SAPIENZA
UNIVERSITÀ DI ROMA

Business Process Re-Engineering (BPR) of the supply chain of an e-Commerce company

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Summary

Introduction

This work has been planned to re-engineer the supply chain of a Company in the e-Commerce sector redefining its existing logistics processes, whereas it is necessary, in order to improve both the Company's aims (efficiency) and the customers' satisfaction (effectiveness).

It deals with the international trade, focusing on the distribution chain through which a product moves from the supplier to the customer.

Before treating the real company case, it was necessary to understand how this kind of company works in this sector, which its aims and strategies are to have comparison guidelines.

The main aim of this work is to analyse the total landed costs and the warehousing costs that affect a company in the inbound process and to know how each cost component referred to each phase of the supply chain influences the selling price of a single unit.

An analysis of the costs was done first for a generic company, and then for Brico Bravo the company interested. A model on variable direct costs was created to define the price per unit and later to have a comparison with the one defined by the company.

Then, the import process efficiency were analyzed through different parameters that have the highest influence on costs. By working on these parameters it is possible to reduce the inbound cost for each article and improve the price definition knowing how a single article cost.

Chapter 1 introduces the e-Commerce sector, its development in the last decade and explains the drawbacks that affect it. It introduces the importance of the logistics sector and its influence on the e-commerce sector.

Chapter 2 presents how the logistics is tied to e-Commerce. After a general introduction about the supply chain management and its phase procedures needed to the e-Commerce success, the main aspects that influence the e-commerce success are shown and discussed.

Chapter 3 presents the methodological approach through which the work has been treated. It shows the passages to reach a solution, the method adopted and explains the re-engineering process in a company and the method adopted.

As the inbound costs represent the main object of this work, a detailed panoramic view of theirs has been introduced.

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Chapter 4 deals with the cost model realized. The model considers all the costs affecting a company in the inbound process and thanks to it, an estimation of the cost per article unit was possible.

Chapter 5 deals with Brico Bravo case. The method represented in the previous chapter was actualized and Brico Bravo inbound costs analysis was done. Through it, it was possible to know functions and processes and a functional organigram was realized in order to have a panoramic view of the total processes and their connections. The re-engineering method was applied to the case and the results analysed.

Chapter 6 introduces the possible improvements for the company in order to increase its efficiency.

Chapter 7 deals with the conclusions of this work.

Considering that the growth of a company, especially in this sector, is based on the customer satisfaction, the result attended is the optimization of the whole process, which means the reduction of management costs, keeping high standard service as required by customers.

1 E-Commerce and logistics

1.1 The e-Commerce sector

The e-Commerce (Electronic Commerce) sector deals with all the business done by internet, as the sales or the purchase of goods, services carried out by the company, costumers and/or public institutions.

During the recent decades, a continuous growth of the online sales retail both in Italy and in international level has been seen. It is a sector strictly closed to the satisfaction of the customer and has to establish with him a strong and durable relationship. A lot of e-Commerce projects fail or remain unfinished because of shipping staff not so professional and organized shipping staff.

In Italy, the development of the e-Commerce business needed longer time because of the different business organization composed of firms with less than 10 employees. The lack of commercial and marketing politics, of resources to relate to the new digital instruments, has reduced the possibility of approach to this new market.

Nevertheless, the number of companies that are starting this new business is growing up. It is connected to the growth of users of internet but mainly it is the result of the compromise between the needs of the customers and the flexibility of the shipping service available.

In Italy, 42,6 million people declare the possibility to use internet by computer or phone. The latter has surpassed the use of the computer. The numbers respectively are 36,4 and 35,4 million. The use of the phone has grown of the 11,5 % respectively to 2015.

The e-Commerce sales volume shows positive results for all the sector, but the general growth is less than the one of the previous year. It is because of some sectors as home, fashion, home furnishings and food, where the sales are still not so developed and so the supply is insufficient while sectors as tourism and free time are growing rapidly.

1.2 The main issues of e-Commerce

Through research and statistics data, some of the most common problems that can arise during the activity are represented.

-*FAKE WEBSITE*: The existence of fake website reduces the potential consumer's confidence to shop online.

-*PAYMENT METHOD*: The payment methods as well may provoke discomfort to the customer. Possible hackers and frauds reduce the security of the online purchase. Additional reasons are limited ways of payment and the difficult procedures.

-*CARRIER:* The carrier does not comply with the company needs. It should be established a sort of cooperation among carriers because each of them offers a specific service especially in the transport of small, medium and big parcels. Another limit is the offer of supply services like delivery on appointment, the customer is informed of the delivery a short time in advance and he has no possibility to change the place of delivery, if necessary. Carriers do not deliver at evening time and on Saturdays.

-*PRODUCT:* Problems connected to the product can be shortage in store, so the customer does not find what he wants, limited information about the product or the latter is not in line with what has been required (It does not correspond to the demand).

-*PACKAGES:* A bad or inadequate package can cause damage to the product and consequently complaints and its return by customer.

-*DELIVERY:* The delivery phase can have various problems. It may happen that some parcels are lost or delivered to wrong addresses. Delivery is a delicate matter and most customers require delivery at home. It may happen that the package is delivered when the customer is not at home, because of a delay that can be caused either by the carrier or by the company's organization chain. The main reason is the lack of control by the company on the carrier.

-*POSTSALE SERVICE:* A critical point is the return of the product (RMA) and mainly the time connected with it.

1.3 The importance of logistics and supply chain management

The logistics sector is the base of the online sale system. It covers all the activities, processes and resources of the transfer of goods from the company to the final consumer. Logistics transforms a virtual order into a real object through a well managed supply chain. It deals not only with the physical activities within all the facilities and the transport

services to ship the goods, but also the distributions of the information and data flow between the different companies and within the leader company. A good information exchange helps the coordination of the activities and it is fundamental for the improvement of the service provided.

Logistics system for the delivery of online purchase has been and will be a key element to improve e-Commerce in Europe.

In the chapter below, it will be represented how a company works to provide a service.

2 Logistics key elements to improve e-Commerce

2.1 Introduction

In the e-Commerce sector, the companies aim is to guarantee high levels of services and the highest quality of products to the customer trying to minimize total costs. This aim is achievable through an efficient supply chain management.

The supply Chain represents all the processes beyond an order lead the customer to get his product. It involves all the facilities as: supplier, manufacturing centers, warehouses, distribution centers and stores and their processes. It can be considered a Logistics network.

