account capability levels.
- Missing activity diagram that shows the suggested sequence of the implementation of the activities according to capability levels.
- The guideline does not present a mapping between the Evalprosoft model [33], which would be good to have in order to provide guidance to achieve high capability levels in a faster and easier manner.

Although the guideline presents some weaknesses, they can be eliminated by referring to the suggested sequence of activities suggested by the process MAN.1 in the MoProSoft model and using the Evalprosoft model itself to evaluate the capability of the processes. In addition, the weaknesses are overshadowed by the contributions, as the guideline provides the more important thing, which is to provide a solid, understandable and easy starting point for the SMEs to define, implement, improve and control their processes, which will lead in the increase their productivity and profitability.

FUTURE WORK AND RESEARCH IN PROGRESS

Due constraints of time, the development of a case study remain pending. Performing a case study by implementing the guideline in real situations will provide feedback with valuable information about the utility of the tool in real situations, allowing the continuous improvement of it.

The incorporation of best practices related to information security to the process MAN.1 of MoProSoft is contemplated. A number of initial practices has been identified and reported in [41], which is a paper published in the 11th research seminar of the Universidad Autónoma de Aguascalientes (see annex b).

The recommended steps of A1.1 Establish or update the Process Elements Definition and the templates to describe the tasks of Chapter 5 were taken as basis for the development of a methodology and notation to define requirements based on business processes, that were reported in the paper entitled “Use Processes - Modeling Requirements Based on

Elements of BPMN and UML Use Case Diagrams" [42], that was published in the 2nd International conference on software technology and engineering (see annex a).

Finally a notation for modelling processes is under development. It is intended that supports a simple but complete representation when modeling processes (e.g. when carrying out the task A1.1 Establish or update the Process Elements Definition of the process MAN.1). A preliminary version of the notation is depicted in Fig. 10, as can be seen it allows depicting the involved roles, tools, input, outputs, internal products, the flow of the activities and the start and end of a process in a single diagram.

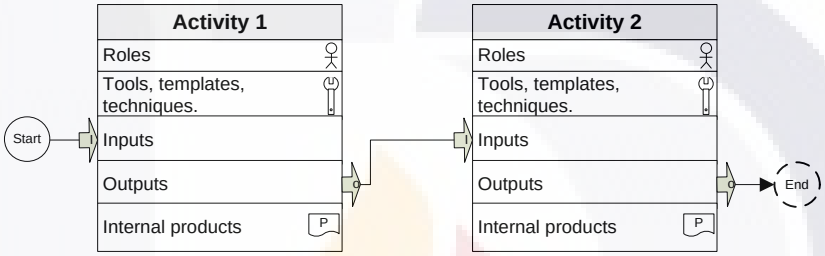


Figure 10. Notation under development for modelling processes.

PUBLICATIONS

The following papers were published during the development of this research:

1. Ulises Ibarra Hernández, Francisco Javier Álvarez Rodríguez, Miguel Vargas Martin. "Use Processes - Modeling Requirements Based on Elements of BPMN and UML Use Case Diagrams." San Juan, Puerto Rico, USA: Institute of Electrical and Electronics Engineers, Inc. (IEEE), 2010. 2nd International Conference on Software Technology and Engineering (ICSTE 2010). Vol. 2, pp. 36-40. ISBN: 978-1-4244-8666-3.

2. Ulises Ibarra Hernández, Francisco Javier Álvarez Rodríguez, Miguel Vargas Martin., "Identification of information security practices for the "Process Management" of MoProSoft (Identificación de prácticas para la seguridad de la información en la "Gestión de Procesos" de MoProSoft)." Aguascalientes, Ags., Mexico: Universidad Autónoma de Aguascalientes, 2010. 11vo Seminario de Investigación de la Universidad Autónoma de Aguascalientes. ISSN: 1870-4921.

3. Ulises Ibarra Hernández, Francisco Javier Álvarez Rodríguez, Julio César Ponce Gallegos, Arturo Barajas Saavedra, Juan Muñoz López., "Relationships between MoProSoft and Six Sigma: A Path Towards the Development of an Interpretation Model to Implant the "Process Management" in Small and Medium Businesses." Research in Computing Science: Advances in Computing Science and Applications: Instituto Politécnico Nacional, 2009, Vol. 43, pp. 97-108. ISSN: 1870-4069.

