



# Centro Universitario de la Defensa en la Escuela Naval Militar

## TRABAJO FIN DE GRADO

*Projects and Organizations management using agile  
methodologies: Study of its application to the Armada Logistics*

## Grado en Ingeniería Mecánica

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Intensificación en Tecnología Naval

Cuerpo General



# **ABSTRACT**

The goal of this project is to make a detailed analysis on agile methodologies and to study the possibility of applying these practices to the Armada Logistics.

As an introduction to this project, we have analyzed the importance that project management has in the development of products and services, and what impact do methodologies have on the development of these projects. To have a better understanding we have made a general view of the PMBOK way of delivering projects.

Methodologies have always been important to organizations. Having this understood, we move on to analyze traditional methodologies, which have been around for many years and have proved to succeed in many project areas. However, these practices seem to have flaws in adapting to environments of complexity that emerge as technology develops. The study and understanding of agile methodologies through Scrum, Kanban, and Scrumban practices, helps us realize how these upcoming procedures solve the problems that traditional methodologies couldn't face.

For the development of this project and to conclude with our study, we have introduced the Armada Logistic Organization, analyzing its principles, area of work, and procedures or methodologies that they are implementing right now. Once the facts are set, we try to match agile thinking and practices (Scrum, Kanban, Lean thinking) to Logistical activities.

This study shows how agile methodologies can be the solution for volatile environments both in civil and military organizations.

## **KEY WORDS**

Project Management, methodologies, agile, Logistics, Lean management

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# 1 INTRODUCTION AND OBJECTIVES

## 1.1 Introduction

Project management has been around for many years. The importance of having a good way of managing the development of a product or service has proven to be keen for organizations' success. Management is nothing but allocating resources and putting them into work. If the processes and techniques used are well distributed, the development of the project will be efficient and it will have an impact in the organizations' productivity.

These techniques and processes conform a methodology of work. Methodologies have been helping work teams to develop their products, ever since project management was created. One of the most recognized methodologies was the one implemented by PMBOK, which applies well for a large range of projects. Other kinds of methodologies were developed in the mid twentieth century, the so-called traditional or heavyweight ones. These practices emerged to solve the problem of mass production, and applied for both small and big projects, with one common element; these projects moved in a simple and stable environment. As soon as changes appeared in the execution of these projects, heavyweight methodologies seemed to have no response whatsoever to the problems that confronted their work process. As a result waste was produced, the delivery of the project late, costs increased and most important, the customer wasn't satisfied.

With the development of technology, the standards change. We meet customers with high product or service expectations. Technology advances and so needs to do the companies in order to keep up their business in the market, but how do they do that? Clients want to get results fast, and the main factor, clients want to have flexibility in their products, as the needs and ideas that they may have today might not be the same as tomorrows. With that said, companies have to face the reality of having to adapt to this new complex environment in which their projects are going to move, that is where agile methodologies fit in. Agile methodologies derive from a series of principles that were implemented in the automobile industry by Toyotas' company. These principles suggest that the success of the organization is down to the people and not the work process, because they are the ones that control the process and not the other way around. Agile methodologies have adopted the Lean thinking and tend to focus all their efforts in providing customers value right from the start, rather than following a rigid process that doesn't adapt to the client. It is obvious that agile methodologies are having a huge impact in many organizations. So, Could we apply these new methodologies to the military?

We already now that Logistics was created with military purposes in order to carry on the support of the military Force in a more agile way. From the time it was developed, Logistics has been moving

in one of the most volatile environments, the military operations. Furthermore the Logistical organization of the Armada has a Pyramid structure that slows down the support service of the Armada. These two factors are the only constant of the Logistics, with that said, it would be wise to look to the organizations using agile methodologies, and try to apply them to the Logistics in the Armada.

## 1.2 Objectives

The idea of making this project emerges due to the necessity of managing projects during their development.

The main goal of this project is to make a detailed study of agile methodologies and the influence that they are having in civil organizations. By analyzing these methodologies we are able to come up with some conclusions that might be applied for the Armada Logistics.

This study shows that Logistics in the Armada have implemented lean thinking form the time it was created. It also shows that because of the environment in which Logistical Operations play, the organization needs to use agile methodologies in order to meet with the Force expectations.

## 2 STATE-OF-THE-ART

### 2.1 Project Management

#### 2.1.1 Introduction

A **project** is a temporary set of activities planned to create a unique product, service or result. It is temporary, as it is limited in time, and so are the scope and resources; and it is unique, as the operations are set to accomplish a specific goal. [1]

#### 2.1.2 Factors of success of a project

The main goal of a project is to achieve the objective of the project inside the limits of the triangle of steel: Scope, Resources and Time.

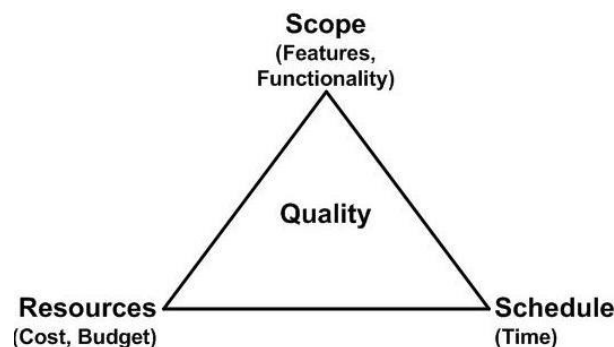


Figure 2-1. Iron Triangle [2]

#### Schedule

The schedule is interrelated with the projects' scope. Working within the parameters of a project management plan, a schedule sets out target dates for the completion of tasks within each phase, at the end of the schedule, the project has to meet a deadline, in which the final product has to be delivered.

#### Scope

It refers to the scale of a project. "*Project scope is the part of project planning that involves determining and documenting a list of specific project goals, deliverables, tasks and deadlines.*" Margaret Rouse.

## Resources

In a project, resources must be used according to a plan, which guarantees that the project doesn't exceed the given budget. Organizing tasks and deliverables in phases assures the efficiency of time management, therefore stopping the project for running over-budget.

## Quality

When projects are developed inside the iron triangle, organizations manage to keep the projects' quality, ensuring that the final product satisfies the customer.

### 2.1.3 Project Management according to PMBOK

#### 2.1.3.1 Definition

*“Project management, is the application of knowledge, skills and techniques to execute projects effectively and efficiently. It's a strategic competency for organizations, enabling them to tie project results to business goals — and thus, better compete in their markets.”* Project management provides a framework to help accomplish goals. [3]

It is also said, that Project Management is, from the managers point of view, the art of getting things done by others. Managers manage the most difficult part of the company, the people. In an organization, the Project Manager is not working at the same level as the rest of the company, the Manager is the individual designated to organize the team in order to get the best results on the project. Project managers get things done.

#### 2.1.3.2 Methodology

A **methodology** is a system of principles and rules orientated to develop different plans within the scope of a particular project. A methodology is not a formula but a series of practices that serve as a guideline for delivering a product.

A **process** is a series of organized activities that are correlated with one another in order to achieve a certain goal.

A **procedure** is a set of operations that must be performed in the same manner in favor of getting the same result constantly.

Projects have to get through a series of processes. The people of the organization perform the projects' processes. There are two types of processes, which overlap and interact throughout the project: Project Management Processes and Product-Oriented Processes. [4]

Project management processes can be organized into five groups of processes:

- Initiating processes- bearing the idea that a project or phase should begin and committing to do so.
- Planning process-Designing a scheme of work to accomplish the organizations project inside the iron triangle.
- Executing process- Coordinating people and other resources to carry out the plan.
- Controlling process Monitoring and controlling the workflow and taking corrective action when necessary in order to meet the project objectives.
- Closing processes- It is probably the most important process for the company, as it represents the acceptance of the project or phase and bringing it to an orderly end. [5]

The process groups are interrelated depending on the outcome they produce. The outcome of a process group serves as the input to another.

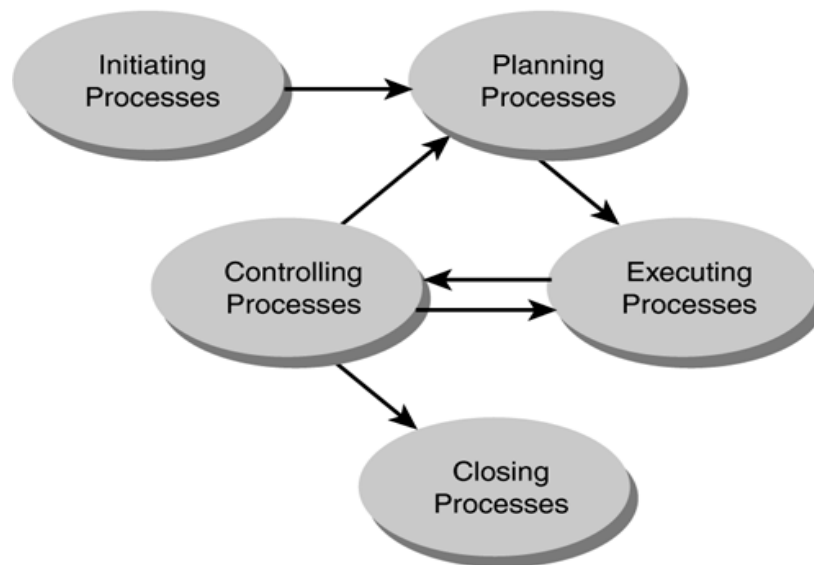


Figure 2-2. PMBOK group of processes [6]

### 2.1.3.3 Importance of methodologies

Almost in any activity that we may perform in our life requires a methodology. This means establishing an order of activities as well as its priorities, so we succeed in the task, achieving our objective in a controlled way, avoiding random facts determine the success of our activity.

Before developing a methodology of work in any organization or a given project, we need to have previous knowledge in the area in which the project is going to be developed, that way we are able to determine the steps to follow in order to achieve our goal in a controlled manner.

In the development of any project, having a methodology of work provides the organizations an effective process that leads to an increase in their performance and productivity. [7]

## 2.2 Traditional methodologies

### 2.2.1 Context

The first steps taken in Software development during the twentieth century were a bit clumsy. Software Engineering was an emerging profession and had no experience in managing its projects, due to the fact that software was nothing like other areas.

This profession found itself in the need of having to acquire a methodology that ensured that projects were brought up inside “the triangle of Steel “ in terms of time, costs, and scope.

At that time software had to be developed by bringing in the already known methodologies, which were being used in other areas, and adapting its basis, values and processes to software necessity of self-development, in order to lead those projects towards its goals. [8]

In the implementation of these old methodologies for software, the development of the Project was divided in a series of processes arranged in a sequential way, this improved the necessities that this emerging engineering had at the time.

This methodologies went to be a solution for software projects, and established the principals/basis of traditional methodologies and even though they have been adapting and improving through time, they will always come as Heavyweight Methodologies. [9]

### 2.2.2 Heavyweight methodologies characteristics

Due to the uncertainty of this new area of study, Heavyweight methodologies implement a disciplined process upon software development in order to make its projects more predictable and more efficient. *“These methodologies are based on a sequential series of steps, such as requirements definition, solution building, testing and deployment.”* [10]

Its main characteristics are the following:

#### **-Predictive Approach:**

Heavyweight methodologies tend to spend long hours planning the whole project to the detail before heading to the actual development of the project. This tendency that comes from an engineering discipline makes the process predictable and repeatable. A lot of effort is put in planning the process, which needs to be written down before being handed over to the team that is going to execute the plan. These drawings specify how they need to build the project; also the plan predicts the task delegation for the team members, the schedule and the budget. All parts have to be considered in order to enclose the project.

#### **-Comprehensive Documentation:**

According to heavyweight methodologies, it is better to gather all requirements upfront before moving to the execution stage. Traditional methodologies view documentation as the key piece of the project's success. This approach may suit well-defined projects with little changes expectations, but for large complex projects, documentation is not as relevant as adding value to the project's cycle right from the beginning. Furthermore, it might be an obstacle for the project's productivity. Also, gathering all the requirements beforehand, and having the customer signing them before ordering the procedures limits predictability, which is crucial for complex projects. [11]

#### **-Process Oriented:**

One of the main characteristics is its simplicity of use. The main goal of traditional methodologies is to have understandable processes that can be used by anyone. Each member of the team works on certain tasks that contribute to add value to the project. There is an established process for each of these tasks, so every member can perform them just by following the process.

There are many different Heavyweight methodologies, but due to the importance and influence on organizations, the ones that best represent the term heavy are **Waterfall** and **RUP** methodologies. Both of them focus their efforts in having documentation defined to the detail in order to follow the Project Plan defined in the initial phase of the Project.

### 2.2.3 Waterfall

During the 1960s, the method that was used for software development was “code and fix”, a long period of time was spent in the coding, once it was finished, if the code wasn't right, the fixing could be an impossible task to complete. In 1970 Winston Royce published a document showing a linear-sequential life cycle model for software development, what is now known as the Waterfall methodology. [11]

This model of sequential processes emphasizes a structured progression between defined phases. Every phase has a certain set of activities and deliverables that must be completed in order to have the phase done. At the end of each phase, a review of what has been done takes place, in order to determine if the Project is on the right path, this helps the organization decide whether or not they keep



moving forward or discard the Project. Each phase must be completed before the next phase can begin, and once you move forward you can never go back, that is one of the main problems that Waterfall methodology has to face, the lack of valuable result until the project is finished. Therefore this methodology is normally used in small projects where the requirements are detailed specified and clear, and are unlikely to change during the execution of the Project. [8]

As we have seen, Waterfall is a linear-sequential life cycle model. This means that phases are put in a sequential order, and never surprising one another during the Project execution. These phases are the following:

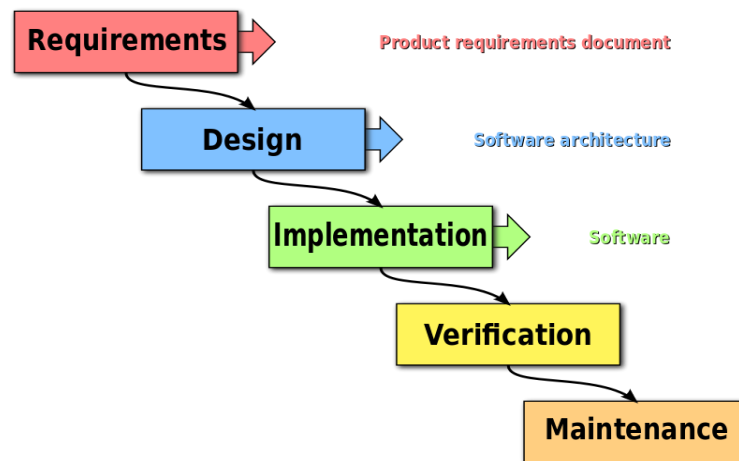


Figure 2-3. Waterfall processes [12]

#### **-Idea and Analysis phase:**

As the name implies, in these phases the problem is analyzed in a form that the main objective of the Project is made clear and the requirements are fixed. The Project Manager must be able to gather all of the customer requirements in this phase; therefore communication is key between the two parties involved. Once all the requirements are settled, they cannot be changed during the Project. [13]

#### **-Design:**

All of the requirements established in the previous phases are submitted into software, where they are organized in order to represent the general lifecycle of the Project, giving the organization a general overview of the main goal, and the activities that must be done in order to achieve it.