"The supply chain management is a set of approaches utilized to efficiently integrate suppliers, manufacturers, warehouses, and stores, so that merchandise is produced and distributed at the right quantities, to the right locations, and at the right time, in order to minimize system wide costs while satisfying service level requirement."

Q. … Designing and Management the Supply Chain

As the definition above underlines, the main object of the supply chain management is to manage each facility and process in order to minimize total cost and at the same time maintain a high level of service.

The configuration of a supply Chain can vary according to the product dealt with. The figure 1 shows the physical flow from the raw material to the final distribution of a finished product.

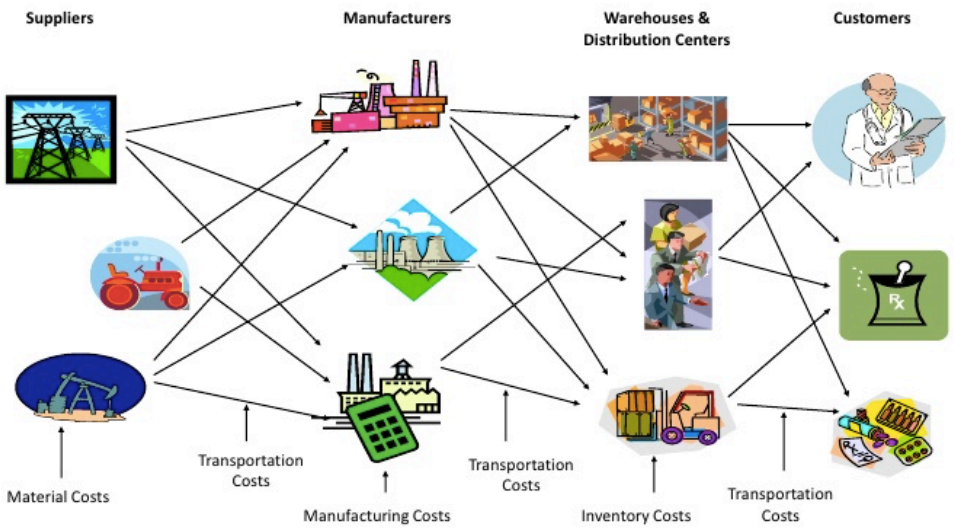


Figure 1: Supply chain management

To improve the service provided, it's necessary a good supply chain management.
A typical logistics cycle in a Company of the e-Commerce sector considers three macro activities: Procurement phase (Inbound), warehousing and delivery (outbound) phase. In easier view, these activities involve three actors as: supplier, company and costumers. When we analyze the supply chain it is important to verify if each actor contributes to a common aim or a personal aim.

2.1.1 Procurement phase

This phase starts with the selection of the supplier and the purchase of goods by the company.
At the beginning of its import market relations, a company has to select which kind of products to deal with and later identify a good and reliable supplier.
The product choice is done according to what the company has concern with and what kind of product is required by the market.
It's necessary to verify whether the products are conformed to the European market. So, we can say that, to agree for a good purchase price is useless if the products, once the goods arrived in Europe, are illegal.
It's important that the company asks certificates of tests granted by a European lab to the supplier. Once the supplier has been chosen, and consequently the products needed, it is fundamental that the company asks the supplier a correct and detailed list of the specifics that the goods should have. The list always reports design, quality and required features. It is necessary to be precise and clear so that the supplier doesn't have free venture about the list and in this way preventing the possible uses of no standard material unknown to us.
It is suitable to get in touch with various suppliers to avoid you find yourself without goods if something goes wrong.
When everything has been verified, the company places the order.
With the order of the company, the supplier needs and asks for materials to its suppliers. So, the production starts.
When the goods are ready, they are shipped to the port or to the airport. The airplane and the ship are usually the most common freight transport means for import orders. The two differ on speed and quantity shipped. The choice depends on the typology of goods.

With maritime transport, good are organized in unit of load (usually Boxes) and put in the container (another unit of load). The boxes are organized so that the container volume is totally empty so having economy of scale for the transport costs.
The containers are boarded on a truck, shipped to the port from the manufacturer and boarded on the ship.
At this moment, the shipping agent comes into view.
Once the goods have arrived at the destination port, they are unloaded and moved to the designated position waiting for the customs clearance.
Finally, the goods are ready to be shipped to the company's warehouses. The procurement phase ends when the goods cross the warehouse gate.

2.1.2 Warehousing

It has a fundamental role in the logistics chain especially for the distribution phase to the customers. In a simple way, we can say that the aim of a warehouse is to transform the inbound products in outbound products.
Inside the warehouse various activities are done in order to handle, move and prepare the inbound products for the final shipment.
Below all the activities done will be described.
RECEVING: When the truck arrives at the warehouse, the carrier consigns the document of transport related to the goods to the main gate. The officer controls the unload gate dedicated to those goods and shows it to the carrier. Once the truck is stopped at the unload gate, the goods are unloaded. The warehouse worker checks either the quality and the quantity of the goods are the same of those reported on the copy of purchase or not. Once the check has been done a delivery document is released and sent to the administration.
PUT-AWAY: Usually each pallet or each box contains units of a single product. According to the goods, the warehouse worker moves them to the dedicated positions.
STORAGE: The storage phase means the occupation of the products within the warehouse. It is related to the time but also it depends on the warehouse organization.
It is possible to distinguish two main warehouse storage typologies: Block stacking (figure 2) and Racked storage (figure 3).
The former does not require a storage equipment in fact pallets or boxes are stocked on the floor building up stacks to a maximum stable storage height. Lanes are created to have access to the different stock keeping units (SKUs).

The maximum height depends on different factors as: strength, weight and stability of the load, pallets condition, safety limits, weather (humidity wind ..) and of course warehousing height.

It is important to organize the space planning length and depth of the lanes in order to avoid under-used space. In fact, when units are picked, the space created cannot be used until the entire lane is cleared.

Figure 2:Block stacking

Figure 3:Racked storage

ORDER PICKING: Customers order gets to the warehouse, the officer downloads it and prints all the documents to go with the product. At this point, the warehouse workers pick up the object from its dedicated position.

There are two different picking strategies: FIFO and LIFO.

The FIFO (First In First Out) strategy means that the picking is done considering the arrival order of the products into the warehouse. Thus, the warehouse workers pick up the product unit that has been there for longer.

With LIFO (Last In First Out) strategy, the product unit picked up is one of the last ones got into the warehouse.

FIFO is the most common strategy because the fist goods acquired has usually to be the first consumed or sold in order to avoid the obsolescence phenomenon and the expiration data for perishable products.