4. Ulises Ibarra Hernández, Francisco Javier Álvarez Rodríguez, Julio César Ponce Gallegos, Arturo Barajas Saavedra., "Tools generated through 'Design for Six Sigma' in order to implement the 'Process Management of MoProSoft (Herramientas generadas a través de 'Diseño Para Seis Sigma' para implementar la 'Gestión de Procesos' de MoProSoft)." 10mo Seminario de Investigación de la Universidad Autónoma de Aguascalientes, Aguascalientes, Ags., Mexico: Universidad Autónoma de Aguascalientes, 2009, pp. 156-160. ISSN: 1870-4921.

Other publications:

1. Ulises Ibarra Hernández, Miguel Vargas Martin, Francisco Javier Álvarez Rodríguez, Ricardo. Mendoza Gonzalez, and Fabio Armando Garcia Toribio. “A requirements Taxonomy and Rating Model for Secure and Usable B2C/C2C e-commerce websites.” Thunder Bay, Ontario Canada, 2010. IEEE Fifth International Conference on Digital Information Management 2010.

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ANNEX A

PAPER: USE PROCESSES - MODELING REQUIREMENTS BASED ON ELEMENTS OF BPMN AND UML USE CASE DIAGRAMS.

Use Processes – Modeling Requirements Based on Elements of BPMN and UML Use Case Diagrams

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***Abstract*—This paper presents a new approach to gather requirements called Use Processes. The approach includes a Use Process Diagram which is based on notation elements of the OMG Business Process Modeling Notation and Use Case Diagrams of UML v1.5. We also propose a set of templates to describe the elements of the Use Process Diagram. We believe that a business process-oriented approach to gather requirements will lead in the customer and user satisfaction because it allows their participation in the requirements definition. This is very important because the main customers of the software applications are business people who are usually very comfortable in working with visualization of business processes. To prove the validity of our approach, we implemented it to develop three small object-oriented software projects in two organizations, one in a department of a bureau of the Mexican Government and two in a private enterprise that develops software.**

Keywords- Business Process Modeling Notation; Use Case Diagram Notation; Use Process

I. INTRODUCTION

It is well-known that a good definition of requirements should lead to a product of quality. This statement is supported by Kamata et al., [1] who argue that there is a relationship between the quality specification of software requirements and the outcome of a project. The participation and involvement of customers and users in the development of software increases the probability of their satisfaction. At the present there are techniques and methodologies that look to gather requirements of quality such as the approached by Li et al. [2] and the widely used UML the Use Cases (UC) [6], but none of these presents a business process (BP) oriented approach for gathering requirements, which is important as the main customers of the software applications are business people who usually feel comfortable when working visualizing business processes in a flow chart [7]. Lübke et al. [3] presents an approach to group UC in BP diagrams, so it is easier the identification of errors in the requirements during the elicitation process. Pichler et al., [4] presents a BP-based for the requirements definition and it takes into account the interaction with the customer and user(s). However none of their approaches allows to graphically representing the BP and UC in a single diagram.

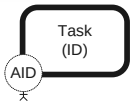
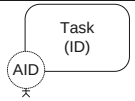
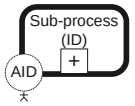
Regarding these issues and taking into account that the successful operation of the enterprises is based on their business processes, we believe that a BP-oriented approach to gather requirements will lead in a strong involvement of the customer in the requirements definition, and as a result a successful project. Therefore we developed the Use Processes (UP) approach to gather requirements, which consists of a Use Process Diagram (UPD) based in notation elements of the OMG Business Process Modeling Notation v2.0 (BPMN) [7] and the Use Case Diagrams (UCD) of UML v1.5 [6]. Also we present a set of templates to describe the elements of a UPD. The purpose of the UPD is to present a general view of the functionalities that a system must provide within the activities of a BP.

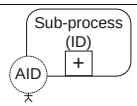
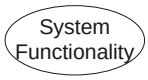
The remaining of this paper is organized as follows: Section 2 presents the notation elements for the UPD. Section 3 presents a set of templates to describe the notation elements of the UPD. Section 4 presents a methodology to implement the UP approach. Section 5 presents a summary of a case study as proof-of-concept of our proposal. Finally we conclude in Section 6.

II. USE CASE DIAGRAMS AND BPMN ELEMENTS FOR USE PROCESSES DIAGRAMS

Table 1 presents and describes a set of elements in which the UPD are based.

