



Universidad de Valladolid



**ESCUELA DE INGENIERÍAS
INDUSTRIALES**

UNIVERSIDAD DE VALLADOLID

ESCUELA DE INGENIERIAS INDUSTRIALES

Grado en Ingeniería Organización industrial

**PRODUCTION PLANNING SUPPORTED BY 4.0 INDUSTRY
TOOLS IN THE SECTOR OF THE LOGISTICS**

Autor:

García-Lago Riego, Ignacio

Izquierdo Millán, Segismundo Samuel

Universidad de Nysa (Polonia)

Valladolid, junio 2019.

TFG REALIZADO EN PROGRAMA DE INTERCAMBIO

**TÍTULO: Production planning supported by 4.0 industry tools in the sector of
the logistics**

ALUMNO: Ignacio García-Lago Riego

FECHA: 13 de junio del 2019

CENTRO: Universidad de Nysa (Polonia)

TUTOR: Mariusz Kolosowki

Resumen

Este trabajo ha estado enfocado a mejorar los problemas que tiene la logística tradicional usando las herramientas de la industria 4.0 como el big data o los sistemas inteligentes, mas en concreto hemos utilizados los ERP y maquinas inteligentes.

El trabajo consta de una introducción a los conceptos mas importantes que en el trabajo son fundamentales de entender. Una vez introducido el tema, hemos expuestos los problemas, soluciones y mejoras que supondrían estas soluciones para finalmente conseguir implantarlas en la empresa.

El objetivo no era otro que hacer un estudio en profundidad de las carencias de la logística actual y poder dar unas opciones de mejora para las empresas que se encuentren en esta situación.

Palabras clave

Logística, industria 4.0, big data, sistemas inteligentes and implementación

Abstract

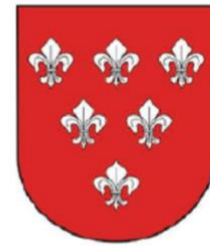
This work has been focused on improving the problems of traditional logistics using the tools of industry 4.0 such as big data or intelligent systems, specifically we have used ERP and intelligent machines.

The work consists of an introduction to the most important concepts that in the work are fundamental to understand. Once introduced the subject, we have exposed the problems, solutions and improvements that these solutions would supposed to finally do when we will implanted in the company.

The objective was to make an in-depth study of the current logistics shortcomings and to be able to offer improvement options for companies that are in this situation.

Keywords

Logistics, industry 4.0, big data, intelligent systems and implementation



UNIVERSITY OF APPLIED SCIENCES IN NYSA

Degree in Production Management and Engineering

Title:

**PRODUCTION PLANNING SUPPORTED BY 4.0 INDUSTRY TOOLS
IN THE SECTOR OF THE LOGISTICS**

Author:

García-Lago Riego, Ignacio

Tutor:

Kolosowski, Mariusz, PhD
Eng. Institute of
Technical Sciences

Greetements

To everyone from who I have learnt something in this stage of my life.

To my family, for supporting me unconditionally and helping me achieve my goals.

To my friends, to make this path more enjoyable and to be always with me.

To my tutor in Poland, Dr.Mariusz, and my tutor in Spain, Segis. For helping me when I needed.

And especially, to Alicia who has been the person who has helped me the most during all these years.

Contents

1. CHAPTER 1 – INTRODUCTION	10
A. PLANNING IN ORGANIZATION.....	10
I. The essence of planning	11
II. Types of plans	13
B. QUALITY CONTROL	17
I. Quality management	17
II. Tools.....	20
III. Techniques	23
C. LOGISTICS IN ORGANIZATION	26
I. Historical outline	27
II. Tasks.....	28
III. Definitions in logistics	30
D. INDUSTRY 4.0	38
I. Introduction	38
II. Historical outlines.....	41
III. Tools of industry 4.0	43
2. CHAPTER 2 - IMPROVEMENTS IN LOGISTICS BY THE IMPLEMENTATION OF 4.0 INDUSTRY TOOLS.....	47
A. INTRODUCTION	47
B. MAIN PROBLEMS OF THE TRADITIONAL LOGISTICS.....	48
I. Predictive planning of capacity and network	49
II. The last mile logistic and distribution problems	51
C. POSSIBLE SOLUTIONS AND TOOLS.....	53
I. ERP (Enterprise Resources Planning).....	54
II. Intelligent systems	59
D. WHAT IMPROVEMENTS ARE GOING TO BE MADE.....	64
I. Impacts in the quality control.....	65
II. Better planification and better results	68
3. CHAPTER 3 - HOW TO IMPLEMENT THE IMPROVEMENTS	70
I. Introduction	70
III. ERP implantation.....	74
IV. Intelligent systems implantation	76
SUMMARY.....	79
REFERENCES	81

1. CHAPTER 1 – INTRODUCTION

First of all, we need to introduce the term ‘organizing’ in the industrial field. It is a function of management where the coordination of all types of resources such as human, financial or physical, take place. A good combination of these resources is crucial to get the result we are looking for.

Pearce and Robinson defined organizing as “Process of defining the essential relationships among people, tasks and activities in such a way that all the organization’s resources are integrated and coordinated to accomplish its objectives efficiently and effectively”.

The importance of organizing is increasing in most of the enterprises because it is known that having a good organizational structure can bring high benefits on most areas of the company.

Organizing aligns the multiple resources towards a common mission, which is having better results with the same resources. Some of the benefits are:

- Efficient administration
- Resource optimization
- Benefits specialization
- Promotes effective communication
- Well defined jobs
- Expansion and growth
- Scope of new changes

In this project I am going to combine the importance of organizing in the area of logistics with the new technologies incoming such the 4.0 industry tools. For combine these concepts, I need to explain many concepts first and then combine it.

A. PLANNING IN ORGANIZATION

In this part, I am going to introduce some ideas and concepts which are going to be useful for understanding the next chapters in which we will assume that we all know these basic ideas of organization, logistics and industrial concepts.

I. The essence of planning

Planification can be defined as the efforts that are made in order to meet objectives and realize various purposes are framed within a planning. This process requires respecting a series of steps that are fixed at first, for which those who prepare a planning use different tools and expressions.

In organizations, the role of planning is very important, depending on the fulfillment of the mission and the objectives set by management. It will also help you to coordinate the way of working of the employees and the preparation and adaptation to the changes that take place in the context. (*Project management, Harold Kerzner*)

For planning it is necessary to know where we are standing and where we want to go, minimizing the risks and maximizing the time and resources that we have available. For this, we must have a vision of the future, where it is possible to determine and achieve the objectives, through actions and decisions that allow us to reach it.

Planning involves working in the same line from the beginning of a project, since multiple actions are required when each of the projects is organized. Your first step, experts say, is to draw the plan that will be finalized later.

In other words, planning is a method that allows executing plans directly, which will be carried out and supervised according to planning.

In an organization, managers are the ones who have to make the plans that will be governed by planning. The operation and execution of the plans may have been carried out by a single person or another individual, who must necessarily know and understand the level of planning that has been or could be carried out.

Before planning is important Know how the structure of a company in order is to understand what the manager need to plan. (Figure 1)

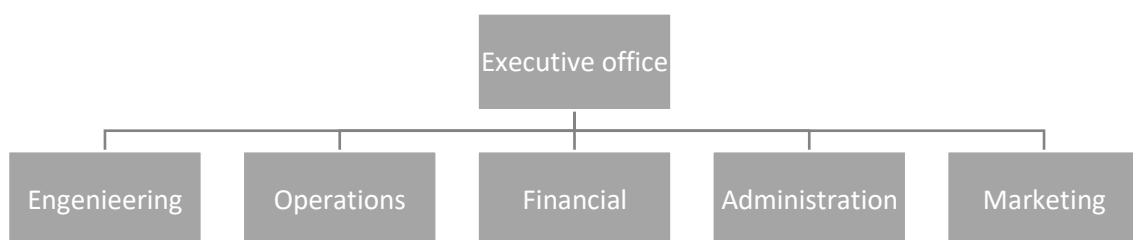


Figure 1 – Structure (Project management, Harold Kerzner)

The essence of planning is the systematic identification of opportunities and dangers that arise in the future, which combined with other important data provide the basis for a company to make better decisions in the present to exploit opportunities and avoid the dangers.

The planning can be summarized in 8 steps that I will explain through an image. In order to plan, we must first see if there is any business opportunity, then mark a series of measurable objectives that are achievable and long-term. The factors that affect the planning or the necessary premises, identify possible alternatives is another step that has importance since you always have to have more than one option. Evaluate these alternatives to assess which of them may be the best and opt for it in the first place. In order to develop this alternative well, a support plan must be made in case there is any inconvenience, and finally, establish the order of how to execute the tasks or activities necessary to carry out the plan. (Figure 2)

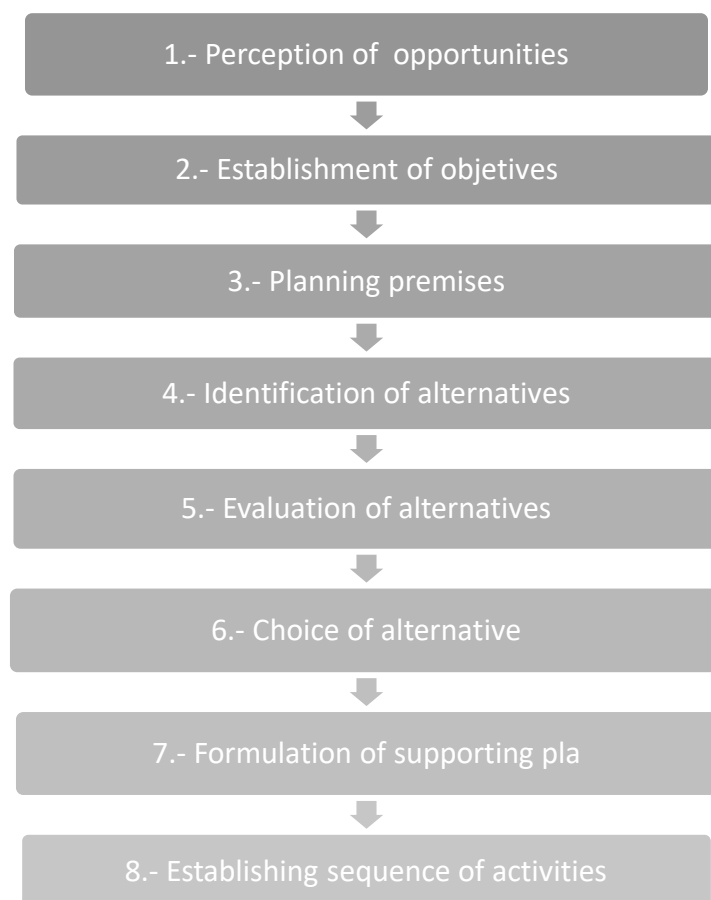


Figure 2 - Steps of planification (iedunote.com)

II. Types of plans

Planning is essential to achieve success, because it determines where the company wants to go and how it will do it to achieve its objective.

For a planning to be successful, it is necessary to involve people of various levels, communicate clearly, ensure that everyone knows their objectives and coordinate the activities of the organization so that things happen. To do this, you need to understand the main levels of planning: strategic, tactical and operational, which differ in the term of the actions, in the hierarchical levels involved and how each planning influences the overall result of the organization. (Figure 3)

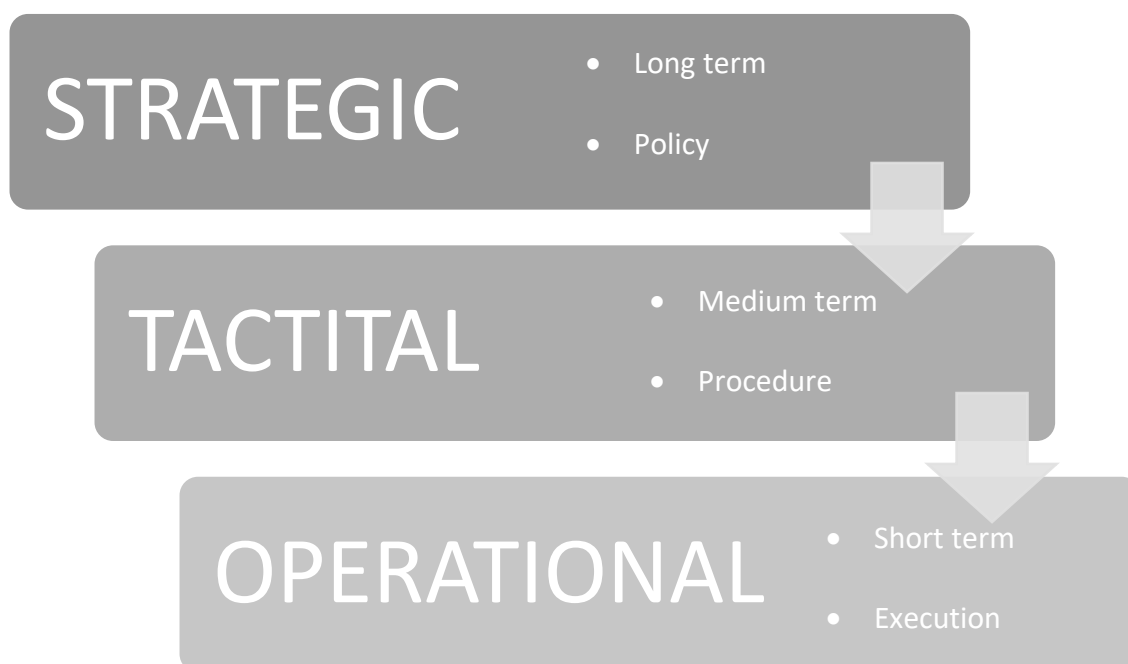


Figure 3 - Levels of planning

1. Strategic

Strategic planning is the process of determining how an organization can make the best possible use of its resources in the future. Through strategic planning, the strategy or direction is defined, establishing the possible ways through which particular courses of action can be followed, based on the current situation. Planning is usually done on any basis of these questions: "what we do", "for whom we do it" and "how we excel"

The strategic planning is the first part of all planning and therefore has 4 main components that every company must define from the beginning.

These components are the mission, the vision, the values of the company and the strategy to follow.

The vision of a company is a statement or statement that indicates where a company is going or what it is that it intends to become in the long term. Many people often confuse the vision with the mission of a company.

The mission of a company is a statement or lasting manifestation of the object, purpose or reason for being of a company. Many people often confuse the mission with the vision of a company.

Values are those ethical judgments about imaginary or real situations to which we feel more inclined by their degree of personal and social utility. The values of the company are the most important pillars of any organization.

Strategies is the map where the road to follow to reach the vision is marked. It is a mixture of objectives and means to achieve them.

2. Tactical

Tactical planning establishes the specific steps necessary to implement the strategic plan of a company. It is an extension of strategic planning, and tactical plans are created for all levels of a company. The tactics are the specific actions, but not very detailed, that are carried out to implement the strategy.

These actions describe what a company needs to perform, the priority of the steps needed to carry out those tasks and the tools and personnel necessary to meet the company's strategic objectives. The tactical plans are usually of medium or short term.

The extension of the tactical plans is shorter than the horizon of the strategic plan. For example, if the strategic plan is carried out for five years, tactical plans could be made for periods of one to three years, subject to the regularity of the change and the type of market the company serves.