PACKAGE: Each product must be packed before being shipped.

LOADING: At this point, each product is moved to the loading area and then it is loaded on the courier's truck with its documents.

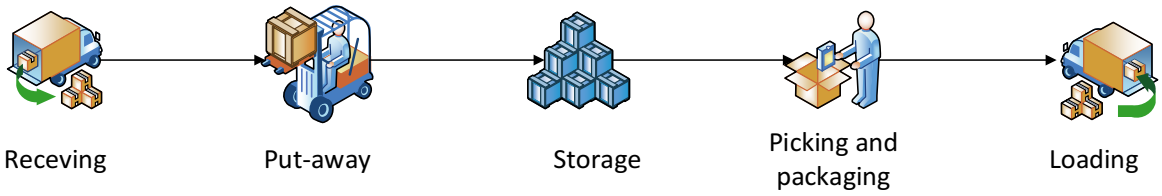


Figure 4: Warehouse activities

2.1.3 Delivery phase

The delivery phase can be considered the most delicate. As said before, in this phase the customer has a direct contact with the company and he evaluates his satisfaction in part according to delivery service.

The e-Commerce sector bases its success above all on the delivery service improvement. Thanks to the latter, people have started to be in confidence with online market and to consider it favorable.

During the years, a lot of measures of improvement have been introduced for the last mile delivery but the customer has become more and more difficult to please and the company had to satisfy his needs because this service is a key competitor between companies dealing with the same products. In fact, the variety of delivery options and the its perceived quality are major decision criteria for online customers.

The different delivery options are based on the delivery time and on the cost of the service. Basing on these, it is possible to consider four customer typologies as: Customers who prefer the cheapest form of home delivery, customers who prefer the delivery in the same

day, customers who base on reliability e.g. time window and who prefer to pay more to have an instant delivery.
Despite an increasing of the same day and instant deliveries, studies have seen that the customer's choice based on the cost keeps the major role with the 50% of customers while other 20% on the cheapest form of delivery home.
The delivery service based its success on four main aspects that are:

- Cost: For a business company, last mile costs are about 30% of the delivery total cost and often are passed on to the customer.
- Transparency: The customer wants to track his product during the delivery. Delivery companies began to generate tracking codes in order to check the delivery status. Now tracking codes don't satisfy customers anymore. They want to have full visibility in real-time. They would like to know where the driver is and when he arrives with at least a four-hour window to wait for their parcel.
- Efficiency: To be successful it is important to satisfy the customer so to improve the efficiency it is necessary to implement a faster delivery. Efficiency can be increased through the supply chain management but regarding to the delivery phase above all the last mile, technology is the key.

Let's focus our attention on the outstanding features a company has to have so that the online sale is successful. A successful E-commerce has to have a practical and simple website, together with a very good SEO and a marketing plane. Also a logistics plane is necessary. Let's represent the main features to be evaluated. It is good to consider the functionality, the service's quality and costs that will be high.

2.2 Models and strategies for a company's supply chain

The first step to have a successful supply chain is to define the most suitable models of supply chain management according to its own needs and resources. To evaluate the correct model and strategy, it is fundamental to avoid bankruptcy.
There are different processes of treatment of the product according to the level of complexity and functionality.
In case is the first time that people approach to E-commerce with no economic and/or physical capacities to manage a warehouse and the shipping, delivery and packaging phases, they apply to a *dropshipper*, that is, the supplier handles the final distribution to

the customer. The seller, in this case the company, advertises the product. The order goes directly to the supplier that provides the shipping.

In House is another model, it needs high management costs because it manages the whole logistics chain. So, the company has its own warehouse and its own courier for the final delivery to the customer. The advantages are high. The company has the full control of the total management processes of an order and so it is the only responsible for the of the relationship with the customer.

Another common model is *Outsourcing.* In this case, the company entrusts to a third party with some phases of the logistics chain. The company buys products from national and international suppliers keeping the inventory update than entrust to an external courier with the shipping and very often to an external logistics with the treatment of the product and the preparation of the orders. Only few people can afford their own warehouse but of course goods belong to the seller. Applying to logistics suppliers specialized in a single activity, the company is sure to have a high quality level service that can manage at the best large quantities of products and complex operations. The drawback of the outsourcing model is to lose control on the various logistics phases and the difficulty to integrate and/or synchronize internal and external information systems. The information system is an additional instrument that has to work with the logistics model, website management and marketing activities. It controls stores, data and processes of the whole distribution chain. House model controls directly every phase, it is easier a single and well organized information system. If the company adopts a different model it is necessary to connect the various information systems managing different activities and logistics suppliers, trying to organize their work in a synergetic way.

Distribution strategy

The organization of the facilities and processes network can vary depending on the typology of the network. It can be distinguished in centralized supply network versus decentralized supply network. The former is characterized by a system where decisions are made at a central location and are addressed to all facilities and processes. It means that the information passes through the central company and all the activities are made to reach a unique common aim that is to reduce costs of service assuring a high level of service. This kind of model, usually means that there is a company owner of the all facilities, but it is possible that a company works together with other partners sharing the aims and so working to reach it.

The various facilities, in a decentralized supply network, have usually different aims, and it leads to a local optimization instead of a global one. Each facility has its own strategies and not always share information with the others. They can't have access to the same data as happens in the centralized supply network.

As far as the distribution of goods is concerned, there are different ways to deliver the product to the customer known as Direct shipment, warehousing and cross-docking, but as I deal with an E-commerce sector, the only possibility is to use a warehouse. The other ones refer to the distribution to retail stores.

The distribution system can be identified once again as push distribution system or pull distribution system.

In a push distribution system, the company makes an order to the manufacturer basing on an accurate forecast of the external demand. Thus, the manufacturer starts the production. This system is characterized by a long time to reply to the changing of the external demand.

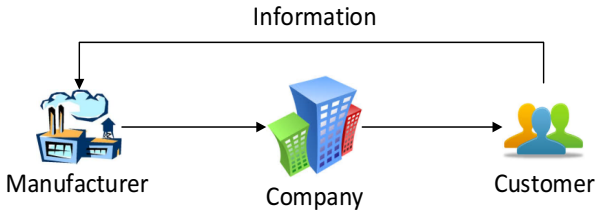


Figure 5: Push system

The picture above represents the process of a push distribution system. As we can see, the order starts from the company's retailer.

The pull distribution system sees a direct exchange of information between the external demand and the manufacturer as shown in the figure below.