TABLE I. SUBSET OF BPMN AND USE CASE DIAGRAMS ELEMENTS FOR THE USE PROCESSES DIAGRAMS

Element	Sub-element		Notation
Event	Start		
	End		
Activity	Task (Atomic)	In the boundary of the system	
		Out the boundary of the system	
	Sub-Process(Non-Atomic)	In the boundary of the system	

Element	Sub-element		Notation
		Out the boundary of the system	
Sequence Flow			
Gateway	Exclusive		
	Parallel		
Use Case			
Actor			
Relationships		Include	<<include>>
		Extend	<<extend>>

Based on the OMG BPMN and UML v1.5 we present the following definitions for the notation elements.

a) Event: Is something that "happens" during the execution of a business process. In order for an event to "happen" there must be a cause (Trigger), as a consequence there is an impact (Result). We consider the following two types of *Events*:

- *Start.* Indicates the starting point of a BP.
- *End.* Indicates the end of a BP, and they are usually triggered when the last step of the process has been completed.

b) Activity: Is a work that is performed within a BP, it is carried out by a role (actor). An activity can be atomic (task) or non-atomic (sub-process). To graphically express the actors associated to an activity, we have added the figure of a person with a big head (in which is contained the identifier of the associated actor) to the notation element of a BPMN activity (task or sub-process). In our approach the activities are not always part of the system that is being modeled, so when an activity is part of the system boundary it is represented with a thicker border (e.g., see Table 1).

- *Task (Atomic).* Is a work carried out by an actor in order to achieve an objective.
- *Sub-Process (Non-atomic).* Represents a set of activities (atomic tasks or other sub-processes), gateways, and its sequence flow.

c) Sequence Flow: shows the order of execution of activities within a business process.

d) Gateway: depicts the control of divergence and convergence of the sequence flow of the elements in a BP.

- *Exclusive.* Represents alternative flows of the elements within a BP. For a given element of a BP only one of the paths can be taken. A decision can be thought as a question that is asked at a particular point in the BP.
- *Parallel.* Represents the flow of parallel paths for the elements within a business process without checking any conditions.

e) Use Case: represents a functionality of an entity like a system without revealing its internal structure. It is composed of a set of actions that the entity can perform

f) Actor: represents a role that interacts with the system, it is represented by a person. The notation for the actor element that we propose is different than the defined by UML V1.5. In our notation the actor have an associated ID in the head.

g) Relationships: represents whether a UC depends or is an extension of another.

- *Include.* Relationship that indicates when the functionalities of a UC depend on another UC.
- *Extend.* Instances of a UC may be augmented with some additional behavior defined in an extending UC.

III. TEMPLATES

In this section we present a set of templates that will facilitate the definition of specific requirements. In these templates, it is possible to describe the elements of a UPD; i.e., tasks, activities, and the roles involved. These templates are intended to be easily understandable for the requirements engineer, customer, user(s), user interface designer, software architect, and even for the programmers.

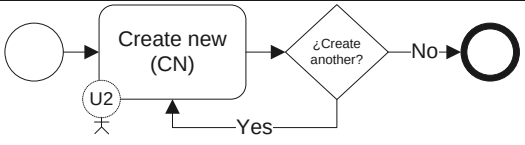
1) Template of the Roles Involved: the template presented as table 2 serves to list and describe the roles involved in the activities and system functionalities within a UPD.

TABLE II. TEMPLATE FOR ROLES INVOLVED

Roles Involved				
Project Name			Project ID	
Document ID			Version	
Created By			Date	
Modified By			Date	
Roles				
No	ID	Role	Related Business Activities	Related System Functionalities

2) Activity Template: the template presented as table 3 serves to describe the activities defined in a UPD. This template allows linking a sub-process with its interior elements and vice versa through the field of *Parent Activity* and *Child Activity*, also allows linking an activity with their predecessor and successor activities through the fields of *Predecessor Activity* and *Successor Activity*.

TABLE III. TEMPLATE FOR ACTIVITIES

Activity Description			
Activty Name		Type	Task or Sub-process
Project Name		Project ID	
Document ID		Version	
Created By		Date	
Modified By		Date	
Activity Description			
Parent Activity		***Child Activity***	
ID	Name	ID	Name
Predecessor Activity		***Successor Activity***	
ID	Name	ID	Name
Input	***Source***	***Output***	***Destination***
Precondition		***Post-condition***	
No	Description		
Associated tool			
No	ID	Name	Description
Related System Functionalities			
No	ID	Name	Relationship	Description
Related Users (Actors)			
No	ID	Name	Description
Related User Interfaces			
No	ID	Name	Description
Notes			
Diagram			
			

In addition the template presented as table 3 allows describing the inputs and outputs of an activity, preconditions that must be accomplished before the activity is executed, associated tools that are currently used to cover such activity, the related UC and actors. It also has as field for a diagram when a sub-process is being described.

3) Use Case Template: the template presented as table 4 serves to define and describe a list of the roles involved with the activities and UC, as well as to describe the relationships among them. The literature reports templates to describe use cases such as Berenbach et al. [8], Bittner et al. [9], and Zelinka et al. [5]. Taking into account their approaches we propose the template presented in Table 4.