Tactical plans should focus on the central objectives of the company; otherwise, the activities of the employees are fragmented too much, and it will be difficult for them to understand how their activities are ultimately related to the objectives.

There are some steps to develop tactical planning. Six are the general steps identified to develop a tactical plan.

- 1) Define the business.

- 2) Analyze the market.
- 3) Request projects participate in the target market and develop a marketing strategy.
- 4) Develop models of organization and management.
- 5) Evaluate the financial and mission implications of the business.
- 6) Put everything together in the final tactical plan.

Tactical plans are important for companies because the steps developed in the plan help management to discover inefficiencies in their operations.

After the operational deficiencies are revealed, management can make the necessary decisions to make the corrections.

Bold goals and thoughtful strategies produce nothing if steps are not taken to put them into action. The objectives and strategies give a vision, but the actions make the company really plan.

3. Operational

Operational planning is a management tool that facilitates the coordination of the organization's resources (human, financial and physical) so that it is possible to achieve the goals and objectives that are contained in the strategic and tactical plans of said company.

Assuming that senior management has prepared a strategic plan and management has a tactical plan, low management must have a clear idea of what is being sought. You just have to draw up a detailed operational plan to make it happen.

The main objective of operational planning is to provide the staff of the organization with a clear vision of their tasks and responsibilities, consistent with the goals and objectives contained in the strategic plan. It focuses on the services and products (production, equipment, personnel, inventories and processes) of a company.

The purpose is to deploy plans in order to develop financial projections and maximize the company's participation in the market. An operating plan uses the financial ratios of an organization to analyze its profitability.

The plan may include a contribution analysis to determine what processes are required to increase profits. This could involve concentrating on selling premium products or reducing variable costs.

An operational plan is based directly on tactical plans that describe missions, objectives, goals and activities.

Like a tactical plan, an operational plan addresses four questions: where are we now? Where do we want to be? How will we get there? and how do we measure our progress?

Operational planning must contain:

- Clear objectives.
- Activities to be delivered.
- Quality standards.
- Desired results.
- Requirements of personnel and resources.
- Implementation schedules.
- A process to monitor progress.

The operational plan presents highly detailed information for the people who will perform the daily tasks required in the administration of the organization.

Management and staff should frequently consult the operating plan to carry out their daily work. Operational planning indicates what, who, when and how much:

What: The activities and tasks that must be carried out.

Who: The people who have responsibility for each of the activities.

When: The periods in which the activities must be completed.

How much: The amount of financial resources provided to complete each activity.

Operational planning dissects a company's financial position, establishes its weaknesses and develops ways to increase profits. The operational plans of a company have a positive influence in different areas of the company. The plan that is implemented helps establish the business objectives and achieve specific goals.

It has a positive impact on both the operational and physical aspects, in terms of staffing, appearance of the business and daily procedures. It is an excellent way to ensure that all areas of business are being addressed in a constructive manner.

B. QUALITY CONTROL

Quality is a fundamental part of the company from my point of view because it is the way we have to measure how well or how badly we are doing and also tells us if the planning we have done is good or bad. (*Juran's quality handbook / ed. Joseph M. Juran, A. Blanton Godfrey*)

In a globalized world like the current one, the challenges are ever greater, especially between the competition of companies, which allows challenging high competition, both nationally and internationally.

The good quality is a condition that must have all service to achieve greater performance in its activity and durability, complying with rules and rules necessary to meet the needs of the client.

Quality within a company is an important factor that produces satisfaction for its customers, employees and shareholders, and provides practical tools for comprehensive management. At present, it is necessary to comply with quality standards in order to compete in an increasingly demanding market; therefore, you should look for:

- Continuous improvement
- Customer satisfaction
- The standardization
- The control of the processes.

I. Quality management

A Quality Management System is a tool that allows any organization to plan, execute and control the activities necessary for the development of the mission, through the

provision of services with high quality standards, which are measured through the indicators of user satisfaction.

The quality management system is that part of the organization's management system focused on achieving results, in relation to quality objectives, to meet the needs, expectations and requirements of the interested parties, as appropriate. The ISO 9000: 2005 defines it as a management system to direct and control an organization with respect to quality.

Quality management includes strategic planning, resource allocation and other systematic activities, such as planning, operations and quality evaluations. The concept of quality management implies:

- A systemic analysis of the organization as a whole.
- Consider quality as a strategic element of business planning.
- That all the members of the organization must be responsible for the quality of their product or service.
- The integration of all activity of the organization.

There is a standard by which most companies are regulated, this standard is ISO 9001. ISO 9001 is an international standard that applies to quality management systems (QMS). These group all the elements of quality management with which a company must count in order for its system to be effective; that does not prevent you from managing and improving the quality of your products or services. (*Project management, Harold Kerzner*)

The objective of the ISO standard is to increase customer satisfaction through continuous improvement processes. It is designed so that the organizations that apply it can guarantee their ability to offer products and services that meet the demands of their customers.

In other hand, every company must follow a series of principles so that quality works and therefore improve the company in several ways. Eight quality management principles have been identified as a framework towards improving the performance of an organization. Its objective is to help organizations achieve sustained success.

- Customer-focused organization: Organizations depend on their customers and therefore should understand the current and future needs of customers, meet customer requirements and strive to exceed customer expectations.

- Leadership: Leaders establish the unity of purpose and orientation of the organization. They should create and maintain an internal environment, in which staff can become fully involved in achieving the organization's objectives.
- Staff participation: Staff, at all levels, is the essence of an organization, and their total commitment enables their skills to be used for the benefit of the organization.
- Process-based approach: A desired result is achieved more efficiently when the activities and related resources are managed as a process.
- Systems-based management: Identify, understand and manage interrelated processes as a system, contributes to the effectiveness and efficiency of an organization in achieving its objectives.
- Continuous improvement: The continuous improvement of the overall performance of the organization should be a permanent objective of this.
- Fact-based approach to decision-making: Effective decisions are based on the analysis of data and information.
- Mutually beneficial relationships with the provider: An organization and its suppliers are interdependent, and a mutually beneficial relationship increases the ability of both to create value.
- These eight principles of quality management form the basis of the ISO 9000 family quality management system standards.

Below I show an image in which it describes very well the main functions of a quality management system. In it we can see that everything has to be planned and that it is important to have everything organized. (Figure 4)



Figure 4 - Quality management system (orielstat.com)

II. Tools

There are seven basic tools in the quality, these tools are a little old and for that reason we will explain them but in the following chapters we will use other 4.0 industry tools, more advanced and more effective. (*Project management, Harold Kerzner*)

- These tools are:
- Diagram Cause - Effect.
- Flow diagram.
- Verification or check sheets.
- Pareto chart.
- Histograms
- Diagrams or control chart.
- Scatter diagrams

The Project Management Institute refers to the seven basic tools, as an example of a set of generally useful tools for planning or quality control of a project (PMBOK).

Diagram Cause - Effect

Identify many possible causes of an effect or problem and classify ideas into useful categories.

The statement of the problem, placed on the head of the fishbone, is used as a starting point to trace the origin of the problem to its root cause.

Typically, the statement describes the problem as a gap that must be closed or as an objective that must be achieved. The mechanism for finding the causes is to consider the problem and ask "why" until the root cause is identified or until the reasonable options in each fishbone diagram have been exhausted.

Flowchart

They show the sequence of steps and the possibilities of branches that exist in a process that transforms one or more inputs into one or more outputs. The flow diagrams show the activities, the decision points, the ramifications, the parallel routes and the general order of the process.

Flow diagrams can be useful to understand and estimate the cost of the quality of a process. This is achieved by applying the ramification logic of the flow chart and its relative frequencies to estimate the expected monetary value for the conforming and non-conforming work required to deliver the output as expected.

Verification sheets

Also known as control sheets, they can be used as a checklist when collecting data. The verification sheets are used to organize the facts in a way that facilitates the collection of a set of useful data on a possible quality problem.

They are especially useful when collecting attribute data while conducting inspections to identify defects. For example, data on frequencies or consequences of defects collected in the verification sheets are often represented using Pareto diagrams.

Pareto chart

Pareto diagrams are a particular form of a vertical bar diagram and are used to identify the few key sources responsible for most of the effects of the problems.

The categories shown on the horizontal axis represent a valid probabilistic distribution that covers 100% of the possible observations.

The relative frequencies of each of the specified causes collected on the horizontal axis are decreasing in magnitude, until reaching a default source called "others" that includes all causes not specified. In general, the Pareto diagram is organized into categories that measure frequencies or consequences.

Histograms

They are a special form of bar chart and are used to describe the central tendency, dispersion and shape of a statistical distribution. Unlike the control diagram, the histogram does not take into account the influence of time on the variation in the distribution.

Diagrams or control charts

They are used to determine if a process is stable or has a predictable behavior. The upper and lower limits of the specifications are based on the previously established requirements. They reflect the maximum and minimum values allowed. There may be penalties associated with non-compliance with the limits of the specifications. The upper and lower control limits are different from the limits of the specifications. These are determined by the use of standard statistical calculations and principles to establish the natural ability to obtain a stable process.

Statistically calculated control limits can be used to identify points at which corrective measures will be applied to prevent abnormal performance. In general, corrective action seeks to maintain the natural stability of a stable and effective process.

A process is considered out of control when:

- A data exceeds a control limit.
- Seven consecutive points are above the average, or
- Seven consecutive points are below the average.

You can use the control diagrams to monitor different types of output variables. They are used more frequently to track repetitive activities related to the manufacture of lots.

Scatter diagrams

They represent ordered pairs (X, Y) and are often referred to as correlation diagrams, since they are intended to explain a change in the dependent variable Y in relation to a change observed in the independent variable X.

The direction of the correlation can be proportional (positive correlation), inverse (negative correlation), or a correlation pattern (zero correlation) may not occur. In case a correlation can be established, a regression line can be calculated and used to estimate how a change in the independent variable will influence the value of the dependent variable.

III. Techniques

In this chapter we will talk about some techniques that are used to improve quality in different sectors of the industry, these techniques are five different.

Modal Analysis of Faults, Effects and Criticalities (MAFEC). It is a preventive method whose systematic use allows to identify and investigate the causes and effects of possible failures and weaknesses in the product or process, as well as formulate the pertinent corrective actions to minimize these effects.

Failure Mode and Effect Analysis (FMEA) is a set of guidelines, a method and a way to identify potential problems and their possible effects on a system in order to prioritize them and concentrate resources on prevention plans. supervision and response.

What is achieved when implementing AMEF?

- Identify faults or defects before they occur.
- Reduce the costs of guarantees.
- Increase the reliability of products or services
- Shortens the development time of new products or processes.
- Document the knowledge about the processes.
- Increase customer satisfaction
- Maintains Know-How in the company.

Quality function deployment (QFD). This technique of quality improvement allows to identify the requirements of the client and provides a methodology to ensure that these requirements are present in the design of the product and in the planning process. In addition, it favors the reduction of product development cycles, increases quality and reduces costs.

The importance of design is, therefore, fundamental to success. This design must translate the demands, expressed and latent of the client, to the specifications of the product or service.

So, it is no longer enough to produce according to specifications. These must start from the knowledge about what the client demands and integrate demands, needs and expectations from the design phase of a product or a service.

There are three objectives pursued by the QFD:

- Prioritize the expressed and latent needs of customers regarding a product.
- Translate those needs in terms of characteristics and technical specifications.
- Design, produce and deliver a quality product or service, focusing on customer satisfaction.

Therefore, the QFD can be seen as a structured system that facilitates the means to identify needs and expectations of the clients and translate them into the language of the organization. That is, to quality requirements, deploying them in the planning stage, with the participation of all the functions that intervene in the design and development of the product or service.

In short, the Deployment of the Quality Function integrates the needs of the client in the design. This is done through its conversion into quality characteristics, through the systematic deployment of the relationships between needs and characteristics.

Taguchi Loss Function. This technique offers a way of calculating the loss of quality that a certain analyzed aspect can suffer with respect to the previously fixed quality objective. That is, the loss function will tell us how far we are moving away from our goal.

So that the product, in terms of quality, ceases to be simply cataloged as compliant or non-conforming, to be measured by a function that establishes the cost of moving away from the exact specifications of the client.

Taguchi defines the quality as follows:

Quality consists in avoiding a loss that a product causes to the company, after having been shipped, different from any other loss caused by its intrinsic functions.

In that order of ideas, the cost of moving away from the exact specifications of the client may include the following items:

- Maintenance costs.
- Repair costs.
- Costs associated with failure in operation.
- Costs associated with injuries caused by a defective product.
- Logistic costs

According to Taguchi's hypothesis, the lower the variation in relation to the objective value, the better the quality; so that the losses increase at an increasing rate as the deviation increases with respect to the objective value of the specification.

Likewise, there is a loss of quality from the customer's point of view when the product moves away from the desired specification, even when it is within specification limits, which contrasts with traditional variation control methods.

Value analysis. This technique is used to reduce the cost of the product by reducing the cost of those components that do not add value to the customer. The improvement can occur in two ways: the improvement of the product or the improvement of the production process.

To begin the process, it is necessary to locate where possible opportunities for cost reductions are found, determining which of them has the greatest potential, since it is always possible to find less expensive means to perform the same functions, which makes it essential to know the clearest definition and simple of the functions that must be performed.

To carry out this process you need to look for the main function, the value analysis must be reasonable and critical, you must treat past events and ask questions such as who, how, when, where and why. You have to try to find out what is the cost of each process and gather specifications. With all this information should be raised in which points of the process can save costs in the process.

Four types of relative functions can be established:

- To the user: it could be defined as the action and the effect of the product to satisfy the needs of the clients, this create an outward value.
- To the product: in this case they are actions and effects that generate each component of the product, ensuring the relative functions to the user.
- Of use: usually they are designated to the most habitual, they are those that are going away to wait for that product, and they are in charge to give security.
- Of esteem: refer to those functions that exceed the needs of the client, in this case we would be talking about comfort, image, fashion ... even so this type of functions is demanded by the client.

Once the action points have been set, monitoring and evaluation must be done, it can be done by means of statistics, considering if the desired goal has been achieved, taking data records and comparing them with the previous ones and above all, verifying that it is in accordance with the benefits of the company.

DFMA. It is a tool for the design of operations that allows to systematically analyze any previously proposed design. Through this analysis, possible design modifications that reduce the number of parts and assembly times are proposed, which also reduces the development time of the product. The DFMA methodology establishes a series of criteria and principles that help to make decisions regarding the design of a certain element.

The design of a product, the first step in the manufacturing process, is a stage of great importance, since the decisions that are taken in this have, normally, a great impact on costs. The Design for Manufacture and Assembly (DFMA) consists of taking into account considerations of costs and ease of manufacture and assembly during the preliminary design stage, to avoid later years due to corrections that must be made to the designs when planning the design. manufacture. In many cases where DFMA has been applied, both the costs and the time to launch the new product to the market have been reduced in large percentages.

The DFMA method consists of optimizing the product in terms of its manufacturability, and is based on rules, questions or criteria that aim at reducing time and costs by decreasing: the number of parts, the complexity of assembly and manufacturing operations, inventories, etc.

Because during the design, the DFMA takes into account aspects of manufacturing and assembly that, in a traditional way, were handled a posteriori, this tool is part of a set that is used in the so-called Concurrent or Simultaneous Engineering: a work team in which are responsible for the design and manufacture, among others, contributing their knowledge to obtain a good design.