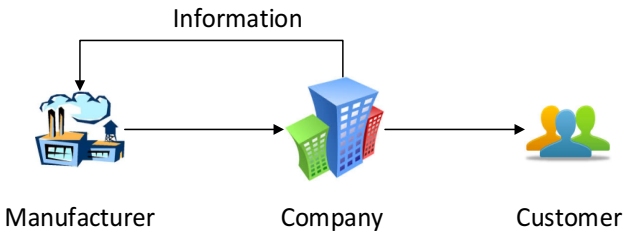


Figure 6: Pull system

As we can see, the manufacturer doesn't wait for the order of the company, but he moves up the production according to the external demand. It is necessary a fast information flow.

Of course, each system has both advantages and disadvantages.

The push system needs of long-term forecasts. It means that from the moment that the company starts the forecast and makes the order, a long time has passed. In this way if the marketplace changes and some products are no longer required, it takes time to reply to this change. So it has to deal with the obsolescence of the inventory.

Furthermore, considering that the variability demand of the retailer and warehouses is larger than in customer demand (Bullwhip effect), the company's warehouses can wind up with high inventory level due to the need of large safety stock. High manufactory costs due to more production batches need for emergency production changeovers; high transportation costs, unacceptable service levels and product obsolescence are to be considered.

The pull system seems to be more useful because moving up the order from the retailer the lead time can decrease, consequently decreasing variability and the inventory level.

All these advantages bring a reduction in system costs. On the other hand, it is difficult to take advantage of economies of scale in manufacturing and transportation if the system is not planned far ahead in time.

2.3 Level of service (LOS)

As said above, the E-commerce sector is revolved around on the customers' satisfaction of the service offered based mainly on the delivery service, the only phase when there is a direct contact between the customer and the company.

The key points for a good service are variety, speed, accuracy and punctuality.

Variety refers to the ability to offer a wide range of products and with enough quantity to fulfill the customer's requirement.

Speed is related to the time of delivery that usually is 24/48 hours within the country. Time of delivery is known as Leadtime and consist in the headway between the instant the customer makes the order and the instant he gets the product.

Accuracy/Precision is reliability of the company to deliver the product that the customer has required, in good condition, avoiding his complaints and replacement costs.

Then punctuality, that means observance of the delivery data and time given to the customer.

2.4 Purchase conditions

Before analyzing costs, it is necessary to clear up a very important aspect, that is, to say who is in charge of the goods during the distribution chain. The choice depends on the buyer basing on his experience, money and necessities. Obviously, every choice will have pros and cons. For example, an experienced buyer would rely on external companies as the supplier or other logistics companies. In these cases a lot of handling problems will be solves but costs will be higher and the control of the goods will be lost.

In order to simplify contract terms between the supplier and the buyer people usually turn to *Incoterms,* acronym of International Commercial Terms are a set of codes aimed to regulate the responsibilities of various subjects in international trade (Import-Export). Every Incoterm specifies when and how the responsibilities pass from the supplier to the importer.

Here follow some of the most common Incoterms.

- EXW (Ex Works) this code represents the situation in which the only cost of the supplier are the production ones. It is the importer who is in charge of the transport and import expenses to his warehouse. Next to the code usually comes the production place. Here attached the distribution costs not paid by the supplier.
    - Cost of the export customs duty: Not included
    - Costs of transport to the origin port in china: not included
    - Cost of transport to the destination port: not included
    - Cost of discharge of the goods in import country: Not included
    - Cost of transport from the port of destination to the import warehouse: Not include
    - Cost of insurance of the goods: Not included

- FOB (Free On Board): In this case the supplier will be in charge of the transport expenses to shipping port in his country and the customs expenses for the export. When goods are on board, the responsibilities is of the importer. Differently from EXW it is not shown the place of the production but the departure port. Below are shown some costs included and excluded in the contract with the supplier.

- Cost of the export customs license: Included
- Cost of transport to the origin port in china: Included
- Cost of transport to the destination port: Not included
- Costs of discharge in import country: Not included
- Cost of transport from the destination port to the Import warehouse: Not included
- Costs of insurance of the goods: Not included

Very often, the most popular code is FOB as companies avoid to get into a foreign market where it is not easy to evaluate, handle and control export procedures from their home country.

2.5 Exchange rate

When the company purchases from a country outside the EU, it has to pay the good with an international coin that in this case is the American dollar. It is a very important aspect because the currency exchange can vary during the time and it can affect the total cost of the good

considering that from the moment that the company make the order and it pays the good can pass more than one month.

Many companies found their commercial strategies on the basis of the trend of the currency. Given that the company has no capital in dollars, it asks to the bank an account in foreign currency to pay the supplier. Studying and evaluating the trend, the company can decide whether set an interest rate of change at the deadline or steady under agreement. So, in the first case, the company hopes that the interest rate is go down at the moment it has to pay, while with the agreement, it makes sure to pay the good as established at the beginning.

3 Methodological approach

3.1 Overview

Three decisional levels are proposed to represent the company, above all its distributions processes both inbound and outbound in order to know in analytic and complete way its supply chain. The knowledge and the modelling of the present supply chain is important to value how to optimize and have possible developments.

The three decisional levels are:

1-The Company's plan of actions (ex: Customer service, supply chain network..)

2- The Network (ex: Infrastructures, information devices..)

3- The functions (ex: processes, activities..)

As first analysis it is shown how the company works now on the various levels.

The optimization means the improvement of the company's processes in order to minimize the total costs maintaining the level of service. So, it is necessary to propose changes. They can be basic changes to the existing processes or the introduction of new processes.

It will need the collaboration of the Brico Bravo managers and external partner to get information and data. There has been a cooperative work to define what is necessary and to evaluate if the change proposed is suitable.

To define the changes, a BPR (Business Process Re-engineering) intervention will be used. It is the re-organization of the company's processes that are not more suitable to the company needs, with the help of the coordination and the support of the new technologies.