TABLE IV. TEMPLATE FOR USE CASES

Use Case Description				
Name (Use Case)				
Project Name		Project ID		
Document ID		Version		
Created By		Date		
Modified By		Date		
Related Actors				
No	ID	Name	Description	
Use Case Description (Functionalities of the System)				
No	ID	Description		
Preconditions				
No	Description			
Post-conditions				
No	Description			
Related Use Cases				
No	ID	Name	Relationship	Description
Related User Interfaces				
No	ID	Name	Description	
Notes				

IV. METHODOLOGY OF IMPLEMENTATION

In order to implement our approach we developed a simple methodology that consists of the following five steps.

1) Problem Statement: the requirements engineer must identify the problems that the customer and user(s) require to solve, and how they expect to be solved through an application. This can be achieved by conducting workshops between the customer, user(s), and requirements engineer.

2) Model the Business Process: develop the diagram of the BP for which we recommend the following steps:

- Define the starting point of the BP.
- Identify the activities, gateways and its flow.
- Define the end of the BP.
- Define the actors and the relationships between them and the activities.

3) Define the System Boundary: define BP activities that are in the scope of the system, and use the inbound activity notation to depict them as appropriate (see e.g. table 1).

4) Describe the Activities and Involved Roles: describe the relevant activities for the system to be developed and its associated roles using the templates presented in tables 2 and 3 respectively. When a sub-process has more than one sub-activity then it is required to describe each sub-activity filling out a new template and linking them with the fields of *Parent Activity* or *Child Activity*. This can be achieved by conducting interviews with the customer and user(s).

5) Identify and Describe the System Functionalities: define the functionalities of the system as a regular UC as well as the relationships (see e.g., table 1) between them and the activities that are within the boundary of the system. Then define the roles associated to the UC. At this point the BP diagram changes its name to UPD because the BP and the system functionalities associated to each activity inside the system boundary are depicted in the same diagram. To define the system functionalities it is required to identify the services that the system must provide to cover the activities within the boundary of the project. Then use the template presented as table 4 to describe the UC. Finally refine and detail the UPD and the description of the system functionalities as required. All of the above is achieved by conducting workshops with the customer and user(s).

V. CASE STUDY

As a proof-of-concept, our approach was implemented in three small projects for organizations with established BP. In the first implementation an object-oriented (OO) desktop application was developed for an anonymous department of the National Institute of Statistics, Geography and Informatics (INEGI), a bureau of the Mexican Government. The second and third implementations were made in a small Mexican enterprise named Applied Intelligent Systems (SINAP), where two OO web applications were developed for two different projects. The purpose of the first system was to allow managing the payments of customers in a financial institution, and the second used pattern recognition for offering telephony services to organizations according to their size and business focus.

In the following paragraphs we summarize as an example the results of implementing our approach in the development of the application for the INEGI's anonymous department. In order to keep the confidentiality of the information we have simplified and made changes to the original UPD. The description of the templates is not presented; instead we describe how they were filled out.

1) Problem Statement: in an interview the customer defined the following as their problem: "we are spending a lot of time and putting a lot of effort to calculate and make reports of *cost-efficiency analysis*." The customer had the following expectation: "we need an application to automate some activities of the process so we reduce time and effort."

2) Model de Business Process: the requirements engineer carried out a workshop with the customer and employees that were involved in the generation of the *cost-benefit analyses*, a problem arose at this point. They found inconsistencies in the BP, which were solved through a brainstorming session, the BP was redefined with seven tasks, one sub-process, three roles, one gateway, and the starting and ending points as presented in Fig. 1. Note: this issue was present in the three projects where the UDP approach was implemented. The customers were excited because they identified issues and improved their BP.

3) Define the System Boundary: regarding the requirements and expectations of the project, customer, and employees, just as described in Step 1, the sub-process "Calculate (SP1)" and the task "Generate (T6)" were defined as part of the system boundary (see e.g. Fig. 1).

4) Describe the Activities and Involved Roles: in order to describe the activities and roles inside the system boundary, the requirements engineer interviewed the employee with the role of "Accountant (U2)," because he is responsible for performing the activities that were in the system boundary. Then, the requirements engineer registered the description of the employee's role and their associated activities using the tables 2 and 3, respectively.

5) Identify and Describe System Functionalities: the requirements engineer analyzed the information of the activities and roles that were described using the templates presented as tables 2 and 3, and then developed the final version of the UPD presented in Fig. 1, for which he defined twelve UC, registered a new role (see e.g., table 2) with the name of "SysMan (U4)," and defined the relationships among them. Then the requirements engineer used the template presented as table 4 to describe the UC.