C. LOGISTICS IN ORGANIZATION

Once the most basic concepts are explained, we will focus on the goal of this project, which is to improve the logistics using more advanced tools.

However, it is very difficult to explain the improvements without having previously stated that it is the planning and the quality in which we will subsequently focus on improving.

Now we focus on the logistics sector, in which we will explain the most basic to the most concrete. First, we will explain a bit of history to put ourselves in context

I. Historial outline

Although the logistics term began to be used at 1940, the ancient nations already used some principles of the logistics while they were organizing their work. To build the pyramids in 2700 B.C., the Egyptians first moved blocks of several tons of stone and they assembled at the construction site. Here we have the first time that logistic was necessary, but Egyptians and their population were not aware what they were doing was logistics. (hdcusa.com/news/history-of-logistics-distribution)

Few centuries after, the Greek empire created the new foundation of intercontinental trade by using rowing vessels. This happened around 300 B.C. Another milestone important in the history of logistics is the construction of the Mezquita mosque in Spain around A.D 700. For building this mesquite, pillars came to Spain from all parts of the Islamic empire.

Around 1200, the international networking known as the Hanseatic League, it was a cooperation for transport bundling and international sea transport.

Three centuries after, the postal service in Europe was progressing. The first-time definite mail shipping service.

A very famous milestone was the discovery of new road conveyances and the railroad. The logistics tasks were growing with the new technologies and new transports.

But the truly beginning of logistics as we know nowadays, was during the World War, where militaries used the term logistics to transport weapons, food or medicine wherever the soldiers needed it. Furthermore, around 1940s it was transferred the concept of logistics to the business world.

In 1956, it takes place the invention of sea container which allows to the commercials send big amounts of products to all over the world, causing a great benefit for the international flows of goods.

Toyota during the 1970s improved logistics. Toyota created some important concepts that nowadays keep on being so important. The main concepts are 'Kanban' and 'Just In Time'. Just in time (JIT) is an inventory management method whereby materials, goods, and labor are scheduled to arrive exactly when needed in the production process while Kanban is a visual system for managing work as it moves through a process. The goal of Kanban is to identify potential bottlenecks in your process and fix them so work can flow through it cost effectively at an optimal speed.

Around 1990, QR and ECR technologies take a big impact in way of distribution. It was a remarkable improvement for have all the goods controlled.

Nowadays, there is another term which is becoming very important in the industrial and services sector, the Supply Chain Management. It looks at the entire logistics chain, from the vendor's supplier to the end customer. As everyone know, globalization advances quickly and, in order to be competitive in logistics it is essential to be as efficient as possible.

In conclusion, we can affirm that logistics is a huge sector of the industry that creates a lot of employment and wealth all over the world, because it helps to increase the efficiency in many different ways. Logistics is growing steadily and improving the way of transport different goods by boat, plane, train or trucks.

II. Tasks

Logistics is not only about transport of different items, it involves a lot of different functions. This are resumed in seven major functions described in the Figure 1 and explained after that. (Figure 5)

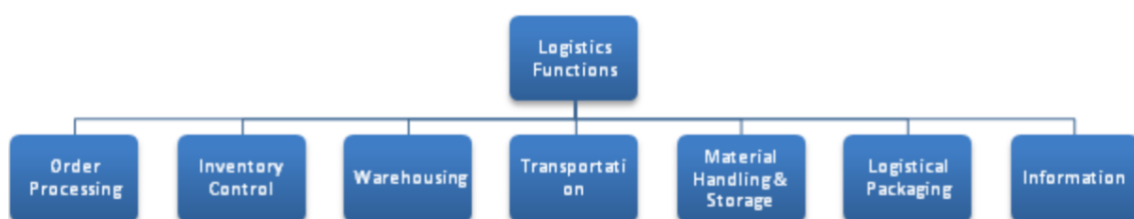


Figure 5 - Main tasks (SCMWIZARD.com)

1. Order processing

The purchase order placed by a buyer to a supplier is an important document of the transactions between the two parts. This document contains the description of the product to supply, price, delivery period, payment terms and other commercial terms.

The order processing activity consists of the following steps:

- Order checking
- Prices, payment and delivery terms.
- Checking the availability of materials in stock.
- Production and material scheduling for shortages.
- Acknowledging the order.

2. Inventory Control

Management need to keep enough inventories to meet the needs of supply and demand and it is carrying cost should be the lowest. The inventory is the main problem in the supply chain of a firm because of its huge carrying cost. Inventory managers should do:

- Stocking the right amount of inventory
- Paying the right amount for your inventory, in order to have the lowest costs
- Knowing your reorder point
- Ensuring you have the inventory in the right place

3. Warehousing

Warehousing consist in storing goods that will be distributed later. Warehousing managers play a fundamental role in the supply chain process. These distribution centers are not only responsible for the storage, sorting, and packaging of products, also the transport and coordination of goods to meet consumer demand.

4. Transportation

Transportation is to move the goods or the people to one point to another. Managers need to coordinate very good all the pallets, drivers and trucks or whatever is necessary to move the goods. Also, they need to plan all the routes and times that are required to comply with the customer demand.

5. Material handling and storage

The speed of the inventory across the warehouse depends on the design of the warehouse and also depends on the methods used for material handling. The storage system is important for maximum space utilization in the given size of a warehouse. The material handling system should support the storage system for speedy movement of goods in and out of the warehouse.

6. Packaging

Depending on your chosen industry, a role in packaging can involve two different ends of the supply chain and logistics spectrum.

On one end, there is the packing and packaging of product and the logistics of running an efficient production line. This will usually involve making sure products are processed to a high-quality standard that prioritizes flow and minimizes time and labor costs. Ultimately, the goods must satisfy consumer expectations.

The other side of packaging is design and research-oriented. After performing market research, you design packaging to attract more buyers.

The role of packaging in supply chain management is rather complex and can involve almost everyone along the pipeline.

7. Information

Logistics is basically an information-based activity of inventory movement across a supply chain. Hence, an information system plays a vital role in delivering a superior service to the customers.

Using of IT tools for information identification, access, storage, analysis, retrieval and decision support, which is vital among the functions of logistics, is becoming a good helping tool to all kind of companies in order to be more competitive.

III. Definitions in logistics

Logistics is the process of planning, implementing and controlling the efficient, effective flow and storage of raw materials, in-process inventory, finished goods, services and information from an origin to a place where the customer required some of these things.

The logistics progress is the following one: (Figure 6)

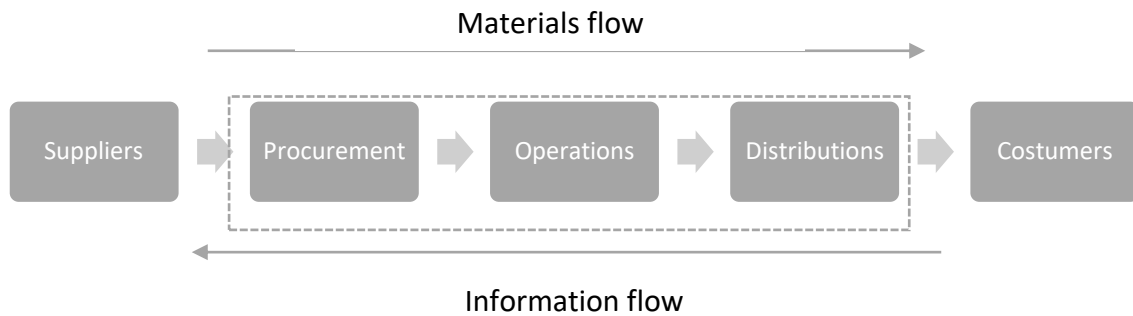


Figure 6 - Logistics process (Logistics & supply chain management / Martin Christopher)

The evolution of logistics has led to the appearance of a new concept that encompasses logistics: the supply chain. The supply chain will encompass logistics, but through its definition, we will see that it is difficult to differentiate them in most tasks.

The difference between logistics and the supply chain is that the second focuses on coordinating the processes of the different companies with the aim of not causing a lack of customer service at the time demanded. A lack of synchronization between the different companies or areas of the supply chain would cause a stoppage in the companies that must act after the organization that causes the problem.

Another definition of this concept more simplified is that logistics means having the right thing, at the right place and at the right time. Furthermore, the goal of logistic is to not stop other process of the production or service lifecycle. To meet with that goal, there are some basic rules called the seven R's:

- Right product
- Right quality
- Right time
- Right condition
- Right place
- Right cost
- Right customer

Logistics from the point of view of a firm is crucial in order to not loss efficiency or time, so that allow to the firms to focus on their core business. Firms often need some machines or employees to function well but some other times they use external organizations to execute logistics functions.

In fact, logistics is an important part of the organization of a company. When managers are doing the planning production of their enterprise, it is necessary to preview the stocks, warehouses and some other concepts we will talk about later.

Logistic have been change and now it has a more orientation to the client. As it has been advancing in time, the client has demanded a greater variety of products. This fact has demanded that the marketing department acquire greater importance within the company, due to the need to study the needs of customers.

The new functions that begin to be part of the logistics are three: the availability of inventories, delivery time and reliability in the delivery of supplies.

The availability of inventories consists of the probability of responding to customer orders through existing stocks in the company. However, it should be noted that a high level of stocks will involve a high cost: insurance, obsolescence, deterioration, ...

The delivery period consists of the time that elapses since the market demands the desired goods or services, until it receives them. You can see represented the general delivery cycle for a product in the following figure.

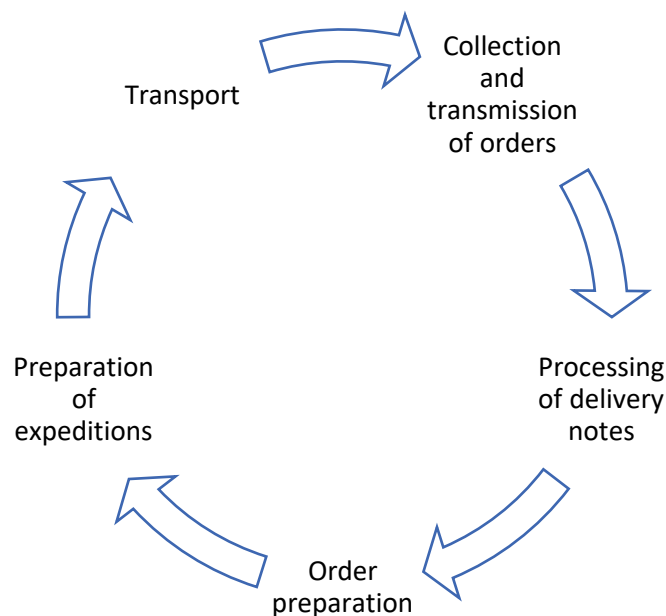


Figure 7 - Cycle of logistic (Anaya Tejero, 1998)

To understand this cycle correctly, we must explain some concepts that determine several functions of the new logistics. (Figure 7)

In the first place, we have the reception of the order that consists of the time that elapses since the market places an order until the corresponding company receives it. Following this step, a series of documentation is made that verifies the payment capacity of the client and the level of existing stock in the company. Once these data have been checked, the delivery note is made and sent to the warehouse.

Once in the warehouse, a series of order preparation operations are carried out. Among them, we can highlight its conformation with the different products required, its packaging, labeling and, subsequently, its location in the warehouse's dispatch area.

Finally, we find transport, which was part of the first definition of logistics. However, the need to reduce the delivery time by customers has added new aspects to this section. In addition to dealing purely with transport, logistics must optimize the loads of trucks, the study of the best routes and modes of transport and, finally, the best way to unload the goods in the client.

The new concept of logistics is responsible for reducing as far as possible the periods of duration of all these activities. By reducing the duration of the logistics processes, it will be possible to reduce the delivery time.

The last concept in which the logistics must be centered is the reliability in the deliveries. This term is the level of confidence that companies present to serve an order within a certain period. That is, the days in which the reception can be delayed or advanced with respect to the defined delivery period.

Customers need to know with certainty the date on which orders will be delivered, so reliability is one of the key factors when choosing a supplier.

To continue, I would like to ask myself why is logistics so important? Companies do not need to have the materials as quickly as possible, but to have them at the times when you need it and to have them at that precise moment it is important to explain the supply, warehouse and distribution logistic. (*The Management of Business Logistics*, John J. Coyle, Edward J. Bardi, C. John (jr) Langley)

SUPPLY LOGISTIC

We could say that the supply segment ensures that the production area has the necessary raw materials to carry out the manufacturing plan necessary to meet the customer's needs.

The objective of supply logistics is the control of supplies in order to meet the needs of the operational processes. The quantities to be supplied and the frequency of supply, the impact on the inventory of the supply chain, the forecast of the demand, the quality of the service, selection of suppliers, delivery dates and the types of packaging and freight units used by the suppliers, are factors to take into account in the supply logistics.

The supply logistics reach a high level of complexity in different situations:

- Management of a large number of products.
- Logistics networks with the interaction of many agents.
- Global procurement, with long replacement periods.

The main functions of the supply logistics which should solve all the previous situations, are the following:

- Decide the quantities to be supplied and the frequency of supply. Here, companies must decide how to supply, especially if they do it in a centralized manner or not.
- Determine the impact on the inventory of the supply chain, designing and implementing the inventory models that are created adequate and studying their impact.
- Forecast and demand improvement.
- Improve the quality of service.
- Make a good selection of suppliers, which guarantees a quality product and its delivery in the foreseen times.
- Dimension and guarantee delivery dates.
- Selection of the packing and loading units used.

WAREHOUSE LOGISTIC

Warehouse management can be defined as the logistics process that is responsible for the reception, storage and movement within the same warehouse to the point of consumption of any logistics unit, as well as the processing of information of the data generated in each of the processes.

The main purpose of warehouse management is to optimize a functional logistics area that operates in two stages of flow, such as: supply and physical distribution, thus constituting the management of one of the most important activities for the operation of the supply chain. catering.

The general objective of warehouse management is to ensure the continuous and timely supply of the materials and means of production required to ensure services uninterrupted, so that the flow of production of an organization, is largely conditioned for the rhythm of the warehouse.

Warehouse management is located in the Logistics Process Map between Inventory Management and Order and Distribution Management. In this way, the area of responsibility of the warehouses area arises from the reception of the physical unit in the own facilities and extends to the maintenance of the same in the best conditions for its subsequent treatment.

Warehouse functions depends on the incidence of multiple physical and organizational factors, some functions are common in any environment, are the following:

- Reception of Materials.
- Register of entrances and exits of the Warehouse.
- Storage of materials.
- Maintenance of materials and warehouse.
- Dispatch of materials.
- Coordination of the warehouse with the departments of inventory control and accounting.

In warehouse logistics we need to talk about inventories or stocks, how can we control, manage or optimize it.

The management and management of stocks and the sale of products becomes impossible if you do not keep track of the inventories of the company. The control and management of inventories is essential to know the production costs and the fixing of competitive prices that allow us to achieve benefits.

However, each company is a world because it has its own characteristics that differentiate them from others. Therefore, there are different systems and methods that allow us to take control of inventories and the administration of products and stocks of our company in one way or another.

One of the most important objectives in inventory control is to know what the cost of your inventory is to know the value of your products, but above all for what the cost price is, and from there to be able to define what the final price will be of the product for the customer. There are different methods.