Re-engineering is based on some principles as for example:

- *Delete instead of automatizing: duplicates and less relevant activities are eliminated.*
- *Unify various activities: The unification of different duties allowed by technology and by the growth of the staff allows to give more complete duties.*
- *Evaluate the results and start again: the change must become a natural condition of the organization. You must adopt a dynamic idea for a continuo adaptation of the market processes.*

The figure below shows typical phases in a Re-engineering process adapted to our work

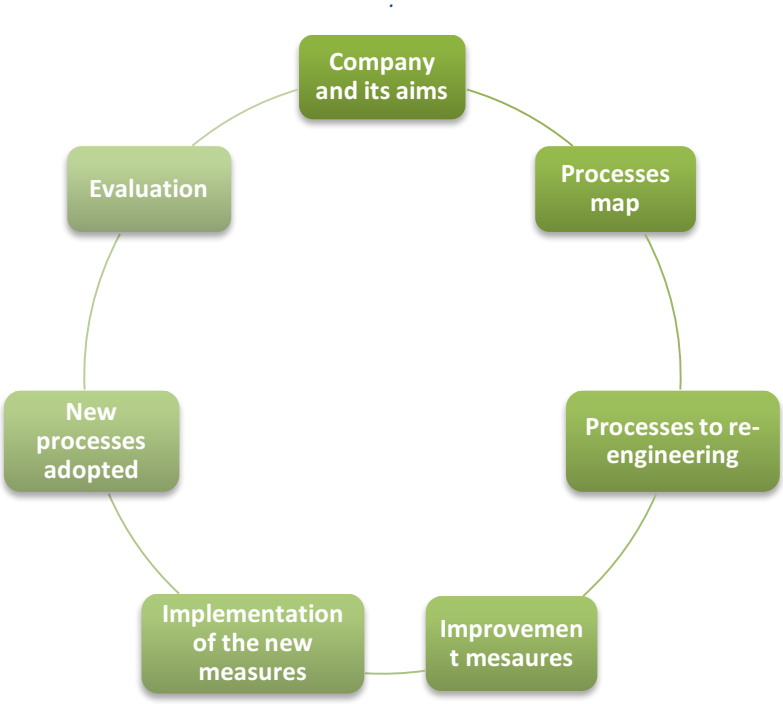


Figure 7: Re-engineering process

1. First of all, it is necessary to identify the company and its market aims, how it works, who its partners are and above all its customers. The analysis of the company provides a first phase of data research and a second one of elaboration.

2. Once all information and data have been obtained, the processes mapping will be done. The processes will be represented in detail including the area of expertise in which they work and all the activities. "*The Functional decomposition diagram"* method will be adopted and each process, activity and function will be described.

3. At this point, it is necessary an evaluation of processes, activities and functions to identify the critical ones or minor performances. Performance indicators will be determined and the results in terms of quality and costs will be evaluated.

4. Once the critical points are identified, improvement measures will be proposed. They could be interesting for the organization structure but also for the technological systems through which the information is managed.

5. The new processes will be adapted to the company structure.

6. The processes proposed will be adopted by the company.
7. The last phase provides the results monitoring over time, checking whether the change has brought to an improvement in terms of costs and quality to the company.

3.2 Functional decomposition diagram

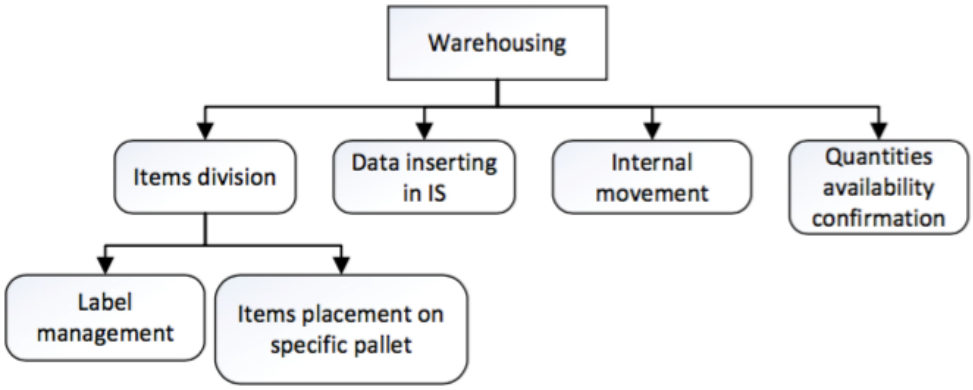
Through the "functional decomposition diagram" method, the general view of functions an processes in the company are shown. The diagram has been broken up in various levels and each one has been combined with a own detail description.

FDD Legend

They are collection of transversal processes of the organization. It is usually to define function both the department in which an organization is divided and the main company processes. Functions may include also subfunction equally by a rettangle.

As organization are complex the use of subfunction gives the possibility to divided functions in more simple components so that it is easier to understand and plan them.

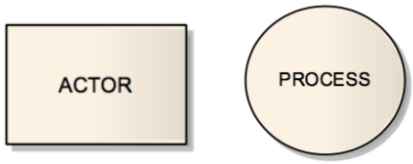
A process is a group of concrete activity following one another exchanging data and information to get a final result. Processes to, where necessary, have been divided into subprocesses.



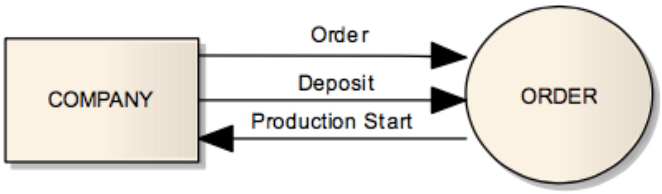
DFD, Step 2: Processes of the subfunction WAREHOUSING of the main function LOGISTISCS AND TRANSPORT

In a process level, process models are shown through "Data flow diagram" which represent both the activities flow and how data and information move between them.

DFD Legend

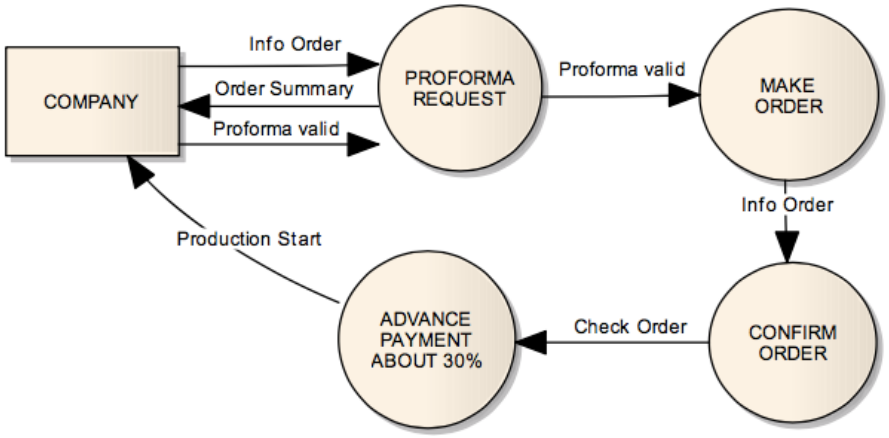


For each process, a "Context diagram" is represented. It shows process input and output data flow of a single process.