After the requirements definition, the final versions of the UPD and the description of its elements were given to the user interface designer, software architect, and then to the programmers; all of them understood the diagrams easily and even for the programmers, the task of reviewing the documentation resulted in a good experience when they had questions about the components they were developing.

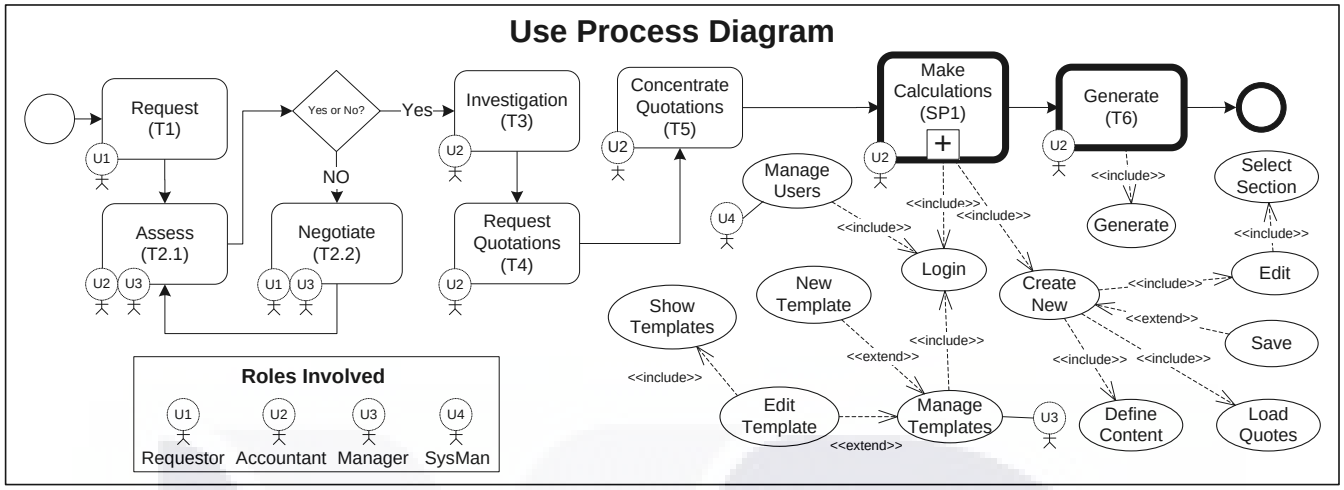


Figure 1. Use Process Diagram of an application that performs calculations and generates reports of cost-benefit analyses.

VI. Conclusions and Future Work

We have presented the UP approach to gather software requirements with a BP focus. We also presented a proof-of-concept to support the validity of the UP approach by successfully implementing it in three real projects for OO software of medium size.

Through the implementation of the UP approach it was possible for the customers to identify and correct problems in their BP as they were analyzed at the time they were being described. The requirements engineers mentioned that it was easier to gather requirements with the UP approach rather than with the UC approach, because the customers and users were strongly involved in the project. Moreover when defining and describing their activities they were excited as they were talking about what they do on a regular basis. One practical aspect that the requirements engineers reported about the UP approach is that although the UPD and the templates are documents that are understandable and partially developed by and for the customer and user(s), they contain technical information such as UC, so the requirements engineer, user interface designer, software architect and programmer are able to understand them.

While we informally gathered people opinions about our approach, we recognize that a formal usability test remains to be conducted to further support our claims. In addition we are looking to improve our approach by adding more specific fields to the templates according to the feedback we obtained from the requirements engineers. Also we are looking to incorporate the UML's user interface notation elements into the UCD and develop a template to describe them, as well as to develop a software tool to support our UP approach. Finally we are willing to implement and test the usefulness of the UP approach to gather requirements for big systems or systems based in Service Oriented Architecture (SOA).

We have noted note that the enterprise SINAP continues using the UP approach in their current small projects. Finally we quote a comment from the CEO of SINAP about the UP approach: "The implementation of this methodology increased the trust of our customers in our business as we exceeded their expectations. We not only developed their software, we also helped them to improve their business processes by detecting and correcting issues."

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ANNEX B

PAPER: IDENTIFICATION OF INFORMATION SECURITY PRACTICES FOR THE "PROCESS MANAGEMENT" OF MOPROSOFT (IDENTIFICACIÓN DE PRÁCTICAS PARA LA SEGURIDAD DE LA INFORMACIÓN EN LA "GESTIÓN DE PROCESOS" DE MOPROSOFT).