#### **-Development:**

At this stage of the Waterfall process, the actual work is done; real value is added to the process. This phase belongs to the execution team, as they put the requirements and specifications of the Project to work.

#### **-Verification:**

Testing what you have already done is important in order to ensure that the project meets customer expectations. If analysis and design phases have been meticulously studied this phase can be ignored, therefore the Project is given to the customer.

#### **-Maintenance:**

It is referred to the modification of the product once it has been delivered. This modification needs to be made in order to improve the product. However, in the Waterfall methodology, it is very difficult

to correct faults once the product is finished, due to the high detailed documentation that has been made in the Idea and analysis phase. [8]

### **Advantages and Disadvantages**

The Waterfall method has certain advantages, including:

- The model is easy to understand and use.
- Each phase is processed and completed one at a time, this means that phases are independent from one another and therefore they do not overlap.
- Each phase has specific deliverables and a review process; therefore the model is easy to manage.
- It Works well for small projects where requirements are meticulously defined and understood.

Unfortunately, the Waterfall method is a heavyweight methodology and therefore:

- At times, clients may find difficult to define the requirements
- The process flows forward, that means that it is very difficult to change something that hasn't been done well in a previous phase.
- High amounts of documentation.
- It is not a good model for long and ongoing projects where planning gets challenging, producing high amounts of risk and uncertainty.
- It doesn't adapt for projects where requirements are suitable to change during the Project lifecycle. [13]

Waterfall has proven to be a heavyweight methodology; its use should be limited for projects with well-defined requirements, and making sure they are clearly established for both, the client and the organization. These requirements must be fixed at the very first stage, and cannot change during the Projects lifecycle. The customer is barely involved during the development of the product, and only gets the final result; this tells us that if any mistake has been made in the process, the cost of fixing it is very high, because we have to go through the whole Project.

### **2.2.4 RUP**

*RUP* or *Rational Unified Process* is a framework of formal processes for software development, its use has proven to be successful in tons of projects, and its method has adapted to many different organizations, it is now widely spread all around the world: The Rational Unified Process provides a close approach in order to match certain tasks and requirements in an organization .It was developed by Rational Software, and its main objective is to guarantee that the Project will suit the requirements of the final customers, keeping the delivery on time and respecting the cost. [8]

Some of the key features of RUP are the following:

These features serve as guidelines to be used in the whole projects lifecycle. The team thus can easily follow the development of the Project. RUPs lifecycle is a unified process, which is divided into phases and iterations. These phases are four: Inception, Elaboration, Construction and Transition.

## RUP Phase Model

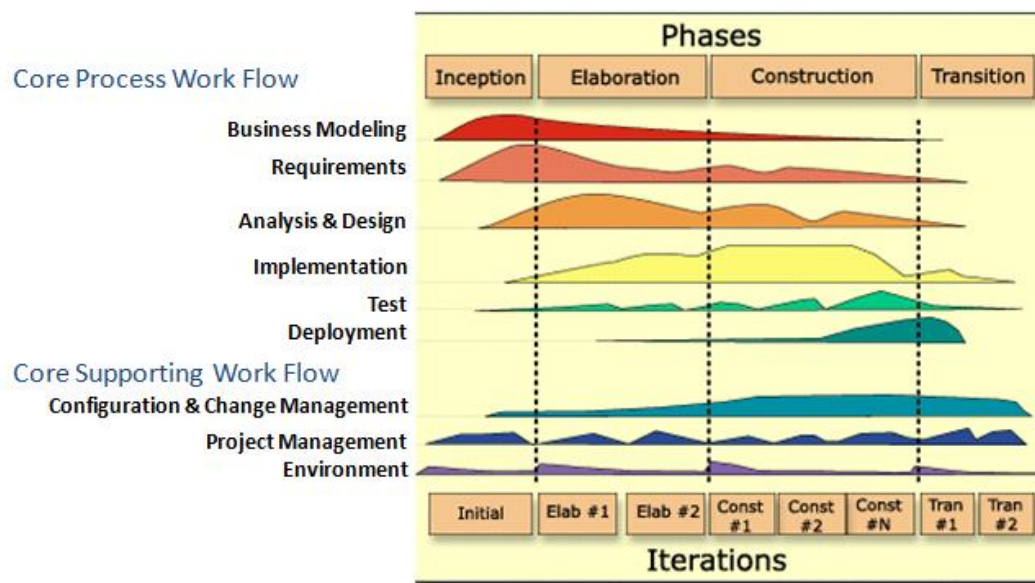


Figure 2-4. RUP phase model [14]

### -Inception:

In this stage of the Project lifecycle, the customer's requirements should be clear. Following those requirements is vital to understand what are we going to develop, and the main goal of the Project. There are some important features that have to be delivered by the end of this process: a business case; risks identification and resolution; feasibility of the Project assessed; and the scope of the design. All of these documents are important, in order to get stakeholders acceptance.

### -Elaboration:

In this phase, risk analysis takes place. Technical risks are of special interest and are carefully handled, therefore, it is important to address major risks in order to set priorities and manage the team's efforts. Also, a basic architecture of the Project and a plan of construction have to be done at this phase.

### -Construction:

In the Construction phase, almost the entire execution of the Project is made, following a basic architecture created in the previous phase.

This process produces a working system that has to be sufficient enough for preliminary testing under realistic conditions.

### -Transition:

At the end of the RUP, the Project is shown to stakeholders and customers. The Project is closed once the Project team and the stakeholders agree that the objectives and the requirements set in the inception phase have been implemented and the customer is satisfied. This is done by testing and improving the Projects details based on the feedback got from the client.

## Advantages and Disadvantages

The Rup methodology has certain advantages including:

- Evaluation in every phase that allows the objectives to change.
- It works well for innovation projects.
- Easy and intuitive.
- Detailed control in each one of the phases.

RUP is also a heavyweight methodology, so it has some limitations:

- Complexity of risks analysis.
- Excessive flexibility for some projects.
- The client might feel uncomfortable or even under pressure having to stay in contact with the work team.
- Our client must have a high level knowledge on the projects area in order to set the requirements and define the scope of the project. [9]

### *2.2.5 Limitations of heavyweight methodologies*

Although traditional methodologies have always been the reference for the development of the projects, they have proven to have some limitations that make them heavy in their development and implementation for some organizations. The truth is that large complex projects seem to emerge in the last decades, and the predictable approach that heavyweight methodologies offered no longer serve as the way to develop these projects.

One of the main limitations that appear in this context is that heavyweight methodologies do not allow change. Defining all requirements at the beginning is a difficult task to impose on the client. It is hard to define the scope and requirements of large complex projects that move in a volatile environment. These projects need to develop a process that guarantees flexibility of the requirements. It also needs to master the ability to respond to unpredictable events rather than making plans for fighting disasters.

Another limitation is the use of high detailed documentation. These documents tend to go into detailed aspects of the Project, which sometimes are not necessary for the development of itself. This means that a lot of effort is put into some activities that do not provide any tangible value to the product, therefore waste is produced and productivity decreases. We will later see how leans philosophy to solve this problem.

The last problem that heavyweight methodologies present is the limited implication of the customer in the Project development process. Traditional methodologies like Waterfall and Rup get the customer's feedback at the end of the Project's lifecycle (monitoring and testing stage). The problem of waiting until the end for this feedback is that most of the times the product will not meet the customer expectations, and changes will need to be made in the product's requirements. These changes are not easy to make, due to the fact that the team will need to look for the problem on the documentation. Instead it would be easier getting the customer's feedback right from the beginning of the Project. [10] [11]

The next part of this study explains how agile has improved some activities of traditional methodologies, and how it has solved its limitations.

## 2.3 Lean management

### 2.3.1 Context

Recent projects tend to move in an environment of complexity and change, where the client demands more and more with time. As technology develops, customers become accustomed of getting a high variety of products faster, cheaper and better than few years ago.

In this volatile environment, the triangle of steel (scope, cost, requirements) is no longer rigid, it is rather more flexible, as in these new projects the only constant is change. This change must be responded with new methods and should not be avoided because of its uncertainty.

As Albert Einstein said *“We cannot solve emerging problems taking the ideas we had when it was created. We must collide with reality in order to get to the solution”*.

*“It is not the strongest of the species, not even the smarter ones that survive change, but those who adapt better to it”* said Charles Darwing.

In the production system there has been a revolutionary company that seems to step ahead of its competitors. Toyota has the fastest development process in the world, taking only 12 months to deliver its products while its next competitor uses 2 or 3 years. Toyota's benefits are greater than GM, Ford, and Chrysler combined. [15]

How have they done it?

### 2.3.2 History

In 1913, Henry Ford created an entire production system based on maximizing the flow of activities and not the amount of work, what he called flow production.

Flow production was a revolutionary break for the auto-industry. In order to maximize the flow of activities, Ford lined up fabrication steps in process sequence with special purpose machines rather than using general-purpose machines. By lining up the fabrication steps, specific products passed from one machine to another, maximizing the flow, and reducing time.

Ford's system had revolutionized the production industry, but it provided no variety. All of his cars were limited in color and equipment in accordance to The Model T of 1926. It seems that almost every machine in the Ford Motor Company worked on a single specific part of the final product, so it was impossible to have changeovers for that model.

It was in the 1930s that Kiichiro Toyoda and other members of the Toyota's company came out with a series of simple innovations that made possible to provide both a constant process flow and the variety of products that lacked Henry Ford. They therefore invented the Toyota Production System.

This system focused on the flow of the product through the total process rather than the use of individual machines of the manufacturing engineer.

Kiichiro Toyoda believed that by working intelligently, by eliminating inventory waste, it would be possible to obtain a production system that could respond to changing customer desires. He was also convinced that information management could be simpler, faster, and more accurate. [16]

### 2.3.3 What is agile?

Lean Management is a control and management system based on the elimination of waste in the process, the reduction of the costs and the continuous improvement of the work system. By doing this, the organization can focus its efforts in those activities that deliver real value to the final product.

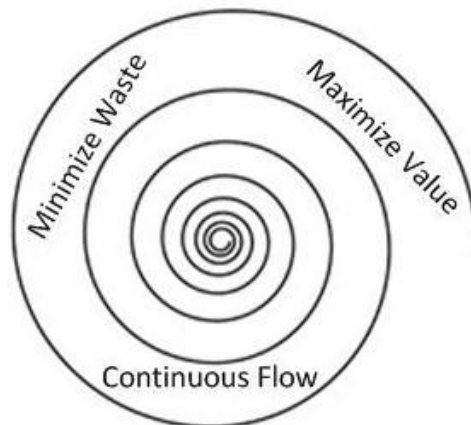
The principal characteristic of this philosophy is the continuous improvement. By simplifying and eliminating redundant activities, we get constant flow of work, which always increases the product's overall value. [17]

The main differences between the lean model and the traditional model are the following:

- Lean focuses its efforts in providing a constant flow of processes, whilst the traditional model operates with over-measured processes that tend to cause a lot of trouble when working with them. A clear example is the substitution of large requests and stocks by little and constant deliverables.
- Overloads of storage, inventory, etc. are eliminated. Processes focus in those process that deliver value to the final product.
- Adaptability and promptness to respond to changes of the project over the slowness of traditional structures.
- The control and maintenance of the equipment must be assured in all aspects, at all stages of the structure.
- Multipurpose teams over single tasked members. In a multipurpose team, each member of the group has a general knowledge of the overall process, and is able to perform almost any teammate's activity. This optimizes the resources and the continuous improvement of the team, as well as the motivation of its staff.
- The teams are the ones that deliver the real work, so they are the principals responsible for the continuous improvement of the flow process. [17] [18]

#### *2.3.4 Lean principles*

The main lean idea is that the organization should focus at all times in producing value to its customer. This constant care for the customers' interests is achieved by applying 5 lean principles, which result in three main objectives of approach to a process of perfection. This process is represented in the spiral below:



**Figure 2-5. The lean spiral [19]**

The basic idea of lean is attractively simple. It is that the organization should be obsessively focused on the most effective means of producing value for their customers. An organization using lean will approach this challenge by:



Figure 2-6. Lean principles [20]

The 5 principles are:

- **Defining customer's Value**  
It is said that most process activities do not provide value for the customer. We have to understand that the products value is what the customer wants, and only by working on those activities that match the customers' ideas, will we get the customer's satisfaction.
- **Selecting Value activities**  
Organizations have to define what activities really work on adding value to the product. It is important to select those activities and to eliminate wasteful activities.
- **Improving workflow**  
A lean organization should focus its efforts in eliminating obstacles that may affect the workflow of the process. Lean philosophy believes that in an organization work has to flow continuously from one stage to another without interruption.
- **Pull**  
In heavyweight methodologies work was *pushed* through the system following the team rate of work. Lean organizations instead pull the work reacting to the customer's demand.
- **Perfection**  
The objective of a lean organization is to implement these principles in order to develop a perfect process that eliminates waste and delivers the right amount of value to the customer. Every activity should be valuable adding, capable (produces a good result every time), available (produces the desired output), adequate (does not cause delay), flexible, and linked by continuous flow. If one of these factors fails some waste is produced.