*Context diagram of the **Order** process*

Also a " Level 0 diagram" has been realized. It shows a more detailed process with its own activities flow and data and information exchange between them.



*Level 0, **order** process*

3.3 Inbound costs modelling

It's important to represent and describe the cost structure within an e-Commerce company before introducing the model cost used for this work.

Cost management is a fundamental aspect for a company success. A good cost allocation to the services and products is crucial to evaluate the company performances during the time.

Indeed, as you will see, product-line and pricing decisions, that determine the product profitability, are affected by a good cost allocation and by the market.

For this work, costs have been divided in four main categories: fix, variable, direct and indirect costs.

- Fix costs: They are above all linked to structural costs as vehicles, warehouse rent, headquarter bills.. They are independent from the volume of the goods produced and vary when the maximum productive capacity is reached.
- Variable costs: They are linked to the goods volume handling as transportation and logistics cost. They increase proportionally to the volume.

About direct and indirect costs, it is crucial to evaluate them to define the cost objective. The cost objective is the purpose for which a cost is measured but it is true that a given cost can be direct for a cost objective and indirect for another. Usually for an e-Commerce company it is the customer. But it can be different from company to company.

Typical cost objectives are customers, products, services and departments.

It is possible define direct and indirect costs as follows:

- Direct costs: Costs directly linked to the company cost objective
- Indirect costs: Costs indirectly linked to the company cost objective

In this work only the direct variable costs have been considered and have been divided in Inbound and Outbound costs. They represent the total costs needed for the shipping of goods from the supplier to the customer.

As we will see, an e-Commerce company usually collaborates with other service providers. Then, the company pays a fixed tariff to get a service. In this section, It has been favorable to introduce a panoramic view of the different types of costs that affect the service rate agreed with the service providers.

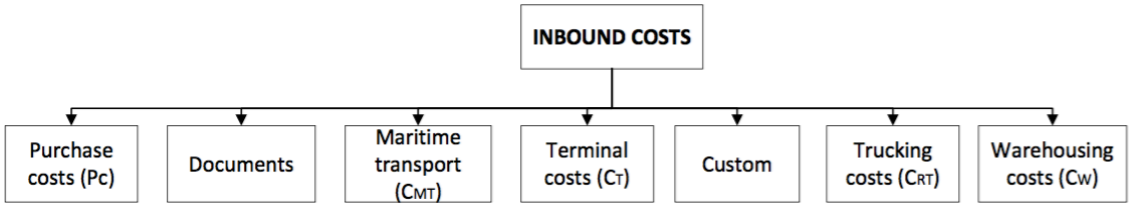


Figure 8: Inbound costs

3.3.1 The purchase price

The purchase cost of a product is the cost that the buyer pays to get the unit. Often, the selling price per unit varies according to the quantity. The more substantial is the order, the cheaper the price is **(€/unit)**.

The total cost of the order and cost per unit are clearly shown on the commercial invoice and as said above, they can be different according to the Incoterms adopted.

When you are making a deal with a supplier about the purchase cost, if you are looking for a further discount it is necessary not to show the supplier that he is the only one because if he is sure that the agreement will be done, he will not be incline to negotiate again. On the other hand, if he realizes that the agreement can vanish he will be more subsidized.

3.3.2 Documents for the exportation

An international trade needs various documents and they can vary significantly depending on the destination and the goods shipped. The buyer provides the seller data and information about the documents needed.

All the documents are divided into three categories: Commercial, transport and financial documents. Some of them are described below.

COMMERCIAL DOCUMENTS

Commercial Invoice: It is the invoice of a payment issued that the exporter sends to the importer, it contains all the information about the international trade: units, quantity, price for the service sold, delivery and payment conditions and other expenses that might be included in the sale.

The importer has the original commercial invoice and through this he declares to the tax authority of his country the amount that he must pay, who is going to pay to and the agreed means of payment. For the exporter, this document is a proof of a sale made in a foreign country.

Packing list: This document is a more detailed version of the Commercial invoice but it shows nothing about costs. In addition, it contains: quantity and description of the goods, weight of the goods, invoice number, number of packages and shipping marks and numbers.

It is prepared by the exporter and sent to the importer, the carrier and the import customs clearance.

Insurance policy: It shows the insurance that covers loss and/or damages of the goods shipped. It contains all the details and clauses of the insurance coverage.

TRANSPORT DOCUMENTS

Bill of landing B/L: It is a document that certifies a contract between the shipper agent and the carrier. The customer usually needs the original copy as a proof of ownership to get the goods.

3.3.3 Transportation from the Supplier's manufacturer to the origin port

Once the goods have been produced, the supplier has to organize the shipping from the manufacturer to the port. Usually the transport cost varies according to the distance travelled.

3.3.4 Shipment costs

The shipment costs refer to the operational cost at the moment the goods is arrived at origin port and has be loaded into the vessel.

3.3.5 Insurance premium

It would be advisable to have an insurance, If you don't want to suffer the loss or the damage of goods during the maritime transport. Its premium varies according to the ship company chosen.

It is possible to adopt an Incoterm as CIF (Cost Insurance Freight) which implies that the supplier deals with the cheaper insurance in addition to the transport costs from the manufacturer to the destination port.

The most common way is to take out an insurance through the shipping agent. Thus, you can define what kind of insurance you need, which phases are covered and at the same time you have higher control on it.

Usually the insurance cost is the 0.5%-0.6% of the good value. Below, are shown two models to calculate the insurance cost for the two possible cases described above. It is important to say that each element is refer to a container.

3.3.6 Maritime Transport

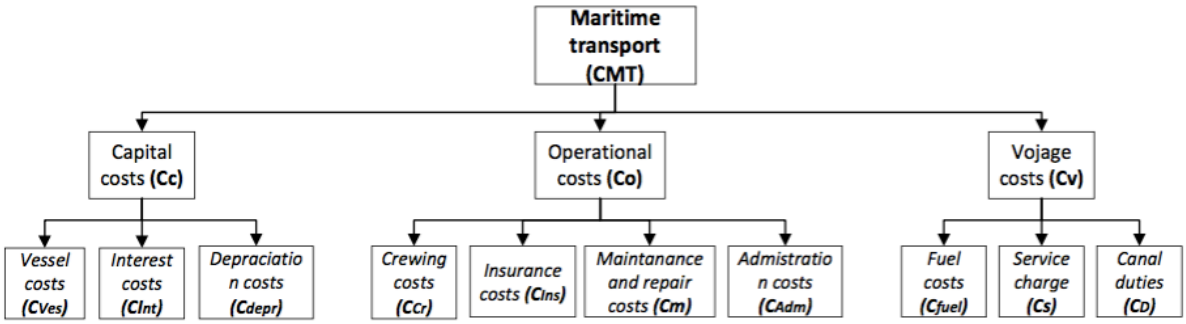


Figure 9: Maritime transport costs

In an International trade market, the maritime transport is fundamental to ship a high number of containers. So, the higher is the number of the units of load, the higher is the economy of scale. One of the drawbacks is the service speed. An international ship can need 30-40 days to arrive at the destination port, it depends on the route.