IDENTIFICACIÓN DE PRÁCTICAS PARA LA SEGURIDAD DE LA INFORMACIÓN COMO COMPLEMENTO DEL PROCESO "GESTIÓN DE PROCESOS" DE MOPROSOFT

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Palabras clave: Prácticas SGSI, Gestión de Procesos, ISO/IEC 17799, 21827, MoProSoft.

INTRODUCCIÓN

La información es un elemento valioso de las empresas, en ella se basa su operación y es por eso que es importante mantener su integridad, confidencialidad y disponibilidad. Hoy en día existe una gran cantidad de amenazas que atentan contra la seguridad de la información ya que buscan corromperla, accesar a ella o eliminarla sin autorización. A fin de conseguir la seguridad de la información, se han desarrollado estándares que constan de mejores prácticas de seguridad, como la familia de estándares ISO/IEC 27XXX, el estándar ISO/IEC 21827 [ISO/IEC 21827], y los modelos ISM^3 [ISM3] y COBIT [COBIT], todos ellos muy extensos y difícilmente aplicables a pequeñas y medianas empresas (PyMEs) [Sánchez et al., 2006]. El estándar ISO/IEC 27002 tiene su base en el ISO/IEC 17799, el cambio de nombre se realizó ya que éste último pasó a formar parte de la familia de estándares ISO/IEC 27XXX y debía haber correspondencia con los nombres. La norma NTP-ISO/IEC 17799 [NTP-ISO/IEC 17799] es una traducción al español del estándar ISO/IEC 17799 hecha en el año 2007 por un grupo de entidades académicas y privadas de Perú, esta norma es uno de los elementos clave en esta investigación. El ISO/IEC 21827 está enfocado al proceso de ingeniería de la seguridad, y contiene prácticas importantes como la identificación de amenazas, riesgos y gestión de las mismas, por lo que también es elemento clave de este trabajo de investigación. De acuerdo a la NTP-ISO/IEC 17799 "La seguridad de la información se consigue

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implantando un conjunto adecuado de controles (buenas prácticas), para definir políticas, prácticas, procedimientos, estructuras organizativas, y funciones de software y hardware". Estos controles necesitan ser establecidos, implementados, monitoreados, revisados y mejorados donde sea necesario, para asegurar que se cumplan los objetivos específicos de seguridad y negocios de la organización". El estándar [ISO/IEC 27000] define un Sistema de Gestión de la Seguridad de la Información (SGSI) como "un modelo para establecer, implementar, operar, monitorear, revisar, mantener y mejorar la protección de los activos de la información, para alcanzar los objetivos del negocio en base a la evaluación de los riesgos y los niveles de riesgo aceptables de la organización". Se dice entonces que un SGSI es un facilitador de la seguridad de la información.

Además en la literatura se han reportado propuestas como la de [Sánchez et al., 2006], en la que se presenta un modelo basado en el ISO/IEC 17799 que busca facilitar la implementación de SGSI en PyMEs basándose en sus niveles de madurez. Su modelo consta de cuatro fases: 1. Auditar el nivel de madurez de seguridad de la organización; 2. Analizar procesos y su flujo; 3. Analizar y gestionar riesgos; y 4. Desarrollar un SGSI. Además menciona que antes de implementar un SGSI se ha de evaluar el nivel de compromiso de la alta dirección con dicha iniciativa, definir roles relacionados a las iniciativas de seguridad, crear una atmósfera entre los empleados para soportar el plan de seguridad mediante la concientización de la importancia de la seguridad de la información y definir métricas de seguridad. Otra propuesta es la presentada por [Bayuk et al., 1996], quien menciona que un proceso para gestionar efectivamente la seguridad de la información debe contemplar sub-procesos conformados de buenas prácticas que permitan gestionar políticas, concientización, acceso, monitoreo, cumplimiento y estrategias de seguridad. Por otro lado la NTP-ISO/IEC 17799 especifica como punto de partida para implementar un SGSI, llevar a cabo la documentación de la política de seguridad de la información, la asignación de responsabilidades de seguridad, la formación y capacitación para la seguridad de la información, el procedimiento correcto en las aplicaciones, la gestión de la vulnerabilidad técnica, la gestión de la continuidad del negocio, el registro de incidencias de seguridad y mejora, la evaluación de los riesgos de la organización, la identificación y evaluación de amenazas y vulnerabilidades, el cálculo de la probabilidad de ocurrencia e impacto de una vulnerabilidad. Por su parte [Anderson et al., 2006]

presenta una metodología para implementar y gestionar la seguridad de la información en una empresa, la cual está compuesta de prácticas para evaluar los riesgos de la seguridad, definir requerimientos y políticas, desarrollar estrategias para el cumplimiento de las políticas, controlar los riesgos y realizar evaluaciones de cumplimiento mediante planificaciones y calendarios. [Dey, 2007] propone un marco de prácticas para implementar un SGSI que describe recomendaciones de actividades a manera de síntesis para cada uno de los once controles del ISO/IEC 17799.