## 2.4 Agile Methodologies

### *2.4.1 Introduction to agile*

The term agile was born in the late 90s and developed on February 2001. A group of experts gathered in Utah with the idea of bringing up an alternative for the traditional methods of the projects development processes.

Heavyweight methodologies demanded a lot of work from the Project team, in areas with minimum productivity such as the elaboration of documentation, and also they had proven to be nonflexible in its processes. That had a huge impact on productivity. As new technologies developed, so did the demand from customers who wanted to get results at the very moment, and who didn't need to know from the beginning the requirements and the scope of the product they expected to get in a near future. The main objective of this meeting was to determine the values and principles that Project teams should acquire in order to develop software faster than using heavyweight methodologies, and to come up with processes that could adapt to changes in the projects lifecycle.

The conclusions made on that meeting resulted in the creation of The Agile Alliance. The objective of this organization was to promote all the concepts and ideas related with software agile development, to keep the study and research in the agile area, and helping the organizations to implement the agile philosophy in their projects as well as in their teams. [18]

#### **2.4.1.1 What does agile mean?**

The objective of agile methodologies is to influence the whole organization so it becomes agile itself. But what does agile mean? According to Jim Highsmith, "being agile means to be able to deliver quickly, change quickly and change often". While agile techniques may change in its execution and emphasis, they all share common characteristics, including iterative development, iterative communication, and the reduction of activities that deliver no value.

Iteration development allows the Project team to adapt to changes in requirements. Communication is key for the company's success, having a well-developed communication process allows the team to gather all the information required faster and therefore decisions can be made immediately, and productivity then increases. The reduction of a task that deliver no real value for the final product, allows the team to focus more on activities that develop the product, those measures have a great impact on the time.

The real change that agile methodologies bring up, are not the processes they implement itself, but a change of mentality. Agile methodologies believe that the real success of any Project and organization depends on their people. Being agile doesn't just mean to follow the process and the activities that agile methodologies suggest; being agile is a way of thinking as an individual and as a team.

When organizations start implementing agile thinking, they become less formally structured, and they begin to operate as a big team, where every member of it puts the general interests ahead of own interests, team spirit is built and even roles change, from given authority (Product Owner, Product Manager...) to recognizable leaders. [21]

#### **2.4.1.2 The agile manifesto**

The Agile Manifesto is the document that best resumes the agile thinking. It was written in February of 2001, at a meeting between some of the best experts in several programming methodologies. In that meeting, the participants came out with four values, which best represent and resume what it is to be agile.



The following principles of agile methodologies are the basis of agile thinking:

**1st. People oriented**

This is probably the most relevant principle of the manifesto. According to Jim Highsmith and Alistair Cockburn, "The most important implication to managers working in the agile manner is that it places more emphasis on people factors in the Project (empathy, talent skill and communication) than on the process". The tools and processes of projects are important for increasing efficiency, but the people are the ones who have the greater influence both on the Project and the company. A competent team with the right technical knowledge and a good attitude is able to develop any process and overcome any problem that emerges. It is often confused the idea in which organizations create their teams, first they build the work environment and then they force the adaptation of the team, when it should be the other way around, first develop your team, and then let the team develop their own work environment based on their necessities. The quality of a process is not as important as the quality of the people. In projects where creativity and innovation are required, processes have to be a tool for the team in order to guide their work, and team members must be well prepared and in a comfortable environment in order to put out their best work.

**2nd. Software over documentation**

The documentation of any Project is very important, but it should serve as a basis for the Project. Traditional projects used to base its projects in a strong documentation with an excess of information, documentation is important but it doesn't provide any real value to the product. Working in iterations instead provides feedback to the team, because the team gets to see the prototype and so is able to come up with new ideas opening new possibilities for the product. Also, if an organization chooses to communicate with its departments and teams using only documents, it creates a Wall between the organization and its teams, this isolates the teams that end up losing the general perspective and the main objective of the Project. The main rule is the following "do not produce any document unless it is immediately required in order to make an important decision". [22]

**3rd. Collaboration over contractual negotiation**

According to Highsmith "Agile Projects are not controlled by conformance to plan but by conformal to the business value" Planning is important but when the product is more complex, then it is more important to develop the product in small constant iterations, having both the Project team and the customer collaborating in the development of the product, this provides a retrospective view of the process and creates feedback between the two parts which results in the projects benefit, developing the product in a much richer way, adapting the Project for the new out coming ideas and requirements. Also, it is very difficult for the customer to settle all the requirements at the beginning, considering that these may be changing in the future, and therefore the Project team and the customer would have to work together in order to adjust the Project to those changes. Having this into consideration, it wouldn't be wise to base our Project in a contract between the customer and the Project team, because it doesn't deliver any real value for the product, and it creates a barrier between the two sides. In the agile development, the client is also a member of the team, he collaborates with the team and is taken into account for the iterations.

**4th. Adaptability to change instead of following an strict plan**

It is more important having a team with the ability to respond to any change that might appear during the Project, than having the whole development planned to the detail, because in reality, projects do not stick to the plan, and suffer variations from

the initial design, so the key to success is found in how teams react to these changes. The principal values of Project management according to PMBOOK were planning and control, while in agile management the most important are anticipation and adaptation. Therefore planning should be flexible. [21] [22]

These main values, lead to the origin of what we know today as the 12 principles of agile thinking:

- a) Our highest priority is to satisfy the customer through early and continuous delivery of valuable software.
- b) Welcome changing requirements, even late in development. Agile processes harness change for the customer's competitive advantage.
- c) Deliver working software frequently, from a couple of weeks to a couple of months, with a preference to the shorter timescale.
- d) Business people and developers must work together daily throughout the Project.
- e) Build projects around motivated individuals. Give them the environment and support they need, and trust them to get the job done.
- f) The most efficient and effective method of conveying information to and within a development team is face-to-face conversation.
- g) Working software is the primary measure of progress.
- h) Agile processes promote sustainable development. The sponsors, developers, and users should be able to maintain a constant pace indefinitely.
- i) Continuous attention to technical excellence and good design enhances agility.
- j) Simplicity- the art of maximizing the amount of work not done- is essential.
- k) The best architectures, requirements, and designs emerge from self-organizing teams.
- l) At regular intervals, the team reflects on how to become more effective, then tunes and adjusts its behavior accordingly. [22]

## 2.4.2 Scrum

### 2.4.2.1 Introduction to Scrum

Scrum gets its name from a famous rugby play. It is the play made by a team when the referee as a result of an illegal action stops the match. The two teams then have to confront each other by making two blocks (Scrum's). Each of these blocks are formed by team members, then ball is dropped between the two teams who push together in the same direction in order to win the balls possession.



**Figure 2-7. Scrum in Rugby [23]**

It is probably one of the main agile methodologies, which has been used in many companies for the last decade and has it has proven to succeed. This methodology is used for long complex projects that are developed in a volatile environment. Scrum main objective is to respond to those changes that

the Project may suffer in the Projects lifecycle and bases its work in iteration processes and the coordination and communication of every person involved in the Project in one way or another.

It is known that, Nonoka and Takeuche took the first steps towards the Scrum methodology back in 1986. Nonoka and Takeuche wrote *The New Product Development Game*. In this article they introduced the concept of an agile process, which Worked fast, in the hands of self-organized teams and that could be implemented in the development of new products. [4]

Scrum was first adapted for the development of technological products. It was in 1993 that Jeff Sutherland used this model in the Easel Corporation for software development. Three years later, in 1996, Sutherland decided to show along Ken Schwaber all the activities of this new model, that they had been using in software, and presented them as formal processes for managing projects of software in the OOPSLA 96. This processes were normalized and included in the Agile Alliance of 2001.

Why do we need Scrum in Project Management? [24]

- It is known that over 80% of the projects are delivered later than it was originally planned.
- The original budget for the projects do not meet the final result either, having about 50% of them running over their original expectations.
- Projects moving in an uncertain environment with high requirements variability do not have a predictable closing.
- “76% of projects do not meet their initial ideas, having most of them running late and over budget”.

#### 2.4.2.2 Scrum roles

For large organizations, Scrum development parts consist of more than one Scrum team. The basic roles that we can find in each development team is: Product Owner, Scrum Master, and the ScrumTeam.

The product owner is responsible for the final result of the project and how is it going to be developed. The Scrum Master is the shepherd of the team, guides the Scrum team in order to get the results ordered by the product owner. The Scrum team is responsible for delivering the work following the Scrum framework. [25]

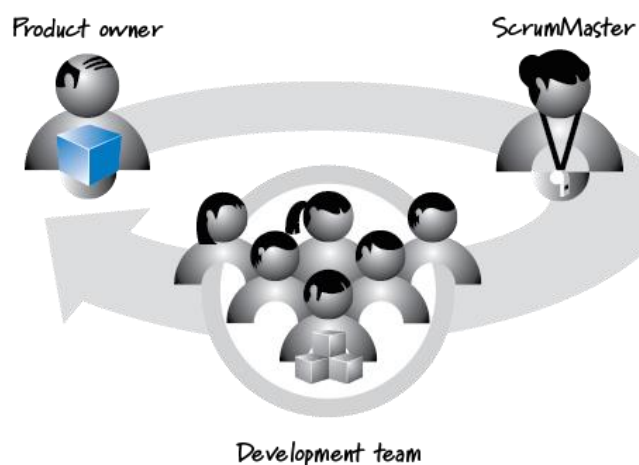


Figure 2-8. Scrum roles [26]

##### a) Product Owner [8]

As the name implies, he is the owner of the product. He has the knowledge needed for the Project, knows the clients environment and has the vision of the final product present. The Product Owner is the responsible of delivering the highest value of the product. He is also responsible for the founding

of the Project, the closing and the return of investment. If the client does not have the abilities required for being part of the team, there is the possibility of naming Product Owner a member of our team. Communications between the team and the client have to be fluent, as if he was one of the members.

As we have seen, the Product Owner elaborates and keeps the Product Backlog updated. Before starting any iteration, he checks the plan according to the value of the requirements, and helps the team in the planning, and study of the sprint objectives.

### **b) The Scrum team**

What sets a Scrum team apart from other kind of teams is that from the time they enter the team, they are collectively committed to complete together the set of work that they have been given in order to achieve the sprint goal. It is for this reason that Scrum teams have so much success, because the team develops a sense of camaraderie among the members. If the project fails the team fails, if it is a success, it is the team's success.

A normal Scrum team is five to nine people. This number of members may seem small if we are trying to develop a complex project.

However it is well known that large teams are difficult to manage and to coordinate. To solve this problem organizations create Scrum teams of Scrum teams, making a pyramid of teams, rather than making bigger teams.

It is current to see big teams arranging Scrum of Scrums meetings, so the pyramid coordination flows. By doing these meetings, organizations avoid the isolation of the teams, which have an awful effect on the project's productivity.

### **c) Scrum Manager**

The Scrum Manager or ScrumMaster has the responsibility of leading the team, making sure all members live by the values and practices of Scrum. He is often considered as the coach of the team who pushes the team forward in order to get the best possible result. He is also the filter between the Product Owner and the team. As he spends time with the team, he knows what to expect from them, having continuous communication and feedback from the team members.

The ScrumMaster serves the team in order to get the best performance for any level. This involves removing impediments to progress, visualizing future obstacles and communicating them, arranging meetings both with the team the daily Scrum and the Product Owner (making sure the product backlog is in good shape). He is also the protector of the team. This means that the ScrumMaster needs to be the "big brother" of the team, protecting its integrands from the pressure that may be given by the Product Owner but also making sure the team does not fall for complacency.

How does the Scrum Master fit into the Project?

Some people may find difficult to understand the Scrum Master role in the organization, due to the fact that he is both the servant-leader of the team, but also the Scrum Master has no legal authority over the members of the team. This contradiction washes away when we realize that the Scrum Master has no authority over the team, his authority is given over the process itself, so for example a Scrum Master is not able to fire someone or to force any member of the team to do a certain activity, instead he will encourage the team to perform the process the way he wants to have it done. Therefore, even though the Scrum Master has no legal authority over the team, the own team gives the authority they get. Depending on the Scrum Master leadership, this authority will be granted to them by their own team. [24]

With that limited authority, the Scrum Master role is quite more challenging than that of a typical Project manager. While Project managers often can give orders to their subordinates, as for example “do it because I say so”, Scrum Master will never do so, ensuring that Scrum is being followed.

### 2.4.2.3 Scrum elements

A Scrum based Project is executed in small portions of work which may be 2 to 4 weeks long, depending on the project, these blocks are called iterations or sprint. Each sprint has to produce a delimited and operative increasing the final product, so the client gets to evaluate the product as it is created.

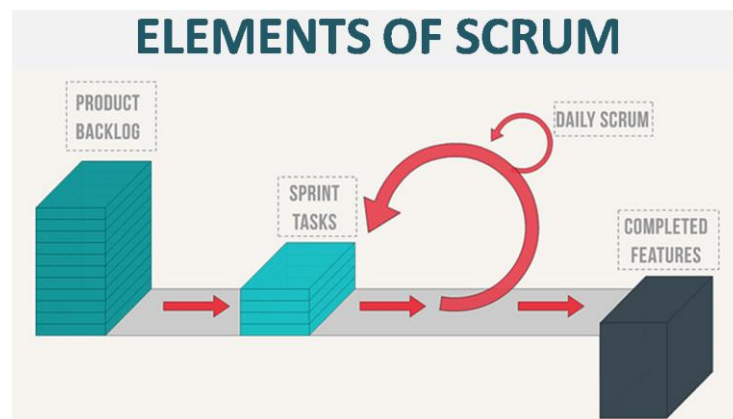


Figure 2-9. Scrum elements [27]

#### a) Product Backlog

The first stage of the Scrum lifecycle is the Product Backlog. We define backlog as the list of requirements that the Project must have integrated. These requirements are prioritize according to the client's perspective of the product objectives.