Transport costs vary widely according to the different products and the different countries of origin and destination.

The transport firm adopts a model of costs based on the route. Back to the movement of a ship there are different operations and relative costs which have been covered by the service rate.

A company pays an amount depending on the number of its own containers.

Usually the cost refers to each TEU (Twenty feet Equivalent Unit-**$/TEU**) and can vary according to the route.

Transport costs can also be evaluated considering the cost per ton **($/ton**) instead of TEU, it depends on the shipped material and, furthermore, it is modified considering the distance **($/ton - km**).

To evaluate shipping costs, various factors have to be considered for the transport firm as it is represented below.

$$C_T = C_C + C_O + C_V$$

C_T = Transport costs
C_c = Capital costs
C_o = Operation costs
C_v = Voyage costs

It is possible to divide them in Capital costs, Operating costs and Voyage costs.

The capital cost is the ship price that can be for a new building or a second-hand vessel**(€/vessel)**. The cost of a second-hand vessel varies according to the new building price. The latter is affected by the ship building demand and supply and of course by the vessel capacity.

$$C_C = C_{ves} + C_{Int} + C_{depr}$$

C_{Ves} = Vessel price
C_{Int} = Interest costs

The ship purchase needs a high amount and usually the company pays it through credit bank loans and the interest rate on credit is very high. It is necessary to take them into consideration in order to evaluate the depreciation.

C_{Depr} = Depreciation costs

The operation costs concern all the cost items needed to use a vessel as: crewing **(€/hour)**, insurance **(€/year)**, repair, maintenance and administration costs.

$$C_O = C_{CR} + C_I + C_M + C_A$$

C_{CR} = Crewing costs

A crew cost model depends on different aspects as size and type of the ship, the number of the crew, the distributions of the crew members between ranks and trades. Furthermore, it varies from country to country according to the pay rates for the different grades and the cost of the allowances.

C_I = Insurance cost

To evaluate the insurance premium is not simple. It depends on type and size of the ship and external factors which have a large influence on the premium.

Some of the major external factor identified are: commodity carried, route sailed, ship operator and size of excess included in the policy.

Usually the underwriters evaluate the insurance premium considering three different premiums known as: Hull, Protection and Indemnity and war premium. Each of them is calculated through a different method related to the type of risk involved.

C_M = Repair and maintenance costs

C_A = Administration costs

Finally, there are variable costs as: fuel costs **(€/t)**, service charges **(€)** and port and canal dues **(€)**.

These are known as **Voyage costs**.

$$C_V = C_F + C_S + C_D$$

C_F = Fuel costs (per day)

C_S = Service charges (Accommodation, stores, lubricants ..)

C_D = Canal dues

Ships have to pay fees for the use of service and facilities. The amount depends on the vessel and the cargo and to evaluate it is necessary to consider volume and weight of the cargo, and gross and net DWT of the vessel.

The charges practices vary according to the area considered.

Two example are represented below. The Panama and Suez canals are the two most famous.

3.3.7 Terminal costs

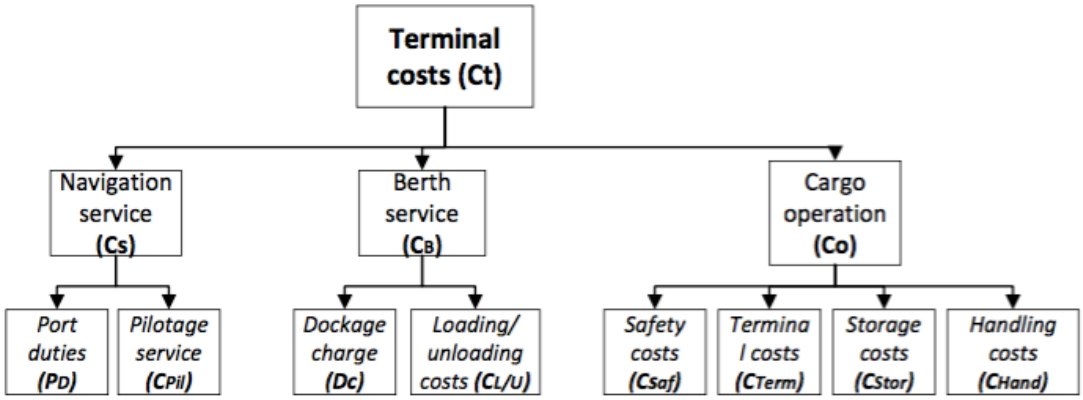


Figure 10: Terminal costs

Once the vessel has berthed, the terminal operations start.

On the quay, there are cranes that discharge the containers from the vessel and put them on vehicles that move them to the container yard.

The Container Yard is the place where the containers are stored. They are stacked in well-marked and numbered block. Here, there are further areas reserved to empty or special containers.

Sometimes, when a container has products with different destinations inside, it has to be unpacked in the Container freight station.

Once the container is ready to be moved, first it passes through the Gate facility. Here, clerks and inspectors attend to inspection procedures and control documents and security. The service cost mainly depends on the time and the clerks needed to do each operation.

So, a shipping company to define the rent cost of a single TEU takes into consideration: annuity, maintenance, operators, and energy consumption.

The cost associated with a single vessel calling at a port can be represented by the equation below but it is fundamental to say that the terminal costs are different port to port.

Terminal cost C_T

$$C_T = C_S + C_B + C_O + C_C$$

Costs associated with navigational services C_S

$$C_S = P_D + C_{Pil}$$

Port duties **P_D**

Some ports provide the payment of taxes by the vessels. Taxes are needed to use the

port services and a part of them covers the maintenance costs.

There are some fixed fees and others varying according to the size (length).