Se puede observar que ninguna de las propuestas mencionadas anteriormente presenta prácticas específicas para implementar SGSI en PyMEs. Tampoco definen roles para llevar a cabo la implementación de un SGSI, lo que es importante tener en cuenta, ya que como reporta [Wiander, 2007] este es un problema que ocurre a menudo en las PyMEs.

MoProSoft [MOPROSOFT] es un modelo de capacidades que consta de un conjunto de buenas prácticas para gestionar los procesos de PyMEs desarrolladoras de software. Sin embargo este modelo carece de prácticas para definir SGSI que permitan gestionar y conseguir la seguridad de la información. Uno de los procesos clave del modelo MoProSoft es el llamado *Gestión de Procesos* (GES), ya que tiene como propósito establecer y mejorar los procesos de una organización. De acuerdo a [Anttila et al., 2004], la gestión de la seguridad de la información es análoga a otras áreas de administración en una organización, la gestión de procesos no es la excepción ya que ambas iniciativas constan de actividades para establecer, implementar, monitorear, revisar y mejorar procesos. De lo anterior surge la propuesta presentada en este documento, la cual busca complementar al proceso GES de MoProSoft con prácticas y un nuevo rol relacionados a la seguridad de la información. Se busca que mediante su implementación las PyMEs que han adoptado el modelo MoProSoft sean capaces de definir un SGSI a través de la gestión de sus procesos.

MATERIALES Y MÉTODOS

Para el desarrollo de este trabajo se utilizaron como materiales los documentos NTP-ISO/IEC 17799, ISO/IEC 21827 e ISO/IEC 27000, así como artículos relacionados con el tema. Para desarrollar la investigación se definieron requisitos generales con que debe contar un SGSI.

Posteriormente tomando en cuenta los requisitos definidos para un SGSI, se realizó un análisis de los documentos NTP-ISO/IEC 17799, ISO/IEC 21827:2002 e ISO/IEC 27000. Como resultado del análisis se identificaron y adecuaron prácticas para complementar el proceso GES de MoProSoft con prácticas para implementar un SGSI. Finalmente la validación de este trabajo se llevó a cabo mediante un panel de expertos utilizando el instrumento de evaluación propuesto por [Mora, 2004], el cual permitió determinar que la propuesta presentada en este documento cumple con los criterios de una investigación conceptual válida. El panel de expertos estuvo conformado por dos Doctores con conocimiento y experiencia en los temas tratados en esta investigación. El primero tiene amplia experiencia y especialización en investigación y consultoría de modelos de capacidad de procesos como MoProSoft y CMMI. El segundo cuenta con dos Postdoctorados relacionados al área de seguridad de la información y además es SNI nivel uno por el CONACYT.

RESULTADOS Y DISCUSIÓN

En base al análisis y revisión de la literatura se definieron los siguientes elementos básicos que debe contemplar un SGSI: 1. Análisis y evaluación de: riesgos, amenazas, vulnerabilidades, probabilidad de ocurrencia e impacto; 2. Política para la seguridad de la información; 3. Clasificación y tratamiento de la información; 4. Concientización, educación y entrenamiento en la seguridad de la información; 5. Monitoreo de la seguridad e la información; y 6. Cumplimiento de la seguridad de la información. En base a ellos en la **T**abla 1 se presentan el conjunto de prácticas propuestas para habilitar la implementación de un SGSI en los procesos de MoProSoft a través de su GES. Además se propone el nuevo rol “Responsable de la Gestión de la Seguridad”, quien es el encargado de realizar la mayor parte las actividades propuestas en esta sección. En la **T**abla 2 se presentan las descripciones del nuevo rol así como de los demás involucrados con las prácticas.