Valuation by specific identification: this valuation system is the most accurate since it consists in the identification of the exact acquisition price of each of the products we have.

FIFO method: this is the system of First Inputs, First Departures, FIFO (First in, First Out). It is based on identifying the cost price of the stock is based on the cost they had when arriving at the warehouse.

UEPS method: this is the system called Last Inputs, First Outputs, in English LIFO Method (Last in, First Out). It consists in that the last tickets that have been acquired are the first ones that you must leave. This means that the cost price of the last products that have been acquired is the one that will be applied to the first exits.

Average Cost Method: this method consists of making the average cost of all similar products but that have been purchased at a different price. To do this, we must add the cost of all the products and divide it by the number of products available.

To finish this section, I want to introduce the different stocks that exist.

Lot Size

This type of stock is directly related to the different sizes of batches of the company. The correct batch is the one that delivers the lowest total costs between the costs of placing an order and the costs of maintaining the inventory. There may be a need to buy or produce 1000 units of a specific product. However, after analyzing the costs, we can see that it is much cheaper to buy or produce 1500 units. In that case, the 500 extra units correspond exclusively to one type of batch size stock. Since the only reason for its existence is precisely the "rounding" towards the lot established by the company.

Security Stock

If we knew exactly how much we are going to sell in the future, we would not need more than that amount in inventory. This always depending on the regularity of the lead time, obviously. However, even the best demand planning mechanism can not predict 100% how many units we will sell later. That is why to cover the uncertainty of sales, it is necessary that we have a security stock. This type of stock will act as a "cushion" for those times when sales are higher than expected.

Seasonal Stock

Imagine a company that is dedicated to the sale of umbrellas. Eventually, in some of its locations it will sell units all the time, for example in the south of Chile. But in general terms, the highest sales will always occur during the winter months. As we know in

advance that between the months of June and August sales will be much higher, it is logical that the inventory during those months is also higher.

Stock of Capacity

This type of stock is commonly found in productive environments. It is defined as the "additional" inventory that is maintained during the period where the demand is less than the productive capacity. Imagine a company that makes glass ornaments, and whose ovens can not be turned off. The monthly productive capacity can be 10,000, although the demand in some months does not exceed 5,000 units. Thus, the inventory will increase by 5,000 the necessary units. The optimization of inventory is produced by maximizing the productive capacity of the kiln. The "extras" units will be sold in those months where sales are higher.

Work in Progress Stock

In a production company, we will not only find available stock of raw materials and finished products. It is also probable to find stock of semi-finished products or those in the production process. Just when the production times are very high, it is preferred to keep inventory in partially processed items. In this way, we can react more quickly and fluidly to the requirements of our clients. Thus, when an order is received it will not take 3 weeks of production to be dispatched, but 3 days. It is a good way of optimizing inventory, since stock is maintained at different stages of the production process.

Strategic Stock

In the assortment of companies, we will always find more or less important items for the business. However, many times we will also find critical or strategic articles. These are usually part of the "core" of the company, whose availability is vital for the performance of the company. They are usually products that are not always available, such as certain currencies (gold or steel). They can also come from highly unstable countries, which can not ensure their purchase availability over time. This works like a super stock of security, since its importance can be crucial. However, the difference of the strategic stock is that it is determined by the top management or management and not in a statistical way. For this reason, identifying it is essential for inventory optimization.

DISTRIBUTION LOGISTIC

Distribution logistics is responsible for getting the final products or services to the consumer. Through the logistics of distribution, therefore, it is possible for the final customer to obtain that product or service that they wish in the place, the form, the time and the desired quantity.

Therefore, a simple definition of distribution logistics, would be to refer to this as the process followed by all products and services, from the start of production or manufacturing until they reach the customer's hands to be consumed.

The main objective of the distribution logistics happens because the customer receives in good condition the product or service that has been demanded. There are some functions of distribution logistics:

- Make available to the consumer, and effectively, the product or service that has been demanded, at the precise moment and quantity.
- Processing of orders. Treat purchase orders in the appropriate order and time to offer a delivery service as optimal as possible and avoiding errors.
- Warehouse management. It is necessary to keep track of the inputs and outputs of the different inventory products that we manage in our warehouse. Otherwise, we will have tremendous chaos, which will slow delivery times and possibly lead to a lot of confusion when it comes to preparing orders.
- Packaging of the products. The products must be protected and prepared in the proper manner. For example, if it is a very fragile product that can be easily broken, it is our obligation to indicate it in the box so that the distribution company handle it with care and guarantee its perfect delivery.
- Product transport Here we will have a series of routes established through different means of transport so that delivery is as agile as possible.

It is very important that companies have launched a strategy in terms of distribution logistics. Since it is not as simple as that the customer receives the product and that's it. It must be done in a very agile way (it begins to demand 24h delivery) and, if possible, minimizing the resources used and, therefore, the business costs of this process. Great examples of distribution logistics are found, for example, in the Amazon company, the undisputed leader in product distribution logistics.

To carry out a correct management of the distribution, we recommend that you know all the available information on how to distribute your products to reach final consumers.

D. INDUSTRY 4.0

I. Introduction

Industry 4.0, also known as the fourth industrial revolution, is the application of new technologies in the production industry.

It consists of the implementation of the Internet of Things (IoT) in the industrial model, which makes the integration of production processes viable. With all the machines and devices connected in the network, it is possible to offer more information and relevant data.

The concept of Industry 4.0 proposes radical changes in the traditional model of manufacturing that we know today, since it is increasingly necessary that companies adapt to the scenario of digital transformation.

These changes seek to integrate intelligent infrastructures and the digitalization of methodologies, through the automation and intercommunication of systems and processes.

That is, in Industry 4.0 the production processes are becoming more efficient and autonomous. The innovative vision in this concept allows industrial processes to be more decentralized so that technological devices connect a whole chain of production.

Some examples of technologies or tools used in factories that have incorporated the concept of Industry 4.0 are:

- Artificial intelligence

Artificial Intelligence (AI) is the combination of algorithms proposed with the purpose of creating machines that have the same capabilities as human beings. A technology that is still far away and mysterious, but that for a few years is present in our day to day at all times.

- 3d print

3D printing, also known as manufacturing by addition, is a process by which physical objects are created by layering a material based on a digital model. All 3D printing processes require that software, hardware and materials work together.

3D printing technology can be used to create all sorts of things, from prototypes and simple parts to highly technical end products, such as parts for aircraft, green buildings, medical implants that can save lives and even artificial organs that are produced with layers of human cells.

- Augmented reality

The augmented reality is an element of new technologies that allows to have a different vision of reality. It consists of the combination of elements of a real environment with other elements of a virtual environment that have been created in three dimensions.

- Use of big data

When we speak of Big Data we refer to data sets or combinations of data sets whose size (volume), complexity (variability) and speed of growth (speed) make it difficult to capture, manage, process or analyze them using conventional technologies and tools, such as as relational databases and conventional statistics or visualization packages, within the time necessary for them to be useful.

- Storage in the cloud

It is a term used to describe a worldwide network of servers, each with a unique function. The cloud is not a physical entity, but a huge network of remote servers around the world that are connected to operate as a single ecosystem. These servers are designed to store and manage data, run applications or deliver content or services, such as streaming videos, webmail, office software or social media. Instead of accessing files and data from a personal or local computer, access them online from any device connected to the Internet, that is, the information is available wherever you go and whenever you need it.

- Internet of things

The Internet of Things (IoT) is a system of interrelated computing devices, mechanical and digital machines, objects, animals or people that have unique identifiers and the ability to transfer data through a network, without require human-to-human or human-computer interactions.

One thing, in the internet of things, can be a person with a heart monitor implant, a farm animal with a biochip transponder, a car that has built-in sensors to alert the driver when the tire pressure is low , or any other natural or artificial object to which an IP address can be assigned and give it the ability to transfer data through a network.

IoT has evolved from the convergence of wireless technologies, micro-electromechanical systems (MEMS), microservices and internet. The convergence has helped to break down the walls of silos between operational technology (OT) and information technology (IT), allowing unstructured data generated by machines to be analyzed to obtain information that drives improvements.

The implementation of the Industry 4.0 concept should be based on six basic principles, these principles we will try to implement in the last chapter but first we need to know which are:

- Real time data: The possibility of capturing data instantaneously will allow analysis and decision making in real time.
- Virtual Systems: The virtual systems are a proposal of virtual copy of the intelligent factory by means of diverse sensors scattered by the area. In this way, it is possible to remotely monitor and track all your systems and processes.
- Decentralization: Decentralization is the idea that the machines connected in the factories are capable of making autonomous decisions. In addition, the machines will have the ability to assess the needs of the factory and provide information on their work cycle in real time.
- Service orientation: It is a concept in which software can offer solutions as services connected with the entire industry, in the form of a catalog of services that allows the interaction and creation of new applications.
- Interoperability: It means, basically, the interconnection between the elements of the intelligent factory, through the use of the Internet of things.
- Modularity: The modularity allows the maximum flexibility in the intelligent factory for addition, replacement or subtraction of elements and change of tasks.

II. Historial outlines

Throughout history there have been several industrial revolutions that have meant, not only changes in industrial processes, but also social, economic and technological.

The first Industrial Revolution that began in the second half of the 18th century in the United Kingdom with the appearance of the steam engine, was the greatest economic, social and technological transformation since the Neolithic. The incorporation of the machines to the productive processes allowed to produce more and faster, multiplying the per capita income and the GDP.

The new sources of energy such as gas, oil and mainly electricity, gave rise to what was called the Second Industrial Revolution in the mid-nineteenth century. It is the time of chain production, new materials, new transport systems (the airplane and the car) and new communication systems, with the appearance of the telephone and the radio. These advances provoked a profound change in the economy, which is increasingly internationalized and globalized.

The third industrial revolution is a more recent concept, coined in 2006 and focused on the changes derived from the use of renewable energies, the automation of processes and the use of the Internet.

Many are the names that are given to the Fourth Industrial Revolution that we are living in today: Industry 4.0, Connected Industry 4.0, intelligent industry, cyber-industry of the future, Industrial Internet of things, etc. As in the previous 3 revolutions, this new revolution is based on the application of new technologies to industrial processes, both at the level of machinery and production and throughout the value chain of the industrial process. (Figure 8)

This is giving rise, as in the previous industrial revolutions, to the appearance of new processes, new products and new business models. And also, as in previous cases, it will cause social, economic and technological changes.

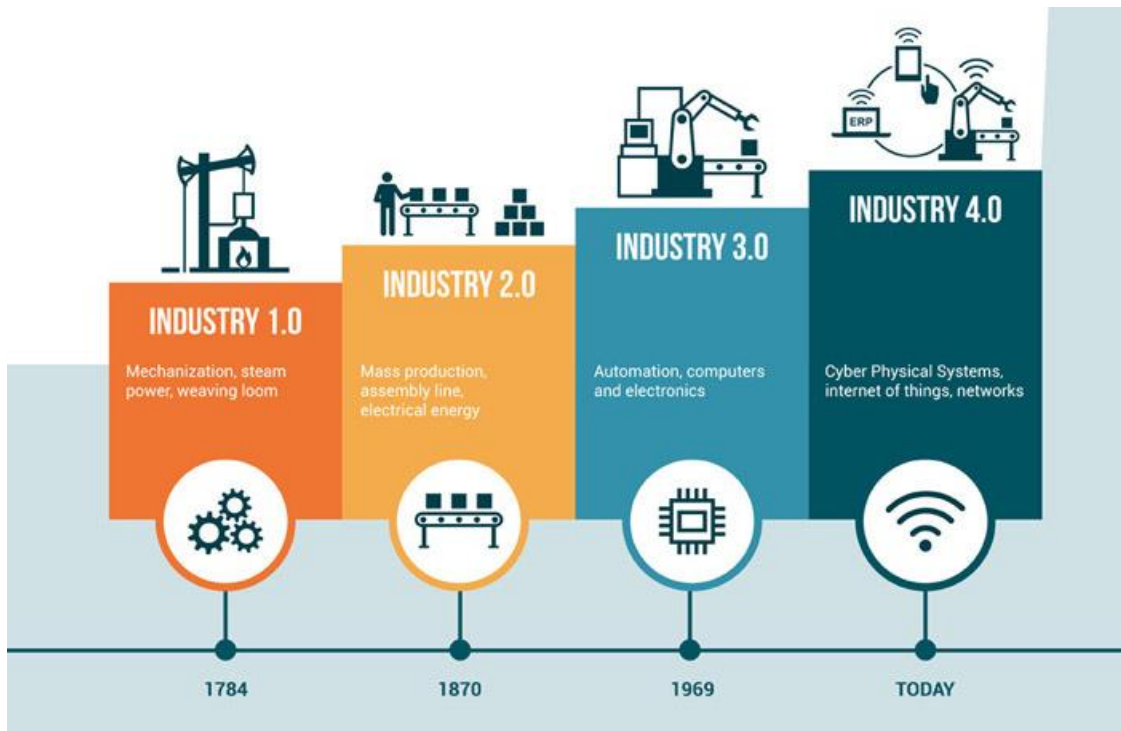


Figure 8 - History industry 4.0 (doingebusiness.es)

III. Tools of industry 4.0

As we mention in the first point of this part, there are some tools that are changing our industries and improving the way of production or service. We are going to focus in two tools that later are going to be very useful for understand and improve our logistics.

In a world where information is power and technology offers an infinite number of opportunities for all kinds of problems, it seems logical to think of a system that applies different tools that solve the problems presented by traditional logistics, which we will expose later, and we must stop.

1. Big data

As a definition we have the one that defends itself in Definitive Guide to MongoDB: The NoSQL Database for Cloud and Desktop Computing: "The Big Data phrase refers to the tools, processes and procedures that allow an organization to create, manipulate and manage large datasets and storage facilities "(*Plugge, Membrey, & Hawkins*).

The first challenge facing Big Data is to improve volume management. As we mentioned earlier, more data is generated every day. This implies that the amount of

data existing in the world reaches huge volumes. Most traditional data management systems are not capable of processing them with stability. (*Big Data, Bernard Marr*)

The second challenge that is presented to Big Data is the **variety** of data. As we have seen, there is a large volume of data. These data have different natures, among which we can highlight structured and unstructured data. The structured data are those that are traditionally stored in databases due to their ease to be labeled and ordered, which allows to extract conclusions easily.

Big Data is capable of working with a mixture of structured, semi-structured, and unstructured data. This is one of the added values it presents compared to conventional systems.

The last of the dimensions dealt with in Big Data is **velocity**. This velocity refers to the rate of data generation, which is increasing exponentially in recent years.

The difference between velocity and volume responds to the difference between the amount of data and the rate at which it collects and processes it. A software could store large amounts of data but collected over long periods of time. The Big Data manages to combine both solutions.

When the first Big Data idea appeared, there were only these main dimensions of Big Data. As it has been entering into matter have evolved the Big Data and have appeared 2 other new features that should have a system of this type. Big Data has therefore been modified, evolving from 3V to become a 5V system.

On the one hand, we find **veracity**. We define this new characteristic as the reliability of the data or the degree of confidence that they present. Due to the large amount of data that we face, we must discard those false, corrupt, or unreliable data.

We can compare Big Data systems with journalists in this case. The latter collect a large amount of information from different sources and then keep those that they consider most reliable. The Big Data collects a large amount of data and submits them to a series of filters, staying with those that have a certain veracity.