Even though the project's initial backlog is established by the client, the product backlog is suitable of suffering changes during the sprint retrospective meetings, therefore this makes the Product Backlog a flexible document.

As a flexible document it may change from one sprint to another, therefore, it is not necessary to wait for this document to be completed in order to proceed to the first iteration. We just need to identify all the requirements of the sprint, making an especial observation in those that are critical for the Project, and having a brief description of the activity its cost, the scope and value. This is made for every item of the list. When elaborating the Product Backlog, every member of the team may suggest some ideas according to his role in the team, but the responsibility of the final result rests in the *Product Owner*. [8]

We may also plan the sprints using the Product Backlog. To do so we must gather all the requirements, in a coherent way according to their functionality, not jeopardizing the general objective of the iteration. At the end of each deliverable (sprint) the client is able to prove the results of the iteration. This method provides feedback of the client's satisfaction with the product, building confidence in the company, before proceeding to the next sprint.

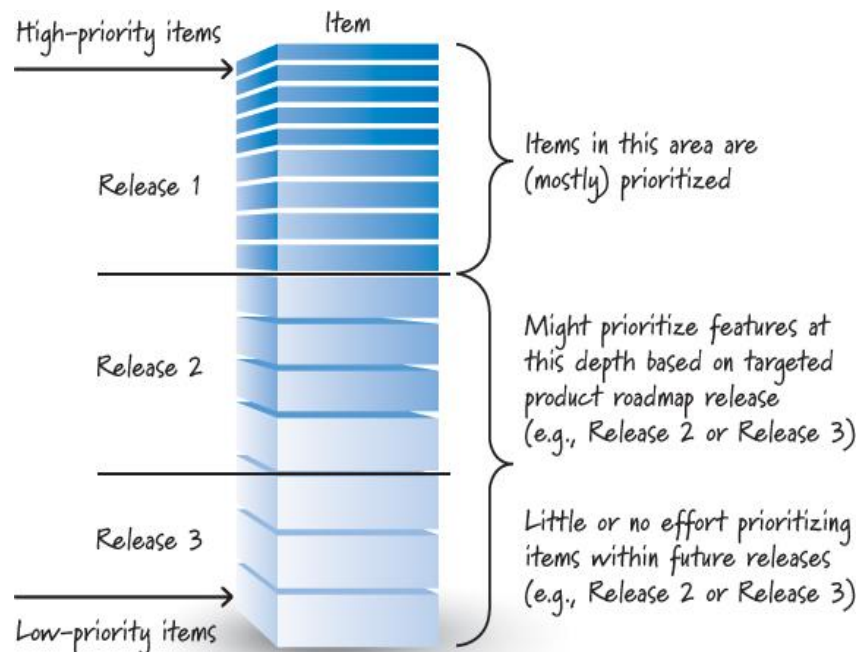


Figure 2-10. Product Backlog

### b) Sprint Backlog

The sprint backlog is the list of tasks that the Scrum team selects to deliver during a specific sprint. These tasks are directly taken from the Product Backlog chart, normally in the form of user stories. Every user story is divided into more detailed tasks that need to be performed in order to complete the story. Single tasks are assigned to every member of the team, making sure that each member of the team performs only one task at a time.

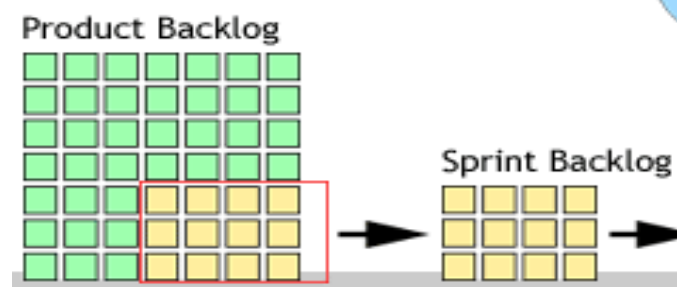


Figure 2-11. Sprint backlog

It is up to the team to decide how many features will form the sprint, however this doesn't mean that the sprint backlog will not change as the sprint goes on. Flexibility is key for the sprint success, therefore it is expected to adapt the sprint to the teams' rate of work, adding or changing tasks of the sprint backlog are a common thing in Scrum, having the team pulling the right amount of work into the sprint. [8]

### c) Complimented features

Also known as the product increment. Whether the product is a new application or a new ship, usable product must be complete at the end of every sprint in order to demonstrate its working functionality. At the end of the project, the product increment all the deliverables result in a product that has the functionality required to meet the customer's goals and expectations.

#### 2.4.2.4 Scrum processes

There are three phases or processes in Scrum, those are: Sprint planning, sprint tracking (Scrum daily meeting) and sprint revision.

##### a) Sprint-planning meeting

Iterations begin with a planning meeting called sprint-planning meeting. The product owner, the Scrum Master and the whole Scrum team attend this meeting.

During this meeting, the product owner shows all the features that need to be done in order to complete the sprint, highlighting the highest priority features to the team. In this meeting the collaboration of the team is keen for the sprint success. The team should make suggestions that go in the benefit of the product, and also questions are important, at the end of the meeting the team should be able to turn a high-level user story of the product backlog into detailed tasks.

The main features that result from a sprint-planning meeting are a **sprint goal** and the **sprint backlog**.

The sprint goal is a brief description of what the team needs to achieve during the sprint. Both the product owner and the team write this objective. The sprint goal must be simple and clear, a line or two are enough to define the objective of the sprint. This goal may be used to report to stakeholders outside the sprint process who may be curious to know what the team is working on at certain moments. The sprint success will be measured in accordance to the sprint goal and the final result, rather than checking if all the features of the sprint have been accomplished.

At the meeting the team has to be able to turn the features from the product backlog, into more detailed tasks. The list of task that result from this meeting is the sprint backlog. Although the team may not have too much to decide in the sprint meeting, it is in fact the team who controls the rhythm of the sprints .It is the team that selects how much they can work in the coming sprint even though the product owner has the final decision, but the truth is that only the team knows how much work they can take, basing their prediction in the previous sprints. [21]

For example, if the first sprint had 5 features, but the team only got to do 3, the product owner cannot expect to get 6 features for the next sprint. Instead, it will be the team that suggests the amount of work for that next sprint, so they may be doing 3, or perhaps 4 if the team considers that they could have done better.

##### b) Daily Scrum meeting

As the sprint is being executed, an everyday meeting between the members of the team takes place before the team heads to work. This meeting has proven to be of use, because it solves a lot of problems just by sharing 15 minutes a day among partners. This meeting is called *the Scrum daily meeting*.



Figure 2-12. The Daily Scrum [28]

The main objective of this reunion is to achieve a good synchronization of the team, with an information flow of quality. This helps all the parts be more collaborative with each other, having a huge impact on the team's productivity, due to the fact that some problems that are shared in this meeting, can be solved by one of the members of the team.

The Scrum daily meeting has a time box of 15 minutes. In that short period of time, every member of the team must answer the following questions:

- **What did I do** yesterday? Could I finish what I indented to accomplish? What was the problem?
- **What am I going to do** today?
- **What impediments I have or may appear**, that will disturb my activities.

In this process, each member of the team is able to listen to what his colleagues have to say about their work. By doing this, every team member can get a close analyses of the work that everyone is doing, this brings a good perspective of the relations between one member's activities and his owns activities. It is also important to share what obstacles may get in the way towards the sprint objective progress. [8]

The daily Scrum meeting must be a habit that the Project team must adapt as part of the Project process. Because it is a process and it has a purpose, there are some restrictions and recommendations that must be considered in order to keep the meeting simple and on the goal. [24]

#### Restrictions

- **The daily meeting purpose is not for solving problems**, the problems are solved after the meeting, and while executing the sprint.  
Members of the team might not be interested in hearing the details of each department.  
In the reunion, members of the team hear to one another and organize appointments to collaborate in solving these problems. All members of the team need to know what are the rest of their partners doing, because most of the problems can be taken care of by one of the members in that meeting. If a subgroup needs to gather in order to have a close conversation, being this mini-talk not of the team's interest, this must be done once the meeting is over.
- **The team must have common set criteria for the execution process of the sprint activities**. Every member of the team must know the execution process of the activities, so we avoid the meeting to be a constant debate about how someone has to do his work.

#### Recommendations

- Take it to the team- It is the team who needs to communicate in the meeting, as they are the ones performing the work.
- All members should be present in the daily meeting.
- The Scrum Manager is not going to solve the problems; it is the team who needs to have the Word.
- Never organize a reunion in a room where the people can get relaxed, this means no chairs, no electronic devices nearby, etc. If the team relaxes, it may not work at its full capacity. Remember it is a very short meeting, so people need to be focus on the task.
- Try not to make the meeting monotonous. Although there are some rules that need to be followed, this doesn't mean that the Scrum meeting has to be the same every day.  
There is nothing worst than a monotonous meeting, because in the long run, people can get demotivated, losing interest on the activity and forgetting the purpose of it.



At the end of each sprint, a deliverable comes through providing the product a potentially shippable increment. So before proceeding to the next sprint, at the end of every sprint there is a review meeting, where the Scrum team shows what has been accomplished in that particular sprint.

**c) Sprint review meeting**

The Sprint review meeting is kept very informal, getting the members to share the final result with all the parts involved, rather than having formalities in the review that only create boundaries in the communication. The objective of the sprint meeting is to see the final result in a natural way, so it shouldn't become a distraction for the team.

During the sprint review, the project is compared with the sprint goal that had been written in the sprint-planning meeting. Although it is important to get each item of the product backlog done, the main objective is to achieve the overall goal of the sprint.

**d) Sprint retrospective**

One of the main principles of agile is the continuous improvement of the process as well as the teams' improvement. Thus, it is good to evaluate each sprint at the end of it, so the team is able to analyze how they are doing, finding ways to improve. This review of the whole sprint process is called the Sprint retrospective.

The Sprint retrospective usually lasts for an hour, however it is normal running into a hot topic, so the retrospective could take longer.

There are three main questions that each member of the team should respond according to the Sprint retrospective:

- What did we do well and we should keep doing?
- What went wrong and we should stop doing?
- What should we start doing in order to improve?

By answering to these questions, the team and the process gets improved, not for the completed sprint, but for the following sprints. [8]

#### **2.4.2.5 Metrics**

In order to understand how Scrum keeps a continuous planning and control of its projects, it is necessary to understand the graphs that Scrum uses; the Burn-up and the Burn-down chart.

- **Release Burn-down Chart**

This is probably one of the most visual tools that the team has in order to track its progress. It also allows the team to predict how much work is left until the deadline, and what is the rate of work they need to be performing in order to finish on time. The Scrum Master updates this chart at the end of every sprint.

In this graph, the number of sprints is represented in the horizontal axis, while the vertical axis shows the amount of work left for each sprint, according to the value given in the product backlog (story points).

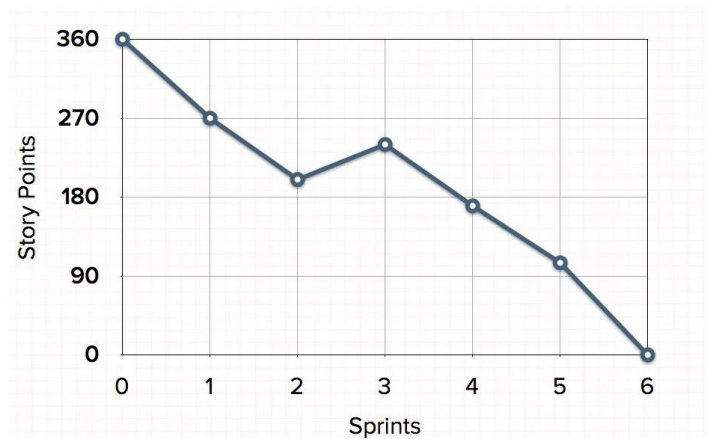


Figure 2-13. Burndown chart [29]

Just by looking at this chart, the Scrum team is able to see what is happening in the project and how much progress is being made during the sprints. The burndown chart is an essential part of any agile project.

- **The Burn-up chart**

The purpose of the burn-up chart is different from the release burn-down chart. The Product Owner uses this graph to understand the margin in which the teamwork is operating. It also helps the team to check their progress, the amount of work that they can take, time scheduled, error deviation, and the actual work rate needed to accomplish the goals set.

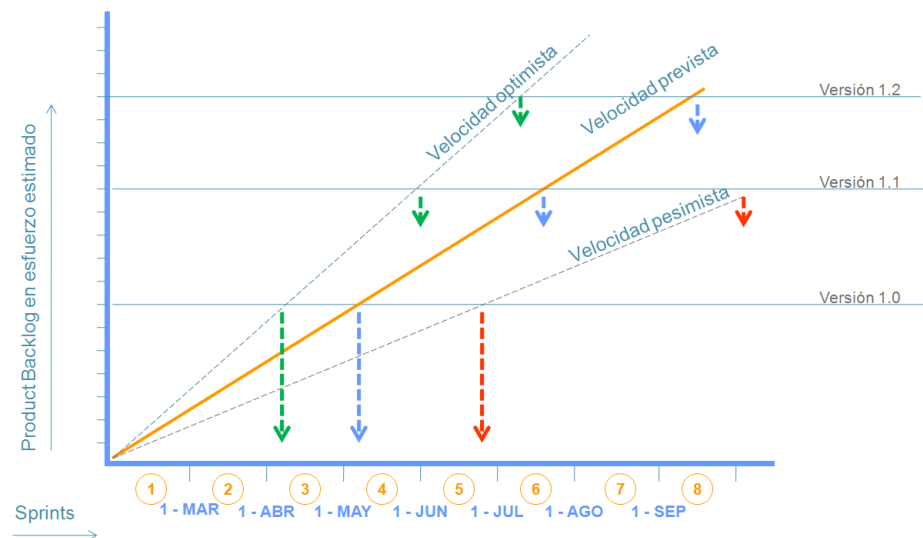


Figure 2-14. Burnup chart [29]

In this graph, the number of sprints is represented in the horizontal axis, and the estimated effort on the vertical axis.