Tabla 1. Prácticas para la gestión de la seguridad de la información

ACTIVIDADES Y TAREAS	
Rol(es)	**Tarea(s)**
A1. Determinación de amenazas, vulnerabilidades, riesgos y mecanismos para la gestión de la continuidad del negocio.	
RGP RGS	T1.1. Identificar amenazas. [21827 – 7.4 PA04]. T1.2. Identificar vulnerabilidades de las que una amenaza pueda tomar ventaja. [21827 – 7.5 PA05] T1.3. Identificar procesos, objetos, sujetos u otros que pudieran ser vulnerables a las amenazas identificadas. T1.4. Definir la probabilidad de que una amenaza explote una vulnerabilidad. T1.5. Definir el impacto que una amenaza ocasionaría al explotar una vulnerabilidad. [21827 – 7.2.6 BP.02.05] T1.6. Calcular el riesgo en base a la probabilidad e impacto. [Nota: esta tarea es la misma que: *A1.6. Establecer o actualizar el Plan de Manejo de Riesgos* para la Gestión de Procesos]. [21827 – 7.3 PA03] T1.7. Definir acciones, procedimientos y asignar responsables prevenir o mitigar un incidente. [17799 – 13.2.1.] T1.8. Definir mecanismos que permitan mantener la seguridad de la información. [17799 – 9.1.1., 11.3.3., 11.4.7., 11.5.2.]
A2. Definición de Política de Seguridad de la Información.	
RGP RGS	T2.1. Desarrollar una política de seguridad de la información. [17799 – 5.1.1.] T2.2. Verificar y validar la política de seguridad de la información. [17799 – 5.1.2.] T2.3 Modificar política de seguridad de la información en caso de ser requerido. [17799 – 5.1.2.] • Corregir errores tomando en cuenta el reporte de validación y de debilidades identificadas. [véase A7.2] • Actualizar en base sugerencias de mejora.
A3. Aspectos organizativos para la seguridad.	
RGP	T3.1. Asignar responsabilidades sobre seguridad de la información. [Nota: véase esta tarea como complemento de la tarea *A2.2. Asignar y notificar a los Responsables de Procesos* de la Gestión de Procesos]. [17799 – 6.1.3.]

A4. Gestión de activos.	
RGS	T4.1. Gestionar el inventario de los activos. [17799 – 7.1.1.] T4.2. Definir guías de clasificación de la información. [17799 – 7.2.1.] T4.3. Definir procedimientos para el marcado y tratamiento de la información de acuerdo al esquema de clasificación [véase A4.2]. [17799 – 7.2.2.]
A5. Formación y capacitación para la seguridad de la información.	
RGS	T5.1. Facilitar conocimiento, educación y entrenamiento de la seguridad de la información. [17799 – 8.2.2.]
A6. Control de acceso.	
RGS	T6.1. Desarrollar una política de control de acceso. [17799 – 11.1.1.] T6.2. Verificar y Validar la política de control de acceso. T6.3. Modificar la política de control de acceso en caso de ser requerido. • Corregir errores tomando en cuenta el reporte de validación. • Actualizar en base sugerencias de mejora.
A7. Gestión de incidentes en la seguridad de la información.	
PER	T7.1. Reportar eventos de la seguridad en la información. [17799 – 13.1.1.] T7.2. Reportar debilidades en la seguridad de información. [17799 – 13.1.2.]
RGS	T7.3. Definir responsabilidades y procedimientos para responder a: [17799 – 13.2.1.] • Eventos de seguridad ó incidentes identificados en la evaluación de riesgos. [véase A1.7]. • Violación a las políticas o estándares. T7.3. Documentar lecciones aprendidas de los incidentes de seguridad de la información. [17799 – 13.2.2.]
A8. Cumplimiento	
RGS	T8.1. Monitorear cumplimiento con las políticas de seguridad y estándares. [véase A7.3]. [17799 – 15.2.1.]

Tabla 2. Roles involucrados en un SGSI en el proceso Gestión de Procesos de MoProSoft.

ROLES INVOLUCRADOS		
Rol	**Abreviatura**	**Capacitación**
Responsable de la Gestión de la Seguridad	RGS	Conocimiento y entendimiento de los conceptos básicos de seguridad y de las áreas de la seguridad al menos en nivel general.
Responsable de la Gestión de Procesos	RGP	Conocimiento de las actividades necesarias para definir e implantar exitosamente el proceso Gestión de Procesos.
Cualquier persona que realice actividades para la organización.	PER	Concientización, educación y entrenamiento en la seguridad de la información.

CONCLUSIONES

En este trabajo se han propuesto ocho prácticas y un rol para complementar el proceso GES de MoProSoft. Mediante la adopción de dichas prácticas se pretende que las PyMEs puedan implantar SGSI en procesos basados en el modelo MoProSoft. Las prácticas mencionadas están basadas en los estándares NTP-ISO/IEC 17799 e ISO/IEC 21827, lo que habilita a las PyMEs dar un primer paso hacia la adopción de buenas prácticas reconocidas internacionalmente que les permitan llevar a cabo una correcta gestión de la seguridad de la información.

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