As the fifth and last V, we find the dimension of **value**. This characteristic defines that the data treated should guide us towards interesting information when making decisions that affect positively the different organisms in which it is used. It is the maxim of having the necessary information at the right time.

There is the possibility that certain collected data may not be useful in order to add value to the company or organization. For that reason, in the same way that in the veracity we stayed only with the reliable data, in this case, the Big Data will classify and filter the data according to the objective to be achieved.

We must understand that the 5 dimensions explained above are related when working in the Big Data system. A system that works with only some of these characteristics can not be considered as a Big Data type data management system. For example, a system that works with a large amount of data would be useless if it is not capable of giving value or truth to them.

2. Internet of things

The Internet of Things is something that the vast majority of people are already in contact with. From a smartphone and tablet to vehicles, we can find intelligent systems that connect these devices with the external world. This has brought various benefits to a society that is more and more eager to be connected every day. In the industry it is not different.

For some time, the industrial sector has looked for ways to connect various devices that are in its production chain (industrial networks, HMI interfaces, SCADA systems, etc.).

The importance of connecting these segments lies in the fact that nowadays the companies are not centralized in a single place, rather they are already worldwide or at least multinational. This results in the supervisors sometimes being hundreds of kilometers away from the operation, making it impossible to monitor the processes. The solution connects the whole process to the cloud.

Among some benefits that we would have when connecting the processes, are:

- Have a more flexible production, profitable and sensitive to changes.
- Reduction of maintenance costs.
- Improvement in the operation of the equipment.
- Increase in speed.
- Increase the final quality of the product.

Despite these setbacks, IIoT remains a tempting concept, as it provides 3 features that would radically improve production:

- Smart machines.
- Advanced analysis.
- Connectivity with people.

To conclude with this chapter, I just want to add that all the concepts explained so far are only the basis of this work to have a more global idea of logistics and industry 4.0.

2. CHAPTER 2 - IMPROVEMENTS IN LOGISTICS BY THE IMPLEMENTATION OF 4.0 INDUSTRY TOOLS

A. INTRODUCTION

A company can be defined as a system that uses resources to achieve, through a series of operations that provide or not added value, products or services that are demanded by a final customer.

Logistics, as a part of a company, also need some operations that require another resource. Both the parcel movement and the storage of this and its final distribution require a series of resources whose use we must optimize.

Logistics resources are much more than raw materials or packages. There are many recourses such as the processing time and space used for storage. Companies face a daily mission to improve the efficiency of their processes. In this chapter, I will analyze the problems and needs that the logistics sector presents to achieve the optimization of its main operations.

We are going to focus on two main problems: The first one is predictive planning of the capacity and network while the second one is the last mile logistic and distribution problems.

Through this division of logistics processes, we will be able to understand deeper the difficulties that are presented in companies. We will try to understand the different operations in a much more detailed and complete way.

As well, in this chapter we will analyze the advantages of use some tools of the 4.0 industry such as: Big data or internet of things (IoT). The analysis of these examples will allow us to understand the improvement in the efficiency of the different operations. We will study the need for Big Data and IoT in improving the efficiency of the different logistics processes.

Finally, we will present some conclusions in which I will give my opinion from the technical point of view of the capacity that Big Data and internet of things can improve the efficiency of operations in logistics.

B. MAIN PROBLEMS OF THE TRADICIONAL LOGISTICS

The companies have structured interconnected departments whose main function is to grant the client the goods or services required in the conditions in which they demand them. Logistics is one of the sectors more affected because this structured change, it is one of the sectors in which the client most influences.

Customers every day demand goods or services in a shorter time. This implies accelerating the logistics processes of many companies. This leads to the fact that the main problem that occurs in companies when it comes to achieving adequate efficiency to meet the needs of customers is the absence of control of the company's operations.

We are going to divide this main problem into parts: The lack of a defined plan for logistics processes and the absence of measurable objectives.

The first parts are that usually a defined plan of the logistics operations does not exist. If we do not know all the logistic processes properly, we can hardly improve the efficiency of these. This problem is linked to quality since everything that is not defined can not be measured. If we do not have a properly defined process, we can not establish objectives to improve the efficiency of each of the operations.

The second problem is quite serious, if we do not have some objectives that can be measured to verify compliance, we can not improve the operations associated with these objectives. These is a big inconvenient to quality processes. Quality is based in measure the data that we obtain from the different logistics process but if we do not have a defined objective or even worse how to measure them, it is impossible to have quality in our services.

Everything that is not measured can not be improved. If we do not know at what point we are failing, we will not know the associated causes that the processes may have, in which we will have to take measures.

Once we have exposed the main problems when facing the optimization of the efficiency of the logistics processes, we can focus on studying each of them deeply. As we have said, we will focus on last mile logistic and distribution problems and predictive planning of the capacity and network.

I. Predictive planning of capacity and network

If we achieve the optimization of the planning, it will offer a key competitive advantage over the rest of the market competitors. It will be possible if we use our resources properly and in an efficient way.

Capacity is defined as the ability to achieve, store or produce. For an organization, capacity would be the ability of a given system to produce output within the specific time period. In operations, management capacity is referred as an amount of the input resources available to produce relative output over period of time.

The basis of capacity requirements is the generation of the production plan, which depends on customer demand. Basically, customer-oriented and market-oriented demand management can be distinguished: With customer-oriented demand planning production follows the orders from customers. Another possibility is the market-oriented demand planning, where sales volume is forecasted with the aim of expectation and data gained from past experience. Requirements are that the demand should be relatively constant, the products should be standardized and customers highly sensitive with regard to delivery times.

Capacity is a key aspect when optimizing the logistics distribution network. An excess of capacity leads to a decrease in the profitability of the company, because we will be stopping using certain resources that are producing a series of costs.

On the opposite side we have the shortage of capacity, which is also not desirable. This is because, if sufficient capacity is not available in the logistics network, it is impossible to satisfy the quality of the service agreed with the client. In this way, there is a loss of confidence and satisfaction on the part of the client.

Adjustment of capacity demand is one option if a resource capacity is over- or under-loaded. It is also called adjustment of capacity load. The prevalent adjustment of the capacity demand is the shifting of workload into other periods. In case of capacity over- load, production orders or lot sizes can be delayed into the next production period, if the due date of the order contains a certain buffer for delay. Lot sizes can be also split and partially shifted. In the event of capacity under-load upcoming orders can be released ahead of schedule or batch sizes can be increased by bringing orders forward. For timely shifting it has to be considered that it influences the finishing time of the order, and can theoretically only be done, if enough time exists.

To have an optimum capacity, we must make predictions. These predictions will give us the necessary clues to carry out the necessary adjustments to get as close as possible to a future solution.

The planning of the operative capacity has a much shorter time horizon, it can be a period of months or even weeks. The predictions that must be made in this regard have to do with the transit points and the transport routes that distribution vehicles must carry out. Through the study of these routes, companies make decisions to use one or other vehicles of their fleet, and even subcontract others depending on the need.

Planning the capacity is also about planning the people you need, the shifts of the works and even the routes where the materials or people should use. Forecasting the capacity, managers should be able to take all these decisions in order to be much more effective.

The problem that we have in this planning of the operative capacity is the traditional way of estimating the demand. In order to predict future demand, historical capacity data are usually studied, as well as an intuition of personal experience of managers. This traditional way of making predictions leads to the loss efficiency of a large amount of resources. (Figure 9)

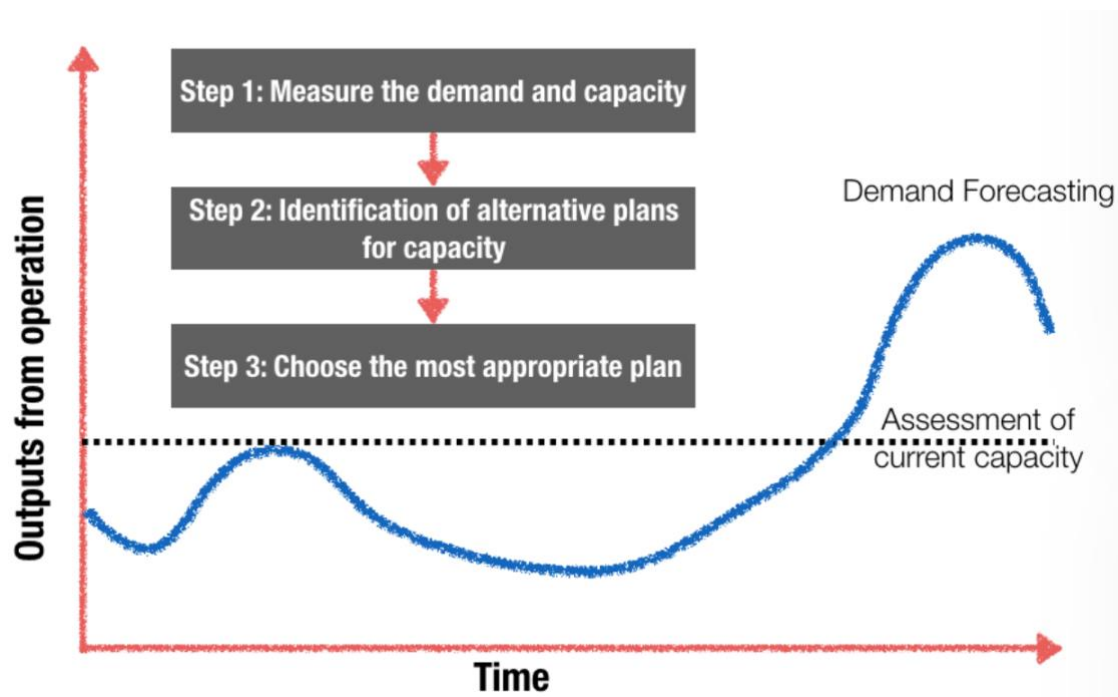


Figure 9 – Demand forecasting (entepneurshipinbox.com)

The strategic network planning. This planning consists of the analysis of some data which it is intended to know the future demand. With the estimation of the demand, we intend to make decisions for a longer term, this being several years.

With a good estimation of the future demand, a series of strategic decisions can be taken, such as: acquiring the distribution centers, necessary warehouses and the vehicles with special measures necessary to satisfy the demands of our customers.

Nowadays many companies have a lot of data, but they do not use it properly. To make good use of it, we should only focus on the useful information and not on the unnecessary. We must have a clear and good structure, one of the tools that companies can use are the well-known ERP systems which we will propose as an improvement or solution to these problems exposed.

II. The last mile logistic and distribution problems

Last mile is used to describe the short geographical segment of delivery of communication and media services, or delivery of products to customers located in dense areas. Last mile logistics tend to be complex and costly to providers of goods and services who deliver to these areas.

In recent years, with the development of electronic commerce, last mile logistics has become one of the key processes in the distribution, because customers do not go to stores to buy their products, but companies are those that send the demanded product to each of the clients.

Why is the last mile logistics important? Well, as we said before, it is the final transportation of goods from the hub to the final customer. The efficiency of the last-mile and the experience of the customer at this stage go a long way in determining the common perception of the business, which flutters about the market in the form of reviews, gossip and even competition.

One good example of the importance of the last mile delivery are the little shops or supermarkets that they have to replace all the days without fail the food, clothes and everything necessary so that they can function with total normality.

Usually, these last kilometers are carried out in cities, so we find a lot of obstacles that companies are not able to foresee. We can see how among these difficulties we find accidents, road works, traffic jams, adverse weather conditions.

In addition to the various setbacks that the infrastructure network may present, we have to take into account the inefficiency presented by the delivery of a large number of small packages to a large number of destinations. The costs are increased by

increasing the distance to travel and, therefore, the number of setbacks that may appear.

Furthermore, customers expect to have at their disposal the product purchased in a very short period of time. Any setback that can not be controlled could result in extra costs due to customer claims for failure to comply with the delivery time.

This problem is one of the mains for the managers because it is very costly and can make the company lose a lot of money. This is so much important, that they have made the logistics of last mile, the process of distribution logistics with higher costs. The percentage of last mile logistics in a company can reach more than 1/4 of the total delivery costs.

In order to avoid these last setbacks and to make everything go better, it is a good idea to go with more time than necessary in which these possible contingencies are contemplated. To be able to earn that extra time that is needed, it is necessary to have a very good distribution system inside the warehouse so as not to leave with any delay.

We propose an improvement of the intelligent systems within the warehouse so that they are all connected to each other and a more efficient distribution can be made. Next, we will explain how connecting the different tools such as the PDAS with which the packages are scan or the carts with which the packages are moved. (Figure 10)



Figure 10 - Efficiency

C. POSSIBLE SOLUTIONS AND TOOLS

As we did before, we will explain the two possible solutions for the two problems. To have the same order, first we start with the solution for predictive the capacity and the we will continue with the last mile problems.

All the solutions that Big Data presents go through a series of operations prior to the application of this new technology. Whenever we introduce a notable change in a company, it requires a change in the mentality of this.

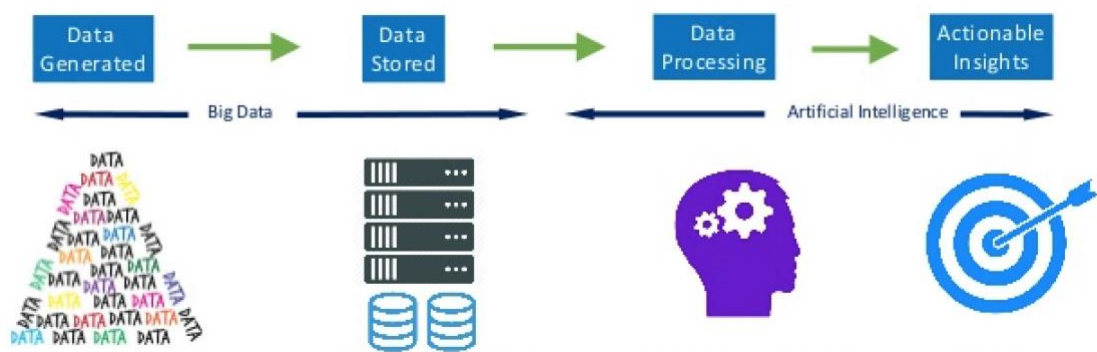


Figure 11 - Big Data (Houseofbots.com)

For example, when ERPs were introduced in companies, daily operations underwent a series of modifications in order to adapt to the new functioning of this ICT. Even when changes are made in some module of the ERP of the companies, the operations suffer adaptations to the new system. (Figure 11)

In the case of the implementation of Big Data, the first step will be to solve the two main problems that were posed in the optimization of the efficiency of operations: defining the processes and establishing measurable objectives in these processes. To deal with the first problem related to the definition of processes, we will have to carry out a detailed strategy of all the operations that are carried out in a process. We must define each of the main and support operations, in order to know their interactions.

Knowing the resources, we use in each operation, we can establish measurable objectives for each of the processes. Thanks to the data of the resources used in each one of the operations, we will be able to establish indicators with which to measure the efficiency of the products.

In addition to the resources themselves, in order to properly analyze each of the processes, we must have a greater amount of data. For this, we must analyze which parameters are the most influential in order to improve the efficiency of the processes. This part is usually call quality control and nowadays this department of quality is taking many importance for the companies.

To collect this amount of data we must use the Internet of Things (IoT), which will allow us to collect data from different objects or machines through different sensors. Once we have collected the data, these must be sent to the different servers that will analyze them later through Big Data technology.