The Product-Owner knows what is the margin of performance that his team can show. So he will try to stay inside the two limit lines. This allows the team to visualize the moment they are going to reach the objective according to the rate they can perform.

The combination of these visual tools guarantees a good performance in the process, furthermore, it brings confidence to the team, that is able to see at any moment how they are doing and how much they have left in order to reach the goal of the sprint and the project.

#### 2.4.2.6 Summary

To summarize Scrum we write down the most important parts of this methodology and their relations among one another:

Roles:

- Product Owner
- Scrum team
- Scrum Master

Elements:

- Product Backlog
- Sprint Backlog
- Deliverables

Meetings:

- Sprint planning
- Daily Scrum
- Sprint revision
- Retrospective

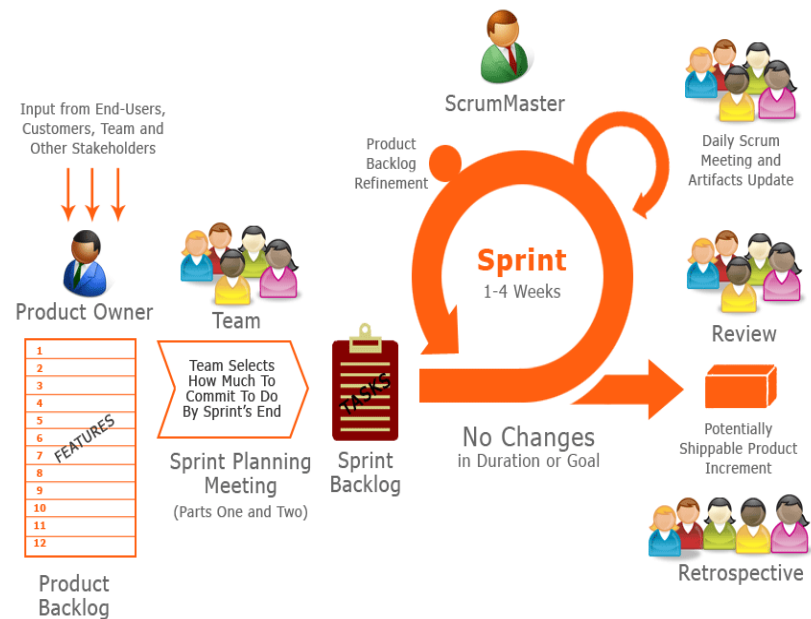


Figure 2-15. Scrum summary [36]

### 2.4.3 Kanban

#### 2.4.3.1 Introduction to Kanban

Kanban is an agile tool methodology that was created by the automobiles company Toyota in 1937, and has been adopted by many more companies ever since then. Kanban is a Japanese word that stands for “visual cards”, and was used in the production line by Toyoda in order to control the flow of activities of the company.

Kanbans' main objective is the control and management of the workflow. This tool was created to control the production line of a company, but with time, this methodology has been implemented in companies handling more complex projects, like software engineering, I+D, Logistics, etc.

In order to visualize the workflow in a flick of an eye, Kanban uses a board in which the flow of activities is represented.

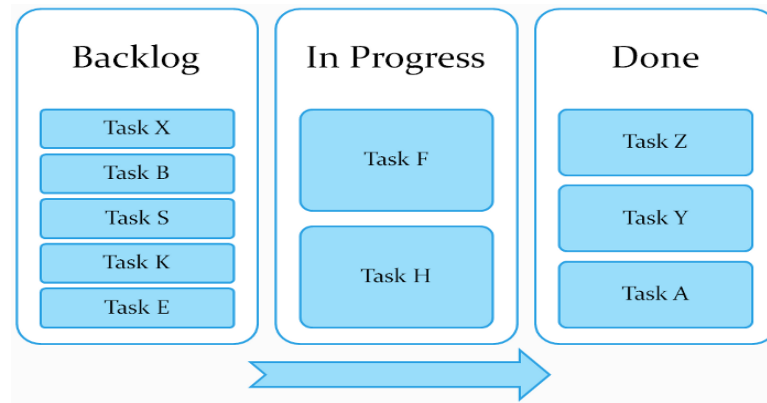


Figure 2-16. Kanban chart [30]

In the Kanban chart, the activities pending of doing are represented in the backlog column. As these tasks start to develop, they are moved simultaneously across the Kanban chart. In order to help the visualization of the whole process situation, each task is written in a different colored post-it or different form, representing the type of task, the responsible of the task, and other information of use.

The Kanban chart has to be checked constantly by the team. This visual tool makes the whole project be more agile. The situation of the columns provides a real understanding of the workflow, so it is easier to measure the productivity of the team. [11] [18]

#### 2.4.3.2 Work in progress (WIP)

One of the main ideas that Kanban has implemented, is the limitation of work in every column of the chart, this means that there should be a limited amount of tasks permitted in each stage of the process, and this number has to be known by the team. This number is also known as the limited Work in Progress.

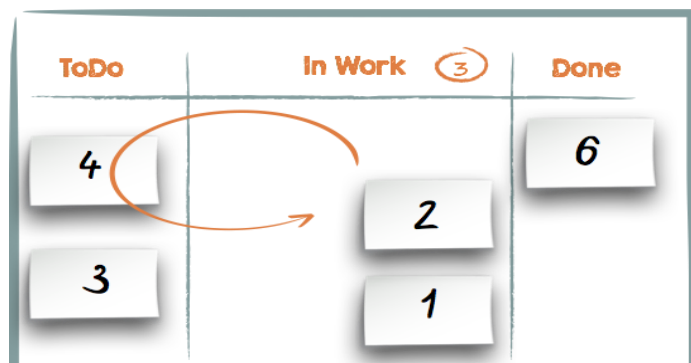


Figure 2-17. Work in progress [31]

If a column is saturated with tasks, in order to begin a new task there needs to be another task moving out of the column, so the flow continues.

The idea that Kanban wants to transmit is the following: focus on those tasks that you have started, and have them finished before you start another activity.

#### 2.4.3.3 Lead-time

The time spent in delivering any activity is also known as “lead time”. This time is measured from the moment the activity is required, to the time it is delivered. There is also another important metric

used in order to measure the efficiency of the process, this metric is the “cycle time”. The cycle time begins in the moment the activity goes to the work in progress column and ends when it is moved to the “done” column.

#### 2.4.3.4 Roles

The main difference between Kanban and other agile methodologies is the fact that Kanban doesn't use roles as a methodology. The lack of roles can be an advantage for the team; this encourages the team to improve them to improve. But for large complex projects, Kanban cannot be implemented as a methodology that is useful to run the whole project process. However Kanban should be considered as a tool or metric that allows the team to see the obstacles and the workflow just by looking at them. That helps the process be more agile, and also helps the team's self-improvement. [24]

#### 2.4.4 Scrumban

Scrumban is the methodology that combines the natural process of Scrum and the tools implemented by Kanban, a combination of two Lean methodologies may lead to an ideal one.

**Scrum** works by dividing the team into small multi-functional teams, assigning certain numbers of jobs into sprints and committing the team to complete them by the end of the sprint. Looking back at previous experiences mainly optimizes it.

**Kanban** concentrates on visualization of workflow and putting a limit onto how much work can be progressed at any given time. The prime source of improvement possibilities comes from measuring and the lead-time, and aiming to better it in the future.

The main difference between these methodologies rests in the items pull order. In Scrum, the team is able to pull the items once the sprint backlog has been set. Kanban on the other hand, places the tasks in the Kanban chart, and it is the team that decides which items must be taken care of first, moving them from column to column as the work flows. Kanban shows to be more flexible as it is down to the team to decide the priorities.

Scrumban uses Kanbans' visibility of the workflow combined with some of the elements used in Scrum, like scrum meetings, and customer feedback as part of the process. To summarize, Scrumban takes the general process of the Scrum methodology, and uses Kanban as a tool to provide more flexibility to the project's execution. The combination of both methodologies allows the teams to process more items. It also increases the control of the process timing, as tasks are pulled from the Kanban chart adapting the workflow to the teams demand. [24]

In order to avoid the saturation of work in iterations, the Scrumban practice states that a team member should never work in more than one task at the same time, ensuring the team's effectiveness. It is important to apply a WIP limit both for the sprint backlog and the Kanban chart, the WIP number normally corresponds to the number of team members, but it can be adapted to the team requirements.

The following image shows a Scrumban board in which the main characteristics of Scrum and Kanban practices are clearly shown:

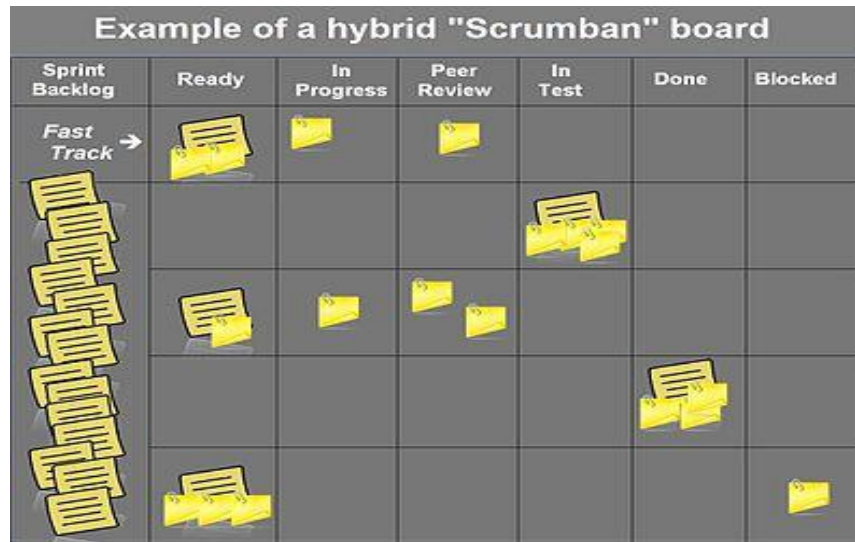


Figure 2-18. Scrumban chart [32]

Scrumban improves the efficiency of those organizations that have already adopted a Scrum methodology. This improvement in efficiency comes from the implementation of the Kanbans' continuous workflow system; limitation of work in progress (WIP); allowing changes in the Sprint Backlog, etc.

In the following table, the main elements of Scrum, Kanban and Scrumban are shown in order to have a better understanding of the Scrumban practice.

Elements	Kanban	Scrum	Scrumban
<b>Roles</b>	No described roles	Product Owner, Scrum Master and Team roles	Team + needed roles
<b>Ceremonies</b>	No daily stand up, no review and retrospective meetings	Daily stand up, review and retrospective for improvements	Daily stand up supported with the Kanban board for status management
<b>Workflow</b>	Continuous workflow	No	Workflow defined, WIP limits used
<b>Iterations</b>	No	Sprints 1-4 weeks	Continuous workflow
<b>Change, Management and bug fixing</b>	Just in time	Next sprint	Can be added at anytime to the board

Chart 2-1. Scrum, Kanban, Scrumban [33]

### 2.4.5 *Traditional vs agile*

	Agile Methods	Heavy Methods
<b>Approach</b>	Adaptive	Predictive
<b>Success Measurement</b>	Business Value	Conformation to plan
<b>Project size</b>	Small	Large
<b>Management Style</b>	Decentralized	Autocratic
<b>Perspective to Change</b>	Change Adaptability	Change Sustainability
<b>Culture</b>	Leadership-Collaboration	Command-Control
<b>Documentation</b>	Low	Heavy
<b>Emphasis</b>	People-Oriented	Process-Oriented
<b>Cycles</b>	Numerous	Limited
<b>Domain</b>	Unpredictable/Exploratory	Predictable
<b>Upfront Planning</b>	Minimal	Comprehensive
<b>Return on Investment</b>	Early in Project	End of Project
<b>Team Size</b>	Small/Creative	Large

**Chart 2-2. Agile vs Traditional [11]**

Traditional methodologies have proven to succeed; in fact these methodologies are widely used all over the world as they serve as a guideline for simple projects' management. However, heavyweight methodologies have a lot of flaws, like linearity, inflexibility, and excessive documentation that derives in general waste for the whole process. On the other hand, agile methodologies appear in response to the volatile environments in which the projects were being produced; as a result, agile methodologies focused more on establishing great compromise and collaboration between the customer and the developers. Agile believes that having constant interactions between both sides of the project makes small deliverables possible; therefore work is divided and easier to perform.

## 3 APPLICATION OF AGILE METHODOLOGIES TO THE ARMADA LOGISTICS

### 3.1 Logistics in the Armada

#### 3.1.1 Definition

There are many definition of logistics, however due to its application in the navy, we have to look for a definition that is related with the strategy, Tactical operations, allocation of the units and the production of new products. *“Logistics is the study of the planning and execution of the movements and maintenance of military units.”* [34]

Therefore we can say that logistics main objective is to support the Force during peace or in an environment of crisis. Logistics efforts should always be oriented in achieving the operational goals, thus achieving the Force goals.

Right from the beginning we are able to see how Logistics main goal is related to lean philosophy. Lean's main idea is to focus all efforts in providing customer value, as the only way to succeeding in its projects, because lean understand that the final success is closely related to the customers satisfaction. In the military, the customer is the Force, and the organization and Project team is the logistics supporting the force.

#### 3.1.2 Logistics functions

The different Logistics functions gather to form the Logistic Support. In the Armada, Logistics is organized according to the NATO doctrine of Logistics, thus the main Logistics functions are the following:

- Material.
- Provisioning.
- Maintenance.
- Support services.
- Transport and movement.
- Bomb disposal.
- Engineering.
- Health service.
- Contracting.



-Budgeting and finances.

### 3.1.3 Logistics principles

The Logistics principles are the fundamentals that must be considered in order to carry an efficient and effective Logistical Support. However, these principles don't have to be understood as nonflexible rules, due to the fact that almost every operation in course represents a complex and fast changing environment. This volatile environment forces the Logistics Corp to adapt for the new requirements. Nevertheless the logistic principles enclose the essence of the military philosophy of confronting these operations.

There are eight logistic principles, which summarize this philosophy: authority, transparency, economy, balance and simplicity are oriented towards the planning stage, and the principles of persistency, opportunity and flexibility, which are oriented towards the execution phase.

<b>AUTHORITY</b>	<p>This principle refers to the power given to the Commander of a squadron or an operational organization. This command is carried out over units, equipment and logistical resources, allowing the authority to use them in the most efficient manner.</p> <p>In general the principle of authority is resumed in two main aspects:</p> <ul style="list-style-type: none"> <li>➤ A strong and clear delegation of authority to both the units and the logistic agencies.</li> <li>➤ Cooperation between the Force, Civil authorities and other organizations settled in the area of operation.</li> </ul>
<b>VISIBILITY</b>	<p>It is important to have real updated information of the situation and state of every unit, as for it logistical resources. This principle is of paramount importance in order to optimize the sustainability of each unit. Visibility in the Logistics Body contributes to an efficient and flexible management of the requirements needed in any operation. Furthermore it provides the authority the information needed to run the logistic operation in any scenario. Visibility makes decisions run faster, so it is easier to adapt to changes in the operation requirements.</p>
<b>ECONOMY</b>	<p>This principle consists on using the logistical means needed for each occasion, eliminating redundant activities and searching the continuous improvement of the logistical activity. This is manifested in the establishment of the right requirements of for the operations, the look for the resources interoperability, the knowledge and understanding of the logistical possibilities, and the protection and conservation of our own resources.</p>
<b>SIMPLICITY</b>	<p>Simplicity implies being practical and realistic in the elaboration of plans and procedures for the operation. It also means that our plans have to be of practical use, simple to execute and mission oriented.</p> <p>This principle is carried out throughout the whole organization by making a simple logistic organization; the reduction of stages for the resources acquisition between the units and the logistical support; a clear allocation of responsibilities; and the most important, a total normalization of material and procedures for all the units in the operational area.</p>
<b>SECURITY</b>	<p>Measures oriented to guarantee the operational capacity and the integrity of our units, in order to assure the mission success. Security is essential in the organization if we want to keep an efficient and effective logistical support, therefore ensuring the sustainability of the units. Security should always be present at any moment of the logistical operation.</p>
<b>COOPERATION</b>	<p>It is one of the main factors for achieving any operation's success. This principle is also related with the communication's principle of the execution phase. Cooperation between the Force and the Logistic Body is based in mutual trust and understanding. The understanding is bidirectional, the units must help the Logistic Authority with the requirements of the operation, and in order to make good decisions, the Logistics Body needs to have a good understanding of how the operation is being carried out.</p>

<b>OPPORTUNITY</b>	Opportunity means to provide the logistical support required by the Force, at the right place in the right time. It is manifested in the building of suitable logistical structures with secure and agile communications.
<b>FLEXIBILITY</b>	<p>It is the ability to adapt to the changing requirements of the operations. Flexibility must be studied in to areas: anticipation and response.</p> <ul style="list-style-type: none"> <li>➤ Anticipation: Being able to make the right decisions by analyzing the Logistics problems that may emerge during the operation.</li> <li>➤ Response: Having the right resources and measures to confront unexpected requirements. Flexibility also means setting the logistical priorities of any situation; these priorities must be of general knowledge.</li> </ul>

**Chart 3-1. Logistics principles [35]**

As we have seen before, the principles that define the logistic philosophy of the navy, matches most of the standards that agile thinking defends. It is easy to find each of these principles in the agile philosophy:

- **Authority:** Not to be confused with the bosses role. We may define authority in the Scrum methodology, where it is very important to have all responsibilities clearly allocated, so everyone knows who is in charge of certain tasks.
- **Visibility:** We may find visibility in the lean thinking, more specific in the Kanban methodology. Kanban is a great tool to check the workflow of the project. Again we find visibility in the team and the organization, both get a good idea of how the project is going.
- **Economy:** This logistic principle is also one of the bases of the lean thinking. The elimination of waste, or activities that are redundant and therefore provide no additional value for the final project.
- **Simplicity:** Scrum itself uses this principle by dividing the whole project into smaller iterations. Simplicity is also part of the whole agile thinking, as they avoid the use of detailed documentation in favor of real value working software.
- **Security:** Security for the logistical operations is vital, and so it is for other organizations and its projects. The interoperability of Toyota's workers is the example that best describes this principle. By training their people in having the skills and knowledge to perform at almost any stage of the production chain, Toyota makes sure that the process is continuously moving forward, and when problems emerge, they are detected and solved instantly.
- **Cooperation:** In Scrum, cooperation between the Client and the Project team is also of key importance. Based in mutual trust and understanding.
- **Opportunity:** This principle is part of the production *Just in Time*. Also it indicates that the project or product is oriented to the customer's requirements.
- **Flexibility:** It is probably the main innovation that agile methodologies introduce to their projects. Flexibility in the execution of the project, due to the fact that this products are moving in a volatile environment, and so, the requirements may be changing during the

development of the project. How the team responds to these changes will determine the success of their project.

### 3.2 Agile methodologies in Logistics current activities

#### 3.2.1 Logistical support using Scrum

The goal that the Armada Logistics has to achieve is to provide the logistical support required by the units during their lifecycle. This support encloses all those activities related to the logistics functionality (transport, provisioning, maintenance, personnel...) that are taken care of in all the areas of the logistics. The overall result is keeping the operability of the Armada at its highest level.

##### 3.2.1.1 Roles

<b>Client</b> ARMADA	Spanish Armada, represented by all the units (academies, arsenals, etc...). These units will determine together with the AJEMA the requirements needed in order to keep their operability on track. These requirements will conform the Product backlog of the project, and may vary during the conduction of operations
<b>Product Owner</b> AJEMA	<p>AJEMA is the ultimate commander and responsible for the Armadas' situation. AJEMA together with his staff and the feedback received from the Commanders of the units, designs the line of action and requirements for the Armadas' general situation. The strategic command is in charge of writing down the expectations of the Armada for every year, setting the requirements of the project as a guideline to follow that might be changed as the units require for logistical support throughout the year.</p> <p>In a period of crisis there will be some units (warships, submarines, helicopters...) running the mission inside the area of operations developing the mission, other units defending Spanish regular interests (the same as in peace) and the rest will be training in order to get ready as soon as possible for supporting the operations.</p>
<b>Scrum Manager</b> AJAL	AJAL is the maximum mandatory of the Logistics Body based in Madrid. AJAL in collaboration with his logistic headquarters leads the logistical support in accordance to the requirements established by the AJEMA together with the units.
<b>Scrum team</b> Commanders of departments	The Logistics team is formed by the responsible of each logistical department. This includes provisioning, maintenance, Transport, supply, construction, infrastructures, acquisitions, etc.

**Chart 3-2. Roles in the Logistic Body**

### 3.2.1.2 Elements

<b>Product Backlog</b>	<p>The AJEMA and the Commanders of the units at the beginning of the project set the product backlog for the year. The list of activities to deliver of the product backlog may be increased as new requirements can appear during the year (deficiencies of the units, lack of training, transport of troops, maintenance...).</p> <p>Without losing the view of the goal, these changes will be a challenge for the logistic Headquarters, which has to work in an environment of complexity, conditioned by the limited budget, the schedule of the operations, deadline of projects, unexpected emergencies, etc. Regardless of the complex environment in which the Logistics moves, support must be delivered following the logistic principles. To do so, it is important to have the tasks organized in order of importance and priority. Focusing the efforts on the execution of those activities eliminates waste in the project.</p>
<b>Sprint backlog</b>	<p>Once the tasks are organized in the product backlog, the JAL has the iterations that it has to work on during the development of the project. The tasks of greater priority and importance will conform the first sprints of the project. The sprints backlog is the lists of task that are going to be developed for the given iteration.</p> <p>All departments have to be working inside the same iteration, as they are going to follow the same sprint goal.</p>
<b>Deliverables</b>	<p>The deliverables for this project are the final support provided to the units. This deliverables have to satisfy the units' needs in quality and in time, this means that the sprints should be flexible as the situation the units may change with time. Thus their operability must be at the highest level once the support is provided, regardless of the changes made on the requirements, this requires paramount coordination and understanding of the situation for the Logistics Headquarters.</p>

**Chart 3-3. Elements of the Logistic Work process**

### 3.2.1.3 Work process

<b>Sprint planning</b>	<p>In the product backlog iterations are organized in a combination of chronological order and importance of the given tasks.</p> <p>Iterations have to be planned constantly in order to meet the Force expectations. In complex environments like operations or crisis scenarios planning is vital, that is why in the Logistics there are not just one Sprint planning, but constant planning.</p> <p><i>"When preparing for battle, I find that plans are useless, but planning is indispensable"</i> Dwight D. Eisenhower.</p> <p>In the Logistics support rather than having Sprint planning meetings, we find Daily Scrums throughout the whole project.</p>
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<b>Daily Scrum</b>	<p>Every morning the Logistic Headquarters gather together to analyze and coordinate the Logistical situation.</p> <p>The meeting takes at eight in the morning, and normally lasts an hour. In this reunion, each department explains what activities are they working on, how are they being developed, which problems are getting in their way and how they affect the general result of the task and proposing solutions.</p> <p>Example: Maintenance Department</p> <ul style="list-style-type: none"> <li>• What are they working on? The replacement of F-100 sonar.</li> <li>• How is it going? The F-100 is based in Ferrol, the maintenance started on the 2<sup>nd</sup> of August. Ferrols' Arsenal has reported that it is going to be ready by the 12<sup>th</sup> of August.</li> <li>• What problems are getting in the way? The F-100 is supposed to leave on the 10<sup>th</sup> of August.</li> <li>• How it affects the general result of the task? Either the sonar will not be ready to operate at peak performance, or the F-100 will have to wait for going to the operation.</li> <li>• Solutions? Taking another F-100 sonar that is on port. Report to the AJEMA that the F-100 is going to be late, therefore the operation will have to be delayed or run by or another F-100.</li> </ul>
<b>Sprint Retrospective</b>	<p>Analyzing the results of what has been done is as important as understanding the road to doing it. Having constant retrospective about the process is the best way to lead to continuous improvement. That is why in the Armada retrospectives are made constantly, by getting the feedback of all parts involved in the logistics process.</p>

**Chart 3-4. Logistic work process**

As we have seen the Logistics work process concentrates mostly in its daily study and planning of the Forces' situation. It is in their daily reunions that the Logistics headquarters analyzes the situation of the units and their requirements. The state of operability of the Armadas' units may change due to many factors. It is of vital importance to maintain the operability state of the units at the highest level, which is why in the daily meetings the first thing that the Logistics headquarters analyzes is the VAROPS.

A VAROP is a document that the Commander of a unit sends to the JAL and the AJEMA when the unit has a deficiency or an issue that derives in a reduction of its operability.

Its initials stand for Operability Variability; this means that the unit is not able to accomplish the mission assigned. The reasons for sending a VAROP are very different, as in a warship there are many aspects that can vary its operability: lack of personnel, no weapons, a problem in the engines, etc.

VAROPS are the most important messages that the strategic command has to take into account, as they represent an urgent problem for the general situation of the Armada.

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1.SOLICITO ASTO OBJETO EFECTUAR REPARACION SISTEMA INDICACION NIVEL
TANQUES SENTINA VIGIA. LEER EN SIETE (7) COLUMNAS: PM/PEDIDO
SIGMA/PRECEDENCIA/CANTIDAD/NIIN/DESCRIPCION/FABRICANTE:
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2 AL NO FUNCIONAR EL SISTEMA CONTROL NIVEL SENTINAS SE CORRE EL
RIESGO DE INUNDACIONES POR NO TENER INFORMACION DEL NIVEL Y LA
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CASO, Y AGRAVANDOSE AUN MAS EN SITUACION DE GUARDIA EN PUERTO.
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Figure 3-1. VAROP message

### 3.2.1.4 JALVAROP used as a Kanban Tool

The JAL VAROP is a program that can be correlated to the Kanban chart. This program is used in the Logistic Headquarters daily meetings, and helps the whole team visualize the general situation of all the units, and has priority over the rest of issues that might be discussed during the reunion.

In this program all units are represented in different columns. For every unit there are some operability aspects that are shown in the program, this aspects must be checked in order to get the units operability.