Once we have explained the previous steps to be able to implement Big Data in a company, we can move on to discuss how to improve the main logistics processes that can be improved: the optimization of last mile logistics and the predictive analysis of networks and capacity.

I. ERP (Enterprise Resources Planning)

This ERP is not only a solution for predictive the capacity, it is a way of controlling the hole company with a very sophisticate system that allow to managers and all workers to take better decisions. This system is linked with the good using of big data because it needs many data to be useful. With ERP we will be able to forecast the demand we need, the people, money and so on, necessary to comply the necessities of our customers. *(ERP, Carol A. Ptak)*

To introduce this system, it is a process used by companies to manage and integrate the important parts of their businesses. Many ERP software applications exist to help companies implement resource planning by integrating all of the processes it needs to run a company with a single system. An ERP software system can integrate planning, purchasing inventory, sales, marketing, finance, human resources, and more. An ERP has a Central Data Base.

It has to be integral. All departments of the company have to be able to exchange information between them. Doing the whole process in the most efficient way, without duplicating information. When we do not have an exchange of information in real time, we will have problems between departments, and the company will have problems.

The departments which are involve in the ERP system are presented in the Figure 12:



Figure 12 – ERP (ehopper.com)

An ERP is divided in different modules, and each person from a company will have access to certain modules. Depending on the companies the necessities will be different of another company. Each company will have his own modules, and each module will be different for each company, so, there are not two ERP equals. It has to be adaptable. For the reason that each company is different, an ERP has to be able to do the tasks a company wants it to. Each company will have certain modules with certain characteristics.

The ERP will give us a series of improvements at all levels that will be reflected in the results of the company. It is good improving the decision-making process. Having a common data base that implies different departments which can share real-time information. With all this information the different departments are able to take decisions in real time doing the processes improve.

Real planning of future situations is another advantage. Having the right information, we can predict what is going to happen in certain situations in the future. For this reason, we will be able to have a good reaction to future problems or even more we will be able to predict the demand.

ERP Systems are composed of different modules. Each module has a group of tasks. The modules are independent between them, but they share information for doing

easy the work for the company. ERP's are adapted to the company needs. All the companies are different, so they can choose the modules that they want but usually the modules are the ones exposed before.

With this system we will be able to control and do the traceability. That will be useful in order to improve the distribution and the last mile delivery which is one of the mains problems that we are trying to solve.

Now, customer and suppliers are integrated to the company. There is an active communication between the company and the suppliers. About customers, the company is able to adjust the production to the demand.

An ERP makes easier the communication. A company with an ERP does not need too many meetings because of the sharing real-time information. Also, reducing costs is a good advantage which make the enterprises much more competitive, and this have to be the first objective in a company. Reducing unitary cost means, increasing gains, reducing prices or both of them.

Thanks to all these advantages we could have a smaller ROI and increase cost effectiveness. So, in a long period of time we will recover the initial investment and we will improve the gains.

However, these are the general advantages of ERP, but we are trying to solve the problem of forecasting the capacity. Now we are going to focus in two modules of the ERP. The first one is the production planification and the second one is CRM which means Customer Relationship Management.

Production Planification has three main points:

1. Master Production Schedule (MPS) is translating a business plan into a comprehensive product manufacturing schedule that covers what is to be assembled or made, when, with what materials acquired when, and the cash required. MPS is a key component of material requirements planning (MRP). It is able to anticipate bottleneck in the production. It is able to anticipate the needed for next orders.
2. Material Resource Planning (MRP) is a system for calculating the materials and components needed to manufacture a product. It consists of three primary steps: taking inventory of the materials and components on hand, identifying which additional ones are needed and then scheduling their production or purchase. It helps to decide when the company has to ask for raw materials

and components, and also it calculates when the raw materials are going to finish.

3. Capacity Requirements Planning (CRP) is an accounting method used to determine the available production capacity of a company. Capacity requirement planning first assesses the schedule of production that has been planned by the company. Then it analyzes the company's actual production capacity and weighs the two against each other to see if the schedule can be completed with the current capacity. It can calculate the workload relative to the factory in specific conditions. It allows to plan many things like overtime or preventive maintenance.

With this production plan we will be much more orderly and forward looking at the time of doing the logistical tasks, everything is connected in the company, but if we do a good planification and optimization of our resources will be reflected at the time of distribution. This information can be used for forecasting capacities or networks also.

The second module, CRM is a technology for managing all your company's relationships and interactions with customers and potential customers. The goal is simple: Improve business relationships. A CRM system helps companies stay connected to customers, streamline processes, and improve profitability.

When people talk about CRM, they are usually referring to a CRM system, a tool that helps with contact management, sales management, productivity, and more.

A CRM solution helps you focus on your organization's relationships with individual people including customers, service users, colleagues, or suppliers throughout your lifecycle with them, including finding new customers, winning their business, and providing support and additional services throughout the relationship.

Both of these modules will structure our data and it will not only provide useful information for production and for customers' relationship, also it will help us to use that data to do some studies about strategic planning of the network or operational capacity planning. These studies will be key to being able to predict the capacity and, therefore, to solve our exposed problem. I want to emphasize that all these tools, such as the ERP or these studies that I am talking about, are what make up the Big Data.

The objective pursued to apply Big Data techniques to the strategic planning of the network consists, mainly, of obtaining a key competitive advantage with respect to the competition. How is it possible to obtain a logistical advantage by predicting the demand that the client will demand in the long term?

The Big Data aims to provide a solution through the study of data that reliably predict the future capacity needed. The first step to be able to arrive at taking correct decisions will be the data collection which we already have from ERP.

The most important data to determine the long-term capacity required will be historical data and data used at transit points and transport routes.

As these data used in isolation have traditionally led to failure in predicting future demand, it is important to add another type of data. The growth forecasts of each region and each type of industry. These data interact with the data previously exposed to obtain greater reliability in the prediction of demand.

It is important to keep in mind that the demand is not always the same and that there will be certain weeks or months like summer or parties where there will be parking lots while at other points of the year there will be a very high demand. Taking into account this, we will make a series of algorithms to have an approximation.

The result to be obtained is a new prediction model that allows us to know the future demand with higher time periods. Companies will obtain benefits both in the reduction of investment risk and in the reduction of contracting of external capacity.

One step further will be to take advantage of immediate feedback from external events. We could, in this way, establish seasonal moments in which the demand was less than our capacity. The system would be able, through a system of pricing and transfer of general expenses, to lend its capacity to other companies automatically. In this way, companies will optimize the efficiency of all their resources.

On the other hand, the objective of operational capacity planning varies from that of the strategic analysis of the distribution network. The objective, in this case, is to manage the daily operations of the transit points and the distribution routes as efficiently as possible.

In order to correctly know the needs of the capacity, different data must be analyzed. These data come from two main sources: those originated within the distribution network and the data that comes from everything that surrounds the network.

Regarding the internal data, we can see how they are collected through different sensors and warehouse management systems. Among these data are the articles that are in transit, enter and are stored in the different points of the distribution network. These data are captured and analyzed in real time, in order to predict the best allocation of resources for the next 48 hours.

On the other hand, it is necessary to collect external data to the distribution network. It is fundamental to analyze possible changes in the preferences of the client that may suppose deviations in the demand. This change in preferences may be due to actions such as: launch of new products, opening of new factories, unexpected bankruptcies.

Through the interaction and analysis of these data through Big Data techniques, companies are able to forecast the necessary operational capacity in each geographical region. In this way, a resource planning is carried out to support the operational capacity with maximum efficiency.

However, this advantage is not the most innovative that Big Data presents due to the need to plan operational capacity. The advantage that provides more added value is the ability to detect congestion in different routes in advance.

Through this competitive advantage, systems that use Big Data will become systems that are automatically optimized. With this technology, the costs caused by unforeseen events will be significantly reduced. In addition, the system is capable of autocorrecting deviations and issuing responses in real time, which considerably increases the service level of the company.

II. Intelligent systems

An intelligent system is a machine which is internet-connected with computer that has the capacity to analyze data and communicate with other intelligent systems. Other characteristic of intelligent systems is the capacity to learn from experience, security, connectivity, the ability to adapt according to current data and the capacity for remote monitoring and management.

Intelligent systems exist all around us in point of sale terminals, digital televisions, traffic lights, smart meters, automobiles, digital signage and airplane controls, among a great number of other possibilities. Built in intelligence is an integral component of the developing internet of things (IoT), in which almost everything imaginable can be provided with unique identifiers and the ability to automatically transfer data over a network without requiring human to human or human to computer interaction.

The good thing about intelligent systems is that they are entities that, with the passage of time, learn from their environment, accumulating experience and that is used in new situations that the environment presents. Intelligence can be seen as a measure that indicates how easy a system achieves its objectives.

It is important explain how the intelligent systems works. So, intelligent systems are composed of elements contained in the figure 13.

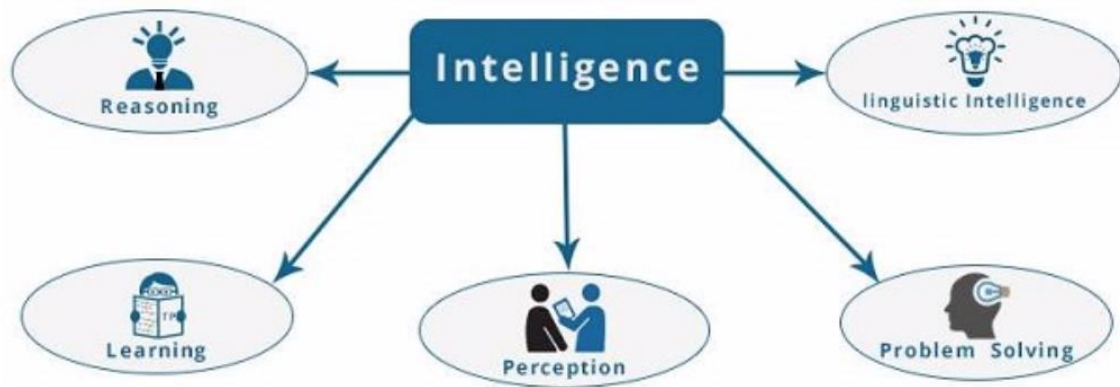


Figure 13 - Intelligent systems (tutorialspoint.com/artificial_intelligence)

1) **Reasoning:** It is the set of processes that enables us to provide basis for judgement, making decisions, and prediction. There are broadly two types: inductive reasoning and deductive reasoning. Inductive reasoning is a logical process in which multiple premises, all believed true or found true most of the time, are combined to obtain a specific conclusion while deductive reasoning is a logical process in which a conclusion is based on the concordance of multiple premises that are generally assumed to be true.

2) **Learning:** It is the activity of gaining knowledge or skill by studying, practicing, being taught, or experiencing something. Learning enhances the awareness of the subjects of the study.

3) **Problem Solving:** It is the process in which one perceives and tries to arrive at a desired solution from a present situation by taking some path, which is blocked by known or unknown hurdles.

Problem solving also includes decision making, which is the process of selecting the best suitable alternative out of multiple alternatives to reach the desired goal are available.

4) **Perception:** It is the process of acquiring, interpreting, selecting, and organizing sensory information.

Perception presumes sensing. In humans, perception is aided by sensory organs. In the domain of AI, perception mechanism puts the data acquired by the sensors together in a meaningful manner.

5) **Linguistic Intelligence:** It is one's ability to use, comprehend, speak, and write the verbal and written language. It is important in interpersonal communication.

One part of the intelligent systems is the Internet of Things (IoT) and that is what we are going to focus on now to be able to explain why it is an improvement for the logistics. All roads lead to the Internet. The constant technological advances linked to

the "network of networks" create new possibilities so that more and more sectors can take advantage of its benefits. The Internet of Things (IoT), driven by the best possibilities of connectivity and the use of mobile devices, presents great opportunities for the optimization of logistics operations.

The logistics area there is ignorance about where the products are inside the warehouse, the control of entry and exit of goods or storage conditions. IoT in this case measures all these conditions and incorporates climate sensors, automatic lighting controls, RFID tags for entry and exit, checklist and rounds control for security. With volume sensors and presence of products you can know how they are moving inside the warehouse and where they are located. The most important thing is that these sensors connect via WIFI to the Internet. Given a context of multiple problems that can affect the logistics chain, the use of IoT offers alternatives to solve them. The main one is the possibility of connecting all the goods in a simple and economic way to the Internet, obtaining the possibility of operating them and monitoring them from any device anywhere in the world with a simple connection to the network, since all the information and associated logic it lies on the Internet.

Once the assets are connected via the web, new versions of the software and logic of the sensors as well as the systems are simplified and automatically updated instantly. Some time ago the IoT implementation stopped being something abstract, there are multiple industries that have already adopted this type of solutions, such as long-distance transport (point to point), to optimize security tools, management and value services aggregate. Recently other industries have discovered the attributes of IoT, such as:

- Last mile transport for the optimization and control of deliveries and waste to improve management, with sensors in containers, total vehicle control, optimized routes and geo-referenced incidents survey.
- Post: Track & trace with information to the end user of the status of the delivery.
- Passenger transportation: To provide an estimate of arrival times, associated with traffic information and information systems at stations.

Another attribute of IoT is that it contributes to the environment since it allows to obtain more information about atmospheric damage, carbon footprint, air pollution and sound sensors. To make more accurate diagnoses and action plans tailored to the pollution or prevention level.

In the case of the supply chain, these sensors can be implemented to make it more reliable and efficient. Regarding to production, it is possible to limit errors that arise

due to lack of material, since the internet of things will allow for better control and reduce bottlenecks and production flows.

This technology will make supply chains precise instruments, especially when working under the philosophy of JIT (just in time) and it will have an impact on more precise and narrower logistic deadlines between each of the deliveries. Companies will have at their disposal more accurate maps of their processes and will improve the time needed to transport, manufacture and store the goods, as well as knowing their status in real time.

Let's see how IoT works in logistics and how it can optimize, modernize and boost the business dynamic as a whole and how the benefits of IoT will help to the last mile distribution.