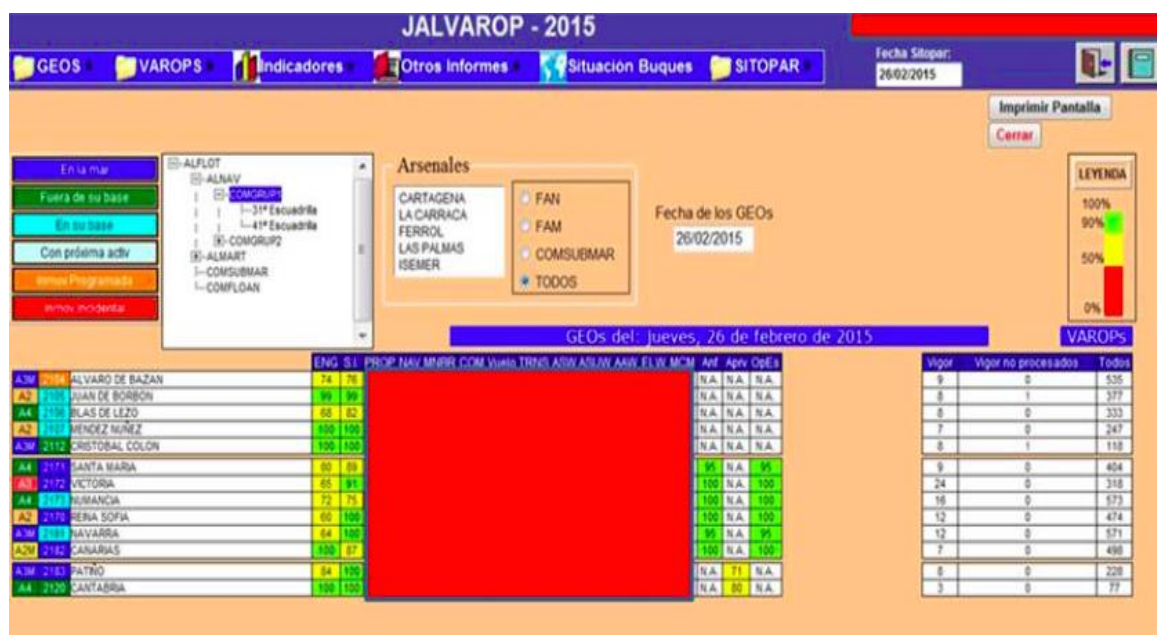


Figure 3-2. JALVAROP as Kanban tool

As in the Kanban chart, where moving tasks from one Column to another controlled the workflow, the JAL VAROP chart shows, in a very visual way, the general situation of the units. The information is managed in an active way, this helps the logistic headquarters to make decisions about what areas do they need to work on first.

### *3.2.2 Sustainability of the units with Lean*

In the military, sustainability refers to the combination of both, the maintenance and provisioning of the units during their lifecycle. Throughout history one of the main problems that the Armada has always faced is lacking an agile system for managing the information. The Armada as a military organization has a pyramidal structure. This form of organization affects the communication process and the management of information, because a lot of time is wasted in passing the information from one stage to the next of the pyramid. This problem results in a reduction of productivity, because the workflow has to stop and wait for the information to get to the responsible of the given task, until he decides what is to be done with that given task. [34]

Logistics sustainability is divided into parts: the maintenance stages and the provisioning stages, each of which have their own structures. Their pyramidal distribution used to cause struggles in the coordination of activities as well as in the management of information, however both parts have developed their own programs that help them visualize the whole situation in a glimpse of an eye.

There are four levels of maintenance which are described below:

1st. First Maintenance stage:

All the activities of maintenance performed by the Units' crew, under the command and responsibility of its Commander.

2nd. Second Maintenance stage:

All those actions of maintenance performed inside the Infrastructures assigned to support the Force. These infrastructures are the Arsenal of the different maritime areas in which each of the units are based.

The command and responsibility of conducting these actions rests in the Admiral in command of the maritime zone of the unit.

3rd. Third Maintenance stage:

All those actions of maintenance performed inside the infrastructures of the JAL.  
The responsibility of conducting these actions rests in the AJAL.

4th. Fourth Maintenance stage:

All those actions of maintenance performed by organizations outside of the Spanish Armada.

The responsibility of conducting these actions rests in the AJAL coordination subordinate.

On the other hand we have the **Provisioning stages**, which are responsible for providing the parts required by the units.

1st. First provisioning stage:

All the provisioning material that is stored in the units, so as to support their activities during a specific time.

The responsibility the first provisioning stage resides in the Commander of the unit.

2nd. Second provisioning stage:

All the provisioning material stored in a virtual stockpile, this stockpile is common for the whole Navy, and serves as a logistical support for running operations units.

The physical location of this virtual store is allocated amongst all arsenals and military barracks, and its responsibility rests in the JAL.

It is important to allocate the responsibilities among the stages, so everyone knows what activities they have to perform. This is a way of making the workflow more agile, as coordination is developed right from the beginning.

### **SIGMA**

SIGMA is the system that keeps a register of all the material that the Armada has. This program automatizes the flow of materials between the units, as for the storage and distribution. Centralizing the control of the material management, and decentralizing the use of it. Furthermore, SIGMA is able to control the parts, its costs and the information around them. Although SIGMA is oriented towards the provisioning process, the program integrates other programs to the system (see attached document).

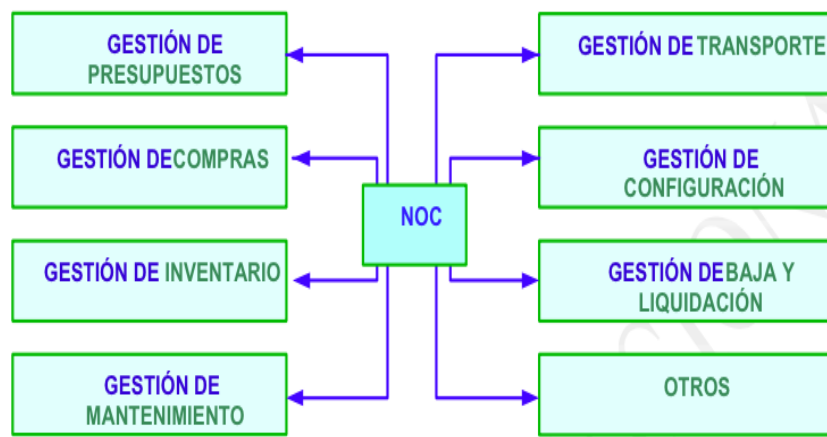
Before the creation of this program, a hand made document called SIGMA document controlled all material requests. This document was sent to the storage associated to the unit that required the material, and it was the given storage that controlled the whole provisioning process. The problem of this method was that for some requirements, the storages located in the arsenals lacked the administration of these materials. As a consequence, the SIGMA document had to be sent to the next stages of the Logistics pyramid, slowing down the acquisition process, and making the unit (client) wait for long periods of time, until the responsible stage decided to take care of the provisioning process.

The necessity of improving the Logistical support lead to the conception of this application dedicated to the management of the whole provisioning process. With SIGMA program, the modernization of the provisioning process was made, making the whole process more agile by developing an automatic system that integrated the whole provisioning support (spare parts, provisions, clothing, fueling, changeables and munitions). The system also provides good active information, presented in the screen with data and statistics that makes the decision process simpler and quicker. [34]

#### **SIGMA-DOS main characteristics**

- a) It is the only system that gathers all the provisioning data. SIGMA-DOS serves as a tool for the second provisioning stage, which is the main participant in the support process as they conform the arsenals in which the units are based. Even though this system centralizes all the data, its use is available to all the parts involved in the provisioning process (units, arsenals, Armadas' infrastructures and JAL).
- b) It normalizes its data. This means that even though the system is working with different kinds of materials, the program has normalized the names of all parts in order to identify requirements in a much quicker way. There is one and only one name for every request, the identification number for any material it's the NOC.





### Figure 3-3. NOC in SIGMA-DOS

- c) SIGMA-DOS also normalizes the document of request, making the SIGMA document the only method of asking for any provisioning support. Each SIGMA document makes reference to a single request article. The centralization of the whole request procedure has been possible because of the combination of both, the NOC and the SIGMA document.

[illegible]

**Figure 3-4. SIGMA document**

- d) Virtual store- Even though the provisioning articles have their physical location distributed between all the infrastructures that the Armada possess, in terms of management SIGMA-DOS unifies the location of all the articles in a single virtual store.  
Users (the units, arsenals, JAL) can manage their SIGMA requests by contacting with this store, thus merging the control of inventory in which every user can be an active source of information.
- e) SIGMA-DOS also serves as a tool for the decision process. The decision process had always been a bit slow due to the fact that a lot of time was spent in the transmission of the information. SIGMA-DOS not only seems to solve this problem, it also makes decisions easier to make by integrating a good presentation of the data as well as statistics.

### Prioritizing support activities -Provisioning

All the requirements demanded by the units are organized according to their importance. Depending on the situation of the units the EMA sets priorities in order to accomplish the mission. The importance and priority of the tasks are indicated with the *Logistic precedence*.

Logistics precedence is a number that indicates the level intensity in which the unit has to receive the logistic support. This number is integrated in the SIGMA document, thus when users see the request, they are able to organize the support process setting priorities between all the documents received.

Logistics precedence is probably one of the leanest tools that Armada has implemented in its provisioning support process. It makes the whole process more efficient, because the system is able to focus all efforts in delivering support according to the clients priorities, we have to remember that it is the EMA (thus the client) that sets the requirements and its priorities, the Logistics body must be able to keep to the clients expectations.

This number comes as a result of crossing over two concepts: *Logistics Urgency* and *Logistics Priority*.

- **Logistics Urgency:** It is the level in which the Commander of each unit qualifies its urgency for logistic support.
  - A. The deficiency affects the security of the unit. It needs to be solved now.
  - B. The deficiency impedes the accomplishment of the mission. It needs to be solved as soon as possible.
  - C. The deficiency affects the efficiency of the mission. It has to be solved whenever is possible.
  - D. Others. It should be solved whenever it is convenient.
- **Logistics Priority:** The level in which the EMA qualifies the priorities of support according to the operations.
  - I. Units running military operations in conflict scenarios, and others defined by the AJEMA. Support is urgent.
  - II. Other military units defined by the AJEMA that represent an important factor for the accomplishment of the mission. Support should be given in order to reinforce its operability.
  - III. Units during its service cycle. Normal support required.
  - IV. Units in port or during training. Reduced support.
  - V. Units that are being repaired on the arsenals. Minimal support

URGENCIA	PRIORIDAD				
	I	II	III	IV	V
A	1	1	1	2	3
B	2	3	4	5	6
C	3	5	6	7	8
D	5	6	7	8	9

Figure 3-5. Logistic precedence number

The logistic precedence is important in order to arrange the tasks of the product backlog. Tasks marked with the lowest precedence number are to be developed in the first sprints, as they directly affect the outcome of the mission. On the other hand those activities with the highest precedence number should be worked on in the last iterations, as they don't really represent a threat for the operations, and are assigned to those units performing training courses or based in the arsenals.

Organizing the iterations in order of importance, guarantees that the overall support of the crisis situation is being efficient and constantly flowing according to priorities, that way waste is not supplied to the overall mission.

## 4 CONCLUSION AND FUTURE LINES OF STUDY

As technology advances, projects tend to move towards volatile environments. Modern organizations respond to these changes by applying new practices and procedures for these changing settings.

Agile methodologies, also known as “Lean Thinking”, have been created to solve the pressing demand of customers. For them the main source of a company’s success resides on the people, therefore they oppose the old concept of “employee” just because it diminishes the overall value of the company. The “agilists” rather refer to team, teamwork and leadership, ingredients required to succeed in complex projects.

The main goal of this project had been to make a detailed study on Lean Thinking and Agile methodologies, and to study the possibility of applying them in the Armada Logistic Organization. To do that, traditional methodologies have been presented, processes have been explained and flaws spotted, to arrive to the position to confront them to the new environments in which projects have to be developed. On a second stage we have compared these old methodologies with the new agile practices, coming up with some interesting conclusions.

- Civil organizations have been searching for innovative methods, and they didn’t know that the Armada had been applying them during decades, although they were differently labeled. This may be better understood by considering the scenarios where the Armada has been operating since its foundation, to mention; wars, operations, humanitarian support, etc. Naval Support has been adapting throughout the years its methods to the stringent requirements demanded by the environment in which its work had to be performed. Procedures have been refined in all logistic areas reflecting how the Armada has been always looking for continuous improvement.
- The importance of the people who make up the organization is a fundamental concept in the Armada whose origin resides in its own essence, the warship. As important for mission success is the commander as it might be the sailor in charge of the galley. The Naval Logistics Organization has permeated from these values to the extent of making them part of their creed: agile communication, mutual cooperation, exchange of opinion between components, foster team spirit, strength of mind, mutual trust and so on,... techniques, all of them apparently discovered for the Lean Thinking supporters.

Over and above all these considerations there is the question of whether or not these methodologies will be worth in the future for use in the Navy.

- The rigid pyramidal structure of a military organization is perceived as the main impediment to fully exploit the theories expressed by the Lean Thinking. Nevertheless the Armada with some logistics administrative application programs, such as GALIA, SIGAPEA and SIGMA-DOS, has eased its own limitations. Therefore instead of paying attention to the application of methods, the Armada should be aware of the structures adopted by modern organizations, which are exploiting the latest technology in addition to this new Agile Methodology for management, coordination and leadership.

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## ATTACHED DOCUMENT: GALIA/SIGMA INTERFACE

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### SECCIÓN V: INTERFACES CON OTRAS APLICACIONES DEL APROVISIONAMIENTO

#### 01170 INTERACCIÓN DE SIGMA-DOS CON OTROS SISTEMAS INFORMÁTICOS

El área de Apoyo Logístico de la Armada utiliza múltiples Sistemas Informáticos para llevar a cabo las operaciones necesarias para la Gestión Logística de la Armada. Los diferentes Sistemas componen un Proceso Logístico robusto y eficaz, a pesar de estar compuesto por aplicaciones que funcionan en diferentes plataformas, construidas con diferentes lenguajes y cuyos datos se encuentran almacenados en Bases de Datos heterogéneas.

Con el objeto de dar respuesta a las necesidades de integración entre SIGMA-DOS y el resto de los Sistemas complementarios que dan apoyo al Proceso Logístico de la Armada, se utiliza un *Módulo de Integración* que permite, mediante llamadas remotas, conectar los módulos de SIGMA-DOS con otras aplicaciones. Por tanto, dicho módulo funciona de intermediario entre los programas de distintos Sistemas, transportando los datos necesarios entre unos y otros.