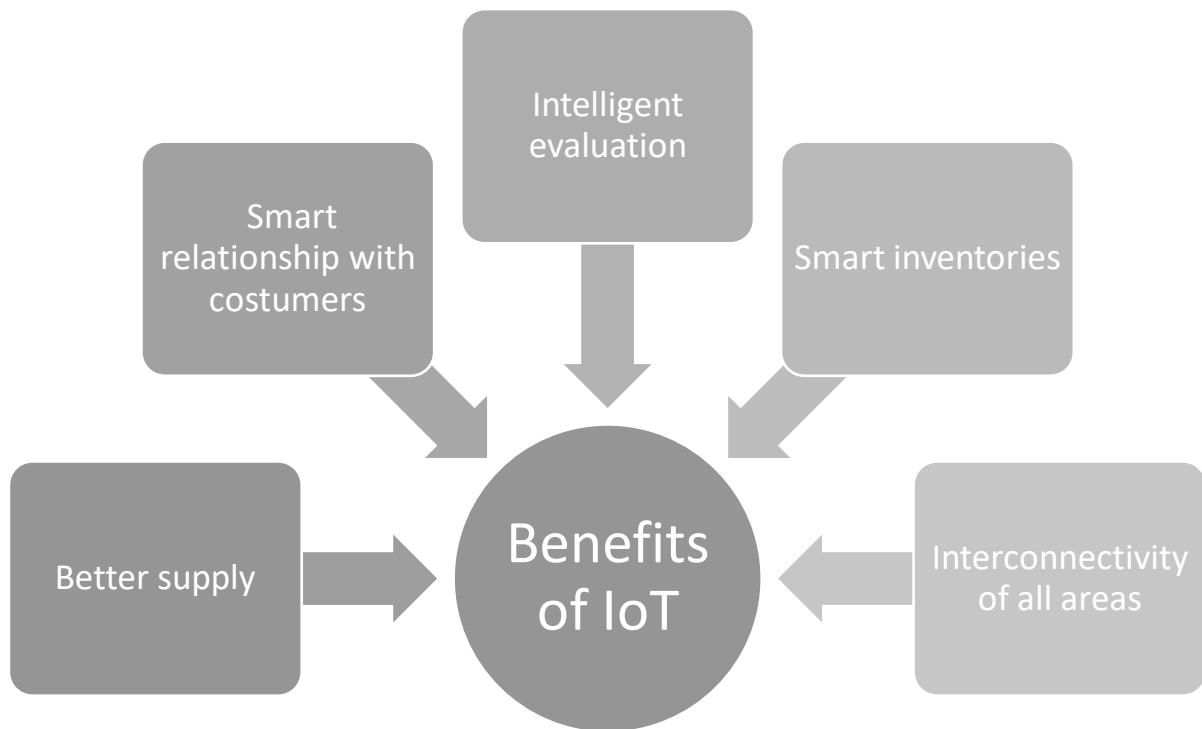


Figure 14 - Benefits IoT

- **Better supply, better deliveries**

Being the vehicular transport one of the keys of the logistics, the use of IoT in its processes -including of course e-commerce- improves its operation in the following aspects:

By means of Big Data, sensors and monitoring it is possible to record in real time the conditions of the vehicles used to distribute the products in distribution centers, stores

or home delivery, which serves to determine which vehicles are suitable for carrying out tasks and which not.

Through smart navigators, from the company and the vehicle, it is possible to know previously and during the journey, the situation of the vehicular traffic in the schedules in which the distribution or delivery of the goods is carried out, which allows to elaborate more efficient plans of distribution.

An important element of the distribution process is, by means of GPS devices and sensors, to track the trajectory of the vehicles that obtain or distribute goods, which allows to verify that the routes, times and strategies are fulfilled as planned and to offer solutions in the case of contingencies, accidents, etc .. This resource benefits large-scale merchandise distribution companies, such as beverages, natural and packaged foods, among others.

In the same way, the temperature of the vehicle and the conditions of the goods that go there can be monitored, to ensure that the products are properly conserved, to monitor the mechanical conditions of the vehicle and even to know about health and physical and mental condition of the driver; all to ensure that deliveries are made in accordance with previously established strategies.

- **Smart relationship with customers**

Through Big Data, adequate software and interconnectivity, with the use of IoT the company-client relationship becomes increasingly personalized and authentic, through the automated tracking of the particular preferences of each client conceived as an individual and not as a standardized consumer anymore; This intelligent marketing directly affects the dynamics of the logistics of a company that will have to adjust to new dynamics generated by this new relationship with the customer, especially in the e-commerce sector.

- **Intelligent evaluation**

By means of Big Data, Machine Learning and convenient software, all of them interconnected to IoT devices, it is possible to evaluate the operation of logistics in all its aspects and correct errors in an automated and immediate way. As we have explained before, machines through intelligence are able to solve problems based on experience and data collection. The evaluation of the machines is a very good benefit since it will make us improve with the passage of time solving the errors found.

- **Smart inventories**

The IoT in logistics is also applied to the storage, ordering and availability of products, by means of sensors connected to computer programs that automatically make a permanent and updated record of the inputs and outputs of the goods, and that thanks to the interconnectivity between devices and the Internet detects missing stocks and immediately orders a replenishment of the same with suppliers, all without human intervention, which reduces costs of various types.

- **Interconnectivity of all areas of a company**

The interconnectivity between all the parts that make up a company, for example, between machines, inventories, marketing and logistics, is one of the obvious benefits of the IoT, in that it allows an integral planning that unifies the part with the whole ; for example, IoT devices connected to an assembly machine report a technical failure that the logistics area records and that serves to reprogram the orders that it had planned to carry out; this interconnectivity also reduces production costs and prevents poor planning in logistics.

As we can see, all the improvements are linked because the IoT application would not make sense without applying big data. In this last benefit of interconnectivity, the ERP, which is the system that intelligently deletes the data and its easy use, has a fundamental role.

The application of IoT brings many benefits in space to the distribution of last mile since it helps us to have everything more controlled through the tracking of the packages, using GPS to optimize the routes and therefore, try to minimize the high cost that this part of the logistics. Combining big data and IoT can make great progress in the long or medium term.

D. WHAT IMPROVEMENTS ARE GOING TO BE MADE

In this section we will explain how the impatience of these tools affects all levels. A priori it may seem that it is easy to implement the big data the IoT but to implement it you have to dedicate a lot of time, have specialized people, teach how to handle these tools to the workers and above all a great investment of money.

The big data is a very powerful tool as we have already explained but I want to emphasize that the most important thing is a good use of the stored data, it does not work with storing a large amount of data, most of which are not useful, data that are

useful and above all, those data that are correct because if we store incorrect data the only thing we are going to get is having erroneous information.

I. Impacts in the quality control

The impact that big data has on the quality is very large, with a good use of this tool can help to improve the quality of the company in all sectors. When we have quality, we refer to the control of important aspects of the company or known as KPIs (Key Performance Indicators) that will give us an idea of how a certain task or processes or even the workers themselves.

Big Data can bring great advantages to companies of all sectors through the management of knowledge of its market and its customers, so that its management is already a priority within the corporate digital strategies.

Companies need to bet on solutions capable of maximizing the power of mass processing of large volumes of data; without forgetting the need to define business strategies on the use of Big Data, security risks or the importance of the quality of the data that must be processed. A good way to address these challenges that affect security, privacy and the nature of information is through an efficient data quality system, with sufficient capacity to optimize the potential of the large volumes of data that this technology integrates. In this way, having a database with quality allows:

- **Increase the effectiveness of marketing actions.** When there are no erroneous addresses and returns, all shipments arrive punctually to the recipient, which is why apart from reducing the cost of stationery and material, it also increases the effectiveness of all campaigns.
- **Cost savings.** One of the main advantages of having high quality data is the reduction of accounting expenses, through a unified vision of credit control and billing, as well as the reduction of costs in shipments. In addition, you can save in terms of productivity, since the staff involved in these tasks will not have to spend so much time reviewing inaccurate or non-existent data, so that your workday will be much more operational.
- **Facilitate customer loyalty and recruitment.** Today, customers expect a satisfying and personalized shopping experience. The better the quality of the data, the easier it will be to provide effective communications with that personal approach that customers demand, which translates into opportunities to increase the value of the business.

- **Achieve commercial intelligence objectives.** Knowing the state of a database (inconsistencies, errors, obsolete information ...) translates into rapid monitoring of changes in the status of information (registrations, deletions, modifications ...) in order to be able to make better strategic decisions. In this context, Data Quality has applications both in the area of personnel efficiency and in the minimization of risks within an organization.
- **Help improve the image of the company.** What image does a company offer when it sends erroneous information, misspelled names, incorrect abbreviations or outdated data? Data Quality is essential to obtain a unique, accurate and reliable view of each client. It is a matter of transparency, consistency and reliability, which not only helps to gain the trust of users, but also improves the operational and transactional processes of any organization. All these aspects contribute in a positive way to improve the internal and external image of a company.

The key to Big Data, therefore, lies in the quality of the information, not in the quantity. The aim is to obtain the maximum performance from the data processing and also to take the lead to the main companies of the competition. For this, the Data Quality Systems become the essential tool to approach the management and decision making in real time based on algorithms that, at the same time, are based on high quality data.

I would like to introduce a term that is very current between companies and is the term of Total Quality. Total quality is a concept, a philosophy, a strategy, a model of doing business and is located towards the client. The concept of quality, traditionally related to the quality of the product, is now identified as applicable to all business activity and to all types of organizations. (Project management, Harold Kerzner)

The total quality not only refers to the product or service itself but is the permanent improvement of the organizational aspect; where each worker, from the manager, to the employee of the lowest hierarchical level is committed to the business objectives.

TQM (Totally Quality Management) is focused on creating quality awareness in all the organization processes. Its extension has made it used by all sectors, from manufacturing to education, through the government and service industries.

Now we show the elements of TQM in the figure 15:

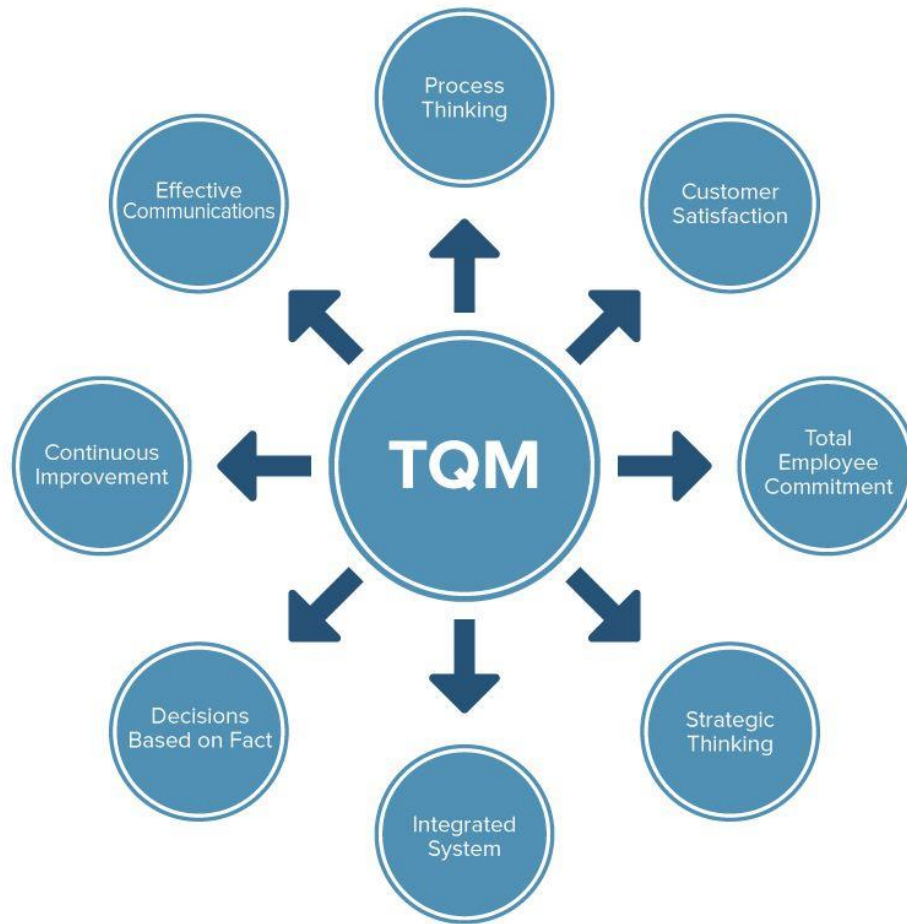


Figure 15 – TQM (Juran's quality handbook / ed. Joseph M. Juran, A. Blanton Godfrey)

Its definition as Total is due to the fact that it involves the organization of the company considered as a whole, including the people who work in it.

Today, Total Quality is the compendium of best practices in the field of organizational management. These best practices are often referred to as the 8 principles of Total Quality:

1. Result oriented.
2. Customer orientation.
3. Leadership and coherence in the objectives.
4. Management by processes and facts.
5. Development and involvement of people.
6. Continuous learning, innovation and improvement.
7. Development of alliances.
8. Social responsibility.

With the implementation of the ERP I will be closer to being able to control the quality and therefore, closer to this total quality that we are looking for with this type of improvements.

II. Better planification and better results

Implementing the ERP and the IoT, we will obtain a series of advantages that will make us more competitive, take advantage of our resources more effectively and, therefore, obtain better profits in the future. To be able to compare if we are right and improve with the passage of time, we must have some data and previous analysis with which we know the starting situation.

Big Data can facilitate your task when it comes to strategic planning in the financial sector. Knowing the value of your data and optimizing processes, will guarantee efficiency in your business, a benefit that will put you one step ahead of your competition.

According to the five forces of Porter, the financial sector is characterized by intense competitive rivalry, the fall in prices that generates reduced profitability, a supply higher than demand, the increase in the threats of substitute providers and competitive costs.

Strategic financial planning and efficiency should be the axes of your actions to improve the profitability of a company. It is not enough just to look for new sources of income, it is important to minimize the cost base to maintain or improve profitability. Some tactics used for this purpose are to participate mergers and acquisitions to achieve economies of scale or to innovate in the automation of continuous processes to reduce expenses.

Although mergers and acquisitions are not available, we can always benefit from continuous improvements in processes, for which the combination of Big Data and Analytics is key.

Big Data is indispensable for the financial sector because it offers quick access to a great variety of information that was not possible to know before. Keep in mind that if a company accesses the information and recognizes the value of the data, it will increase your productivity and profitability, which will give an advantage over the competition.

For its part, Analytics will be effective ally in strategic financial planning as it will help identify areas that could be improved with automation.

These benefits of which we speak, must be measured in some way and as we have discussed in the previous point a good way to measure them is with quality, more specifically with quality indicators that are what will give us a clear reflection of the reality.

Some indicators that can be extracted from Analytics and that show that your company needs to optimize processes are:

- **Unacceptable error rates:** internal error tracking systems and customer surveys can give an overview of the areas that are failing in your company. If we add unstructured information from social networks, we can get even more relevant information about customer service experiences. Undoubtedly, the analysis of these data will give valuable ideas for improvement.
- **Reduced employee productivity:** with Analytics we can easily identify key performance indicators (KPIs) to measure employee productivity. This data can be compared with the achievements of our competitors, so we will have a context about the results and the improvements you must implement.

In summary, the financial industry is a highly competitive environment. However, with the help of Big Data and Analytics and the efficient use of data, profits, productivity and profitability will improve.

If we are able to improve productivity, we will have better results and we can plan our production or services in a more efficient way. I also want to emphasize that together with the IoT we will be able to generate more data and have the quality, processes and tasks more controlled which will give us more experience and more resources when planning our production, our staff resources or our resources of machines.

It is clear that the more information and more organized better forecasts and planning we can do, the ERP to have different modules will allow us to plan the different areas of the company.

To finish with this chapter, we have seen how the tools of the industry 4.0 can help and influence a good change in a company, knowing that it is a long-term investment, you can see very benefited a company at all levels.

All companies should try to stay up to date with the latest technologies so as not to be left behind with their competitors and now more than ever, there is a lot of competition in the markets and the fact of betting on Big Data or the internet of things can give us that extra what we need to be successful.

Next, we will try to explain how a company should consider the implementation of these tools and everything necessary to carry them out.

3. CHAPTER 3 - HOW TO IMPLEMENT THE IMPROVEMENTS

I. Introduction

As in all this thesis, we need to follow a plan or steps in order to success in our goal which is make an improvement for our company in the logistics sector.

We are going to use six different step that we show in the figure 16:



Figure 16 - Steps to implement

These steps will be very useful to follow a define plan and know what to do. Also, there is a concept very important which is change management, we will talk how to management all the improvements and change in the company.