Los Sistemas Informáticos con los que interactúa SIGMA-DOS actualmente son los siguientes:

- Catálogo UNOR *Catálogo UNOR.*
- CONFIWEB *Control de Configuración.*
- GALIA-Arsenales *Gestión del Apoyo Logístico Integrado de la Armada, Subsistema Arsenales.*
- GALIA-Buque *Gestión del Apoyo Logístico Integrado de la Armada, Subsistema Buque.*
- SICADplus *Sistema Integrado de Catalogación de Artículos de Defensa.*
- S.I.G.E. "INTENDENTE MONTOJO" *Sistema Integrado de Gestión Económica "INTENDENTE MONTOJO".*
- SIGEMA-DOS *Sistema de Gestión del Reglamento de Pólvora y Explosivos.*
- SIGMA-EDI *Sistema Integrado de Gestión de Materiales de la Armada, con Intercambio de Datos Electrónico.*
- SIGMA-RF *Sistema Integrado de Gestión de Materiales de la Armada, por Radio Frecuencia.*
- SILO *Sistema Logístico de Información y de Operaciones.*
- TPE *Terminal de Punto de Entrega.*

01170

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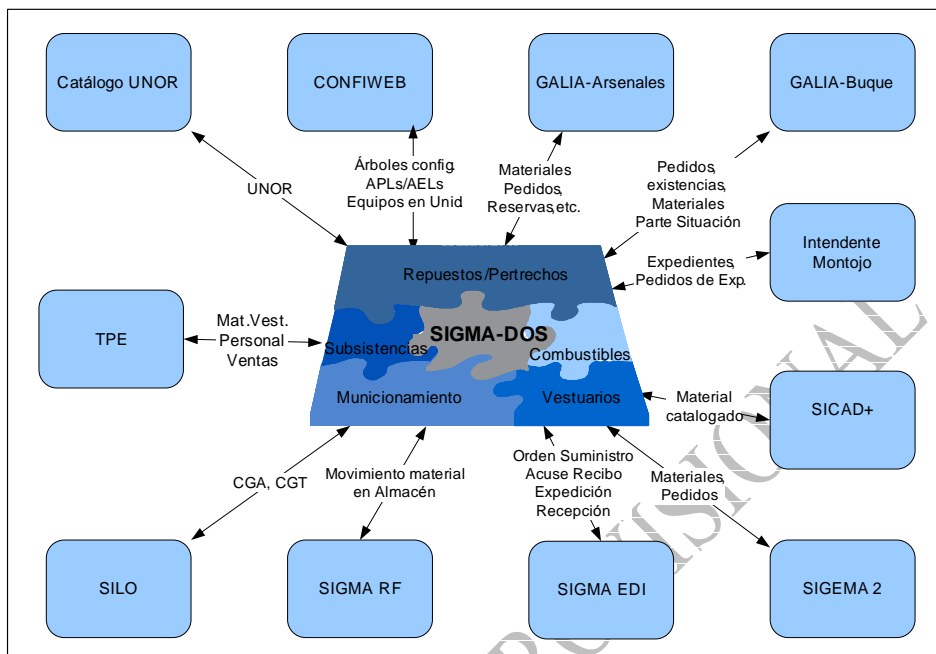


Gráfico 1-35: Interfaces de SIGMA-DOS con otros Sistemas Informáticos.

La integración entre SIGMA-DOS y el resto de las aplicaciones informáticas del Aprovisionamiento se efectúa mediante los siguientes tipos de servicios:

- *Servicios Exportados* por SIGMA-DOS: aquellos que se procesan en el ámbito de SIGMA-DOS y pueden ser solicitados por otros Sistemas.
- *Servicios Importados* por SIGMA-DOS: aquellos que se procesan en el ámbito de alguna aplicación (GALIA-Buque, GALIA-Arsenales, SILO, etc.) y pueden ser solicitados por SIGMA-DOS.

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**01173 GALIA - ARSENALES**

**1. Descripción y funcionalidades:**

La aplicación GALIA-Arsenales (*Gestión del Apoyo Logístico Integrado de la Armada, Subsistema GALIA-Arsenales*) permite gestionar tanto datos operativos como datos administrativos relativos a los distintos Arsenales de la Armada. Se compone de distintos módulos funcionales que recogen las necesidades básicas de un Arsenal y su forma y modo de trabajo habitual. Actualmente son los siguientes: Depuración, Tramitación de Partes de Mantenimiento, Gestión de Inmovilizaciones, Estructura Logística, Seguimiento de Motores, Gestión Partes BUI<sup>21</sup>, Indicadores, Sugerencias, Finalización Obras BUI, Creación de Informes, Seguimiento de Partes y Administración.

El entorno tecnológico en el que se ha desarrollado el Sistema es un entorno basado en Web, con instalación y mantenimiento del Sistema centralizado.

- El acceso a la aplicación se realiza desde la página del CALI, en la siguiente dirección: <http://10.42.8.111/CALI/Index.html>.
  - El Manual del Usuario de GALIA-Arsenales se encuentra accesible en la página: <http://10.42.8.126/galia/ayuda/ManualdelUsuario.pdf>.
- Asimismo, se encuentra disponible una “*Descripción General de los Equipos y Elementos que componen el Sistema GALIA-Arsenales*” en la URL: <http://10.42.8.126/galia/ayuda/ComponentesyEquipos.pdf>.

**2. Interfaz SIGMA-DOS / GALIA - Arsenales:**

Los mecanismos de comunicación entre los Sistemas SIGMA-DOS y GALIA-Arsenales se implementan por medio de tecnología estándar tipo Web Services. Estos permiten efectuar peticiones asíncronas vía Intranet, con intercambio de datos en formato XML.

La interfaz de comunicación entre ambos Sistemas presta los siguientes servicios:

**a) Búsqueda de materiales:**

Este servicio permite que GALIA-Arsenales envíe un NCAGE y/o N° de Referencia a SIGMA-DOS y éste le proporcione los registros de su Sistema que cumplen esos criterios.

<sup>21</sup> Nótese que la terminología BUI, actualmente obsoleta, ha sido sustituida en el presente Manual por la terminología UCO (Unidades, Centros y Organismos de la Armada).

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**01173 GALIA - ARSENALES****1. Descripción y funcionalidades:**

La aplicación GALIA-Arsenales (*Gestión del Apoyo Logístico Integrado de la Armada, Subsistema GALIA-Arsenales*) permite gestionar tanto datos operativos como datos administrativos relativos a los distintos Arsenales de la Armada. Se compone de distintos módulos funcionales que recogen las necesidades básicas de un Arsenal y su forma y modo de trabajo habitual. Actualmente son los siguientes: Depuración, Tramitación de Partes de Mantenimiento, Gestión de Inmovilizaciones, Estructura Logística, Seguimiento de Motores, Gestión Partes BUI<sup>21</sup>, Indicadores, Sugerencias, Finalización Obras BUI, Creación de Informes, Seguimiento de Partes y Administración.

El entorno tecnológico en el que se ha desarrollado el Sistema es un entorno basado en Web, con instalación y mantenimiento del Sistema centralizado.

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**2. Interfaz SIGMA-DOS / GALIA - Arsenales:**

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**a) Búsqueda de materiales:**

Este servicio permite que GALIA-Arsenales envíe un NCAGE y/o N° de Referencia a SIGMA-DOS y éste le proporcione los registros de su Sistema que cumplen esos criterios.

<sup>21</sup> Nótese que la terminología BUI, actualmente obsoleta, ha sido sustituida en el presente Manual por la terminología UCO (Unidades, Centros y Organismos de la Armada).

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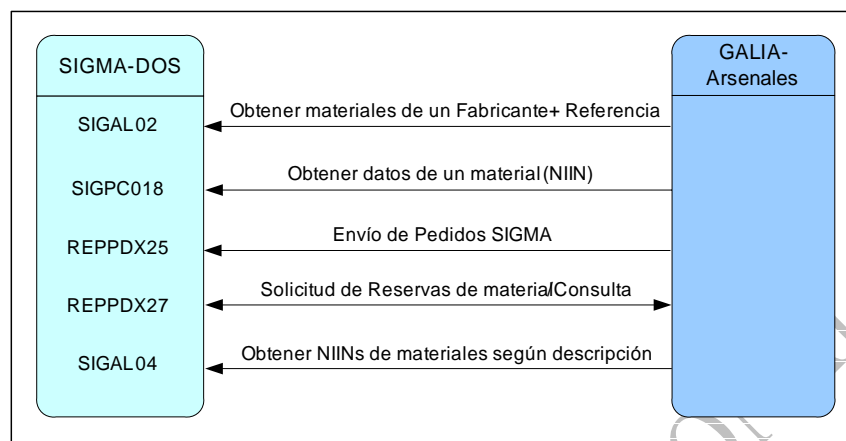


Gráfico 1-38: Relación de servicios ofrecidos por la interfaz SIGMA-DOS/GALIA-Arsenales.

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**01174 GALIA - BUQUE****1. Descripción y funcionalidades:**

La aplicación GALIA-Buque (*Gestión del Apoyo Logístico Integrado de la Armada, Subsistema Buque*) es el Sistema Informático utilizado por los Buques de la Armada para la Gestión Integrada a bordo. Está diseñado para apoyar a los Buques en gran parte de las operaciones que a diario se llevan a cabo en los mismos. Consta de los siguientes módulos principales:

- *Configuración*: Descripción de los SSEC instalados a bordo.
- *Aprovisionamiento*: Sistema de información para la Gestión de Aprovisionamiento de Primer Escalón. Integra los siguientes submódulos:
  - *Control de Existencias*: Gestión del Fichero de Control de Existencias (FCE), con sus correspondientes informes.
  - *Control de Pedidos*: Gestión de los Pedidos SIGMA, con sus correspondientes informes.
  - *Control de Vales de Material*: Solicitud de materiales desde los Destinos/Grupos de Mantenimiento (GM) y gestión de su despacho.
  - *COSAL*: Consultas del libro de cargo COSAL.
- *Mantenimiento*: Sistema de información para la Programación y Control de la ejecución del Mantenimiento de Primer Escalón o PMS.
- *Documentación Electrónica*: Capacidad de visualización online de la documentación digitalizada de todos los equipos a bordo.

Todos estos módulos están estrechamente integrados entre sí y dan como resultado un Sistema Informático de Gestión Logística útil para las dotaciones de los Buques de la Armada.

➤ Información adicional en el Manual de GALIA-Buque.

**2. Interfaz SIGMA-DOS / GALIA-Buque:**

La información acerca del material de 1º Escalón de Aprovisionamiento en Unidades de la Armada se encuentra registrada en la aplicación GALIA-Buque. SIGMA-DOS accede a dicha información a través de la interfaz de comunicación con GALIA-Buque, lo que le

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permite conocer las existencias en el 1<sup>er</sup> Escalón de Aprovisionamiento en aquellas Unidades que disponen de dicha herramienta.

Por otra parte, la interfaz de comunicación permite realizar el intercambio de Documentos SIGMA entre ambos Sistemas.

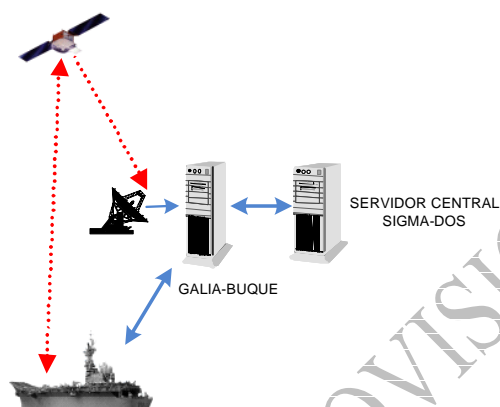


Gráfico 1-39: Sistema de comunicaciones: SIGMA-DOS/GALIA-Buque.

El intercambio de información se realiza a través de un sistema puerto a puerto (buzones en un servidor FTP situado en la Intranet de la Armada), en los cuales un Sistema deposita ficheros (en formato XML), a petición o periódicamente, dependiendo del servicio, y el otro Sistema lee y trata dichos ficheros.

La interfaz de comunicación existente entre los Sistemas SIGMA-DOS y GALIA-Buque presta los siguientes servicios:

**a) Envío de Documentos SIGMA “K”:**

Permite que SIGMA-DOS envíe a GALIA-Buque los Documentos SIGMA K, *Partes de Situación de un Pedido SIGMA*, cada vez que la situación de un Pedido SIGMA experimente un cambio relevante en el proceso de Aprovisionamiento de SIGMA-DOS.

**b) Envío de datos sobre las existencias de un Buque:**

Permite que la aplicación GALIA-Buque envíe datos, con la frecuencia establecida, de las existencias que un Buque tiene en sus pañoles, para su actualización en SIGMA-DOS.

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**c) Envío de Pedidos SIGMA de un Buque:**

A través de este servicio, la aplicación GALIA-Buque envía toda la información necesaria para poder efectuar un Pedido SIGMA. SIGMA-DOS comprueba si todos los datos están correctamente informados y, en caso afirmativo, da de Alta el Pedido SIGMA en su Sistema. Informa a GALIA-Buque sobre el resultado de la acción.

**d) Consulta de datos de materiales:**

GALIA-Buque envía el Código de Fabricante (NCAGE) y el N° de Referencia del artículo que se quiere consultar (Part-Number), con el objeto de que SIGMA-DOS proporcione los datos referentes al NIIN asociado.

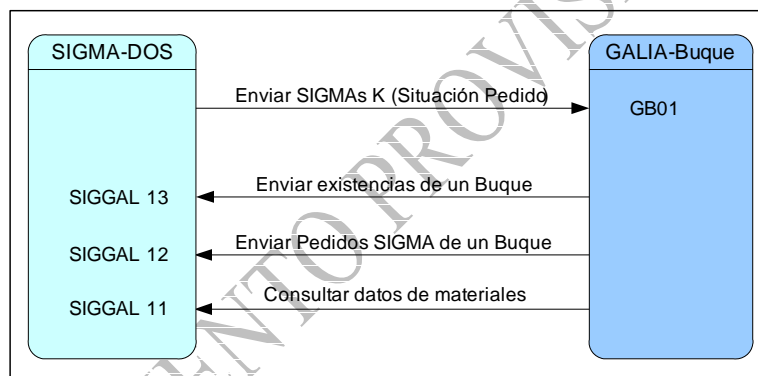


Gráfico 1-40: Relación de servicios ofrecidos por la interfaz SIGMA-DOS/GALIA-Buque.