(projectmanager.com/blog/improve-business-process)

A. Map processes:

Once you have decided which process you want to improve, document each step using a Flowchart or a Swim Lane Diagram. These tools show the steps in the process visually.

Although it can be a meticulous and complicated work, due to the difficulty involved in summarizing all the connections that occur at the level of processes within the organization, managers must develop a process map.

What is it for? The functions for the company and the staff are multiple:

- Define the strategic objectives of the company and the different departments.
- Align the objectives of each activity area with those of the company.
- Define roles and responsibilities within the template.
- Highlight all the work that is carried out by the different employees.
- Improve communication between different workers and departments, preventing the so-called silo effect from occurring.
- Determine the needs and expectations of customers.
- Identify competitive advantages of the company.
- Detect possible deviations or errors quickly and discover possible improvements in project management in terms of time or quality.

In addition, the process map allows for a global-local perspective, placing each process within the value chain framework. Simultaneously relates the purpose of the organization with the processes that manage it, so that it also serves as a learning tool for workers.

B. Analyze the process:

A direct objective of the process analysis is the improvement of them, by eliminating redundant costs and reducing the time for the completion of the cycles of the processes. But for the analysis and improvement of business processes have more possibilities to achieve the desired objectives, these steps must be carried out in accordance with the best practices of the market.

Use the flow chart or swim lane diagram to investigate the problems within the process.

First use root cause analysis, cause and effect analysis, or the 5 whys to trace the problem to its origins. After all, if we only fix the symptoms, the problems will continue.

The analysis and improvement of business processes must also comply with the interests of the interested parties, and comply with corporate governance policies, since the systematization of processes will allow directors to begin to exercise influence from key performance indicators (KPI) standard. - An audit trail will allow the adaptation of the processes to the compliance requirements.

Speak to the people who are affected by the process. What do they think is wrong with it? And what suggestions do they have for improving it?

C. Redesign the process:

Now we are going to redesign the process to eliminate and solve the problems that we exposed in the previous chapters.

The best thing we can do is work with the people who are directly involved in the process. Their ideas may reveal new approaches and also, they are going to be more likely into change if they have been involved them at an early stage.

First, make sure that everyone understands what the process is meant to do. Then, explore how we can solve the problems that we identified in step 2, Brainstorming can help us to create many new ideas. Note down everyone ideas for change, regardless of the costs involved. Then, narrow our list of possible solutions by considering how team's ideas would translate to a real-life context.

Start by conducting an impact analysis to understand the full effects of team's ideas. Then, carry out a risk analysis and a failure mode and Eeffects analysis to spot possible risks and points of failure within our redesigned process. Depending on the organization's focus, also we may want to consider customer experience mapping at this stage.

These tests will help us to understand the full consequences of each proposed idea and allow to make the right decision for everyone. Once all of the parts involved are agree on a process, create new diagrams to document each step.

D. Acquire resources:

We will need to plan all the recourses necessary for implement an improvement, we will need to do an investment, we will need the time of our workers for two things:

workers who teaches the others, and workers that have to learn. And other way to teach the people is the e-learning. We should do a list with all the recourses necessities included the mentioned before and the material resources.

All the departments should be prepared for these changes, so we will to send the list to every department and make sure they understand our propose. Furthermore, they should be convinced of all the improvement we want to do.

E. Implement and communicate changes:

Inform to the people what they have to implement the improvement it is crucial for the good improvement of the solution we said. The key is to communicate the right message, to the right audience by the right medium.

1. Create a shared purpose (What to communicate)

The fundamental thing is that everyone knows the purpose of the change, with a clear and coherent message, this must be transmitted to the organization through different channels of information, in order to achieve an alignment of the collaborators.

2. Having leaders who Communicate (Who Communicates)

The message must be embodied by the leaders of the organization, since they will be in charge of reinforcing and transmitting the purpose of the change, it is essential that they understand the importance of communication, in addition to transmitting trust and credibility.

3. Identify and listen to the different audiences (To whom it is communicated)

Organizations are complex and have different audiences, each one requires messages and specific types of information that are derived from the main message.

4. Use the most appropriate communication channels (How to communicate)

For the communication strategy to be successful in the process of change, it is necessary to think about the audience and the channels that are most effective for them.

Keep in mind that change is not always easy. People can be resistant to it, especially when it involves a process that they have been using for some time. we can use tools such as the change curve and kotter's 8-step change model to help overcome resistance to change.

F. Review the process:

Few things work perfectly, right from the start. So, after we roll out the new process, closely monitor how things are going in the weeks and months that follow, to ensure that the process is performing to expectations. This monitoring will also allow us to fix problems as they occur.

Make it a priority to ask the people involved with the new process how it is working, and what if any frustrations they are experiencing.

Adopt continuous improvement strategies such as Kaizen. Small improvements made regularly will ensure that the process stays relevant and efficient.

Change management is a structured approach to managing the aspects of change related to people and the organization to achieve the desired commercial results. Its goal is to help management, employees and stakeholders to accept and accept change in their current business environment.

This often involves making formal assessments of change impact, developing individual action plans, improving communications and providing training to counteract resistance. The result is that these plans help align the changes to the overall strategic direction of the organization.

- 1.- Lead the idea of organizational change.
- 2.- Communicate to involve: share the advantages of change.
- 3.- New organization and business culture.
- 4.- Measure success.
- 5.- Celebrate, publicize and recognize the results of the change.

III. ERP implantation

An optimal ERP is a key piece in the Digital Transformation of companies. That is why the ERP implementation project must be governed by minimums that avoid frustrating results after the efforts invested in time and money. (*Plantengineering/ how-to-
implement-a-smart-erp-system*)

- 1) Conduct a prior audit and a design of the project. You have to determine from what point you start and where you want to go. It is critical to clearly identify the processes that you want to manage and how. This task will help to control the costs of the initial implementation and will mark the project's calendar, preventing it from being perpetuated.

- 2) Select a modular and flexible ERP program. Investing in an ERP business management solution is a great bet for business accounts, so it is essential to be sure that it is not necessary to initially integrate all your capabilities, but to go little by little adding what you need. In addition, one of the advantages of having the help of a computer maintenance service specialist ERPs is that you can adapt their functions to the requirements of each company, personalizing its use to the fullest, beyond its basic configuration.
- 3) Put the maximum interest in the migration of the data. In this section, the help of an IT partner who handles this transfer from the old systems becomes crucial again, ensuring the quality and reliability of the data that will feed the new ERP and the designed processes. Likewise, it will take care of its integration with the rest of the technology solutions architecture that exists in the company.
- 4) Prioritize the choice of an intuitive commercial ERP to facilitate change management. The final users are those that will determine, to a large extent, the success of an implementation. To ensure the acceptance of a new tool, there is nothing like offering as simple a use as possible. In this sense, it is highly recommended that in the commented phases always participate some representative of the users. Your assessments will be decisive to design the most appropriate solution.
- 5) Betting on a gradual production start. Starting up an ERP program is very dangerous. Not only does it hurt the management of the change, but it can also be accompanied by unpleasant surprises by not performing as expected. The recommended thing is to go little by little, releasing in parts the global project after obtaining the appropriate validations.
- 6) Do not skimp resources in training, support and maintenance. The better you know all the features of the ERP solution and how you can customize it to suit different roles, the more effective it will be. It is something that guarantees having the help of an expert company in IT Management. And not only during the courses that are scheduled after the implementation, but in its daily use giving support to users who have doubts. To do this, establishing a help-desk service is an option that must be taken into account, as well as contracting corrective and evolutionary maintenance services that ensure the continuous updating of ERP software so that the company is always competitive.

There are several ways to develop an ERP solution to meet the needs of a company. The choice of the appropriate methodology depends on the size of the organization,

the level of personalization required, the available budget and, above all, the complexity of its processes. The choice of provider will be conditioned to a large extent by the methodology with which the organization considers it best to work. The most used are the waterfall and agile methodologies.

The time required for the implementation of an ERP is usually much longer than that of other ICT solutions. Taking into account this peculiarity, the ideal would be to collaborate with the supplier during the entire design process. The agile methodology could be the most appropriate choice in these cases.

To begin with, the supplier would not deliver the complete program, but part by part so that the employees of the company, or at least a group of them, can go testing it. This opens the door to the introduction of changes on the fly, without having to wait for the software to be delivered. It would be possible to incorporate functionalities that were not agreed at the beginning, improving the quality of the program and its usability.

However, we must be careful with the continuous implementation of new tools. One can fall into the error of lengthening the process unnecessarily, entering into an endless cycle of prototype deliveries and continuous improvements.

IV. Intelligent systems implantation

In this section we will try to turn our company into an intelligent company, that is, into a company with intelligent systems. These steps are similar to those of the ERP but we group them in four:

- Do an external audit
- Start a pilot test
- Choose an integral or individual solution
- And evaluate the results

This is the best way to begin to become aware of the environment and fine-tune your decision-making process without choking. Now we are going to look more thoroughly at each of these points.

Step 1: External audit

Our action plan must start from a deep knowledge of our starting point.

There are multiple solutions that can be dispersed in our organization and that our team may already be using in different departments to know in depth the environment, but we do not know it.

It would not be the first time this happens. Many times, we think we are more behind what is actually happening.

Doing an inventory and getting to know the starting situation will help us to sort out our priorities and establish an exit point that fits our reality.

Step 2: Create a pilot test by departments

Once we know where we are, we must create a conscious pilot test to evaluate the results of the use of tools, competitive intelligence applications and data analysis.

Here we usually have three alternatives:

- Acquire specialized training, it is about training in depth the people of our team in the use and exploitation of certain tools
- Contract external services, it is about leaving in the hands of a third party the exploration and analysis of data of our company.
- Integrate tools for the analysis of information and data. It's about incorporating certain solutions within our teams to start doing deep work with the data

A good starting point is usually to start monitoring or monitoring competitors. It's simple and it's relatively quick to start evaluating the results. In this way, we will know if we are prepared to extend the activities and applications of analysis to other fields.

It is advisable to start with an analysis activity that requires little training and from which you can obtain short-term results.

Step 3: Choose between a comprehensive solution or individual solutions

Once our pilot test is finished. It is time to make a decision. Here are two options to get started in this to create a smart company:

- Implement a comprehensive solution for everyone

- Go for independent solutions and that each department or person works with their individual solutions

Regardless of the solution we choose, we should keep in mind that both should allow us to measure and establish our key performance indicators. Otherwise we will not be moving too much towards the creation of an intelligent company.

Step 4: Evaluate the results

Once we have chosen our solution, (integral or individual) it will be good to evaluate the results of the operation of the adopted tools.

In this way we can improve what you have, discard what does not work and avoid waste time.

There are many ways to implement different intelligent systems, but I expose an easy and dynamic way to do it.

SUMMARY

The objective of this thesis is simply to investigate, propose and establish improvements for the logistics sector using 4.0 tools.

In order to carry out this work we have had to document and explain a series of concepts some more general and others more specific to be able to put ourselves in context.

We started by explaining what an organization is, what are its parts and levels to know in which area and at what level we could focus, in this case has been in the operational part of the logistics and try to remedy the inconveniences of logistics traditional

We have also explained the quality, because to know if we are improving, we must have some tool or a method to measure it and that is what quality is for. Through quality we will be able to see if through the data or KPI (Key Performance Information) we are achieving our improvement objectives or not.

We have continued explaining the fundamental tasks of logistics, its functions, how to manage it and more in depth the three important parts of it, which are: Supply, warehouse and distribution logistic.

In addition, in logistics we have tried to give a focus to work both from the point of view of a company with logistical needs both a company purely dedicated to logistics.

As this work consists of improvement through tools 4.0, we have had to put into context that is the 4.0 industry, we have also explained what these tools or methods consist of. All new technologies have to be introduced in the company continuously but with a clear plan of action.

In the main part of our work we have researched the traditional logistics to understand what the main problems are, arriving at the conclusion that there are two: predict the capacity of the demand and last mile logistics. We have tried to explain these two problems in a simple but very specific way.

As is logical, once we have exposed the problems, we have tried to propose specific solutions using the 4.0 tools, these improvements are to implement an ERP and make our company a smart company using intelligent systems. Each of these two solutions we have tried to define and understand them to later know that it would improve in our company.

Continuing with the work, once exposed the solutions we have described what would be the improvements and what impacts they would have on our company, we have concluded that they would improve the quality since as we have said before the improvements are made with the purpose of improving and there is no better way to improve than using quality. We would also improve our planification and because of this, we would obtain better economic results in the future since we improve both our efficiency and our productivity.

In the last chapter of this thesis we have tried to implement the obtained improvements. We have done it through a plan to follow, as is logical, this plan consists of a series of simple steps that have as a final goal to make the implementation of these improvements simple.

The issue we have dealt with in this last part is very important, as is the management of change and learning to put workers in favor of improvements so that everything is easier.

To finish this work, I want to add that the theory is always necessary and have a structured head that is going to improve and why, but you also have to know that in practice everything changes and you have to be provided with solutions for small obstacles or impediments in the way that involves introducing improvements in a company.

REFERENCES

- 1) Strategic Management by Pearce and Robinson
- 2) Project management : a systems approach to planning, scheduling and controlling / Harold Kerzner
- 3) <https://iedunote.com/strategic-planning-process>
- 4) Juran's quality handbook / ed. Joseph M. Juran, A. Blanton Godfrey
- 5) <https://www.orientstat.com/blog/medical-device-qms-overview/qms>
- 6) <https://quality-one.com/fmeca/>
- 7) <https://www.hdcusa.com/news/history-of-logistics-distribution-and-supply-chain-management/>
- 8) <https://www.scmwizard.com/functions-of-logistics/> Logistics & supply chain management / Martin Christopher)
- 9) Logística integral : la gestión operativa de la empresa by Julio Juan Anaya Tejero
- 10) Logistics & supply chain management / Martin Christopher.
- 11) Supply Chain Logistics Management / Donald J. Bowersox, David J. Closs, M. Bixby Cooper.
- 12) The Management of Business Logistics : A Supply Chain Perspective / John J. Coyle, Edward J. Bardi, C. John (jr) Langley.
- 13) <https://www.doingebusiness.es/2017/06/05/>
- 14) The Definitive Guide to MongoDB: The NoSQL Database for Cloud and Desktop Computing by Plugge, Membrey, & Hawkins
- 15) <https://www.entrepreneurshipinbox.com/902/entrepreneurial-forecasting-demand-forecasting/>
- 16) <https://www.houseofbots.com/news-detail/4237-1-top-10-predictions-for-ai-big-data-and-analytics-in-2018-19>
- 17) ERP : tools, techniques and applications for integrating the supply chain / Carol A. Ptak
- 18) <https://ehopper.com/articles/what-is-an-erp-system-and-how-does-it-work/>

- 19) https://www.tutorialspoint.com/artificial_intelligence/artificial_intelligent_systems.htm
- 20) Juran's quality handbook : the complete guide to performance excellence / Joseph M. Juran, Joseph A. De Feo.
- 21) Quality and environmental management - continuous change of paradigms / ed. by Jerzy Lewandowski, Zbigniew Wiśniewski.
- 22) <https://www.projectmanager.com/blog/improve-business-process>
- 23) <https://www.plantengineering.com/articles/how-to-implement-a-smart-erp-system/>