Pilotage cost **C_P**

The pilotage service involves the use of items to help the vessel navigation from the seaway to the berth. It is based on a fixed visual reference on the ground or sea by means of signs or radar. Pilotage charge varies according to the vessel size or to the vessel gross registered tonnage (GRT) but it can also be fixed as constant amount per call. It involves also fuel charge per pilot boat movement.

Costs associated with berth services C_B

$$C_B = D_C + C_{L/U}$$

Dockage Charges **D_C**

It is the fee assessed to a ship that has to berth at wharf (molo), bulkhead (paratia) structure, pier (pontile) or for mooring to a vessel, so berthed. A berth is a water area at the edge of a wharf, including mooring facilities, used by a vessel while docked.

Loading and Unloading **$C_{L/U}$**

Costs associated with cargo operations C_O

$$C_o = C_{Hand} + C_{Stor} + C_{Ter} + C_{Saf}$$

Handling cost **C_{hand}**

Handling costs are provided by stevedoring companies under request.

Storage **C_{Stor}**

Usually each port offers a free storage period. Storage costs are demurrage.

Terminal service **C_{Ter}**

It involves costs for all the services occurred during the storage period, e.g., packaging/unpackaging, sorting ..

Port security fee **C_{Saf}**

3.3.8 Customs clearance

When products are imported from a country external to European Union, it is necessary to pay some fees to allow them in. Here goods and documents are inspected.

The customs duty, also known as TARIC, is estimated as a percentage of the value at the customs, that includes the value of the import goods, total expenses to the port of the destination in the European country and also insurance, if any.

The percentage of the fee varies according to the import material and also the country of origin. It can be easy found on the customs agency website. The same item can have different customs duties if it comes from different countries. The assessment of the percentage is based on the uniqueness of the product. The customs duty will be minimum or null for products that are not made in Europe; it will be high if the imported products are of European important branches in order to avoid competition with ones manufactured in Europe.

On each parcel is printed a numerical code called HS()to avoid that the customs officers has to control all the goods. The same code has to be printed on the commercial Invoice.

3.3.9 IVA

The VAT is 22% of the value of goods and customs duties. The cost of goods is the cost of the purchase plus additional costs to the port destination. Differently from customs duties, this percentage varies from country to country and the VAT value can be deducted. Instead of paying the VAT at the customs office, the company can use tax deposit. In this way, the company doesn't pay the full amount on the spot but can pay it in parts selling the products. This means that the company pays the VAT on the selling of each product. The way to pay VAT depends on the company strategy and money availability.

3.3.10 Transport from the destination port to the warehouse

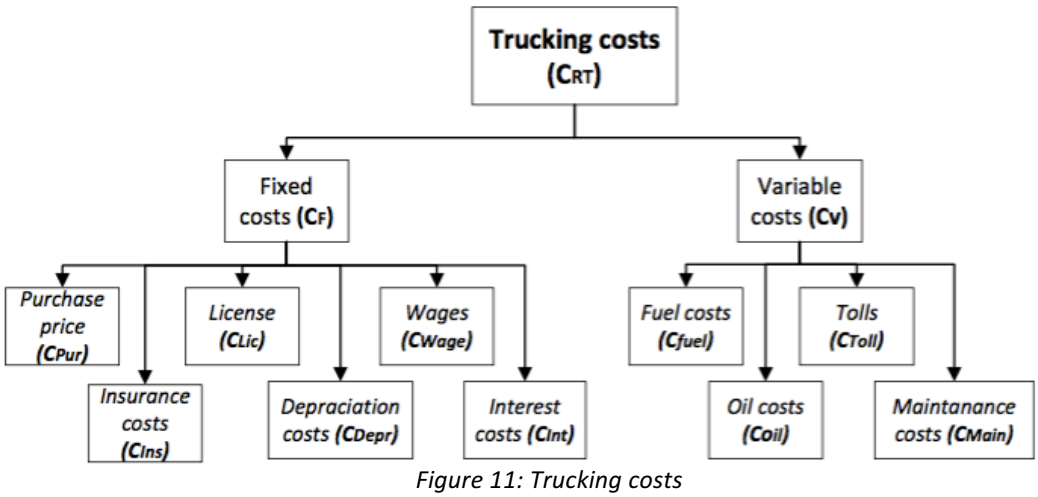


Figure 11: Trucking costs

There are many factors that affect the road freight transport costs indeed they are difficult to estimate for each trucking company. They decrease with volume, size of unit load and the regularity of the shipment and increase with speed and distance.

Trucking companies have different firm size and driving characteristics, prices, truck fleet, geographical characteristics and deal with different products. So, the main factors that may affect trucking transport cost independently on the company examined can be divided as:

- Variable costs: fuel, lubrication oil, tires, spares, maintenance
- Fixed costs: wages, licenses, depreciation and interests, vehicle insurance

It will be a model of costs based on miles covered by a single truck.

$$C_T = C_V + C_F$$

C_T = Transport costs
C_V = Variable costs
C_F= Fixed costs

$$C_V = C_{Fuel} + C_{Oil} + C_{toll} + C_{Main}$$

Fuel costs $\mathbf{C_{Fuel}}$

It is simply the amount payed for the fuel needed. Many factors affect this cost as: price per gallon, engine performance, type city or rural driving, speed..

Lubrication oil costs $\mathbf{C_{oil}}$

Tolls $\mathbf{C_{toll}}$

Tolls are common costs in road transport. They vary according to the business and the geographical position of the countries involved. The amount of each toll depends on the miles to be travelled.

Further cost items are referred to the maintenance operations. Below the most common maintenance works are shown. The majority of them depend on the expected durability declared by the production company.

$$C_{Main} = C_{Tire} + C_{Brake} + C_{Exh} + C_{Cat}$$

Tire costs $\mathbf{C_{Tire}}$

Brakes costs $\mathbf{C_{Brake}}$

Exhaust system costs $\mathbf{C_{Exh}}$

Catalytic converter costs $\mathbf{C_{Cat}}$

$$C_F = C_{Purch} + C_{Wage} + C_{Lic} + C_{Depr} + C_{Int} + C_{Insur}$$

The purchase costs $\mathbf{C_{purch}}$

This is the initial cost of the vehicle. It includes any kind of modification to get it ready for your business and the costs to get it to the company warehouse. Modifications can deal with internal or external optional accessories, paints as the company logo, phone number etc..,

To evaluate the cost per miles for each truck, it is necessary to consider the life expectancy and it is important to take into account that the physical cost of replacement is higher than the maintenance one.

According to the truck type, the production company declares the average life expectancy before a major breakdown. At this point it is necessary to replace the unit.

The wages costs C_{Wage}

The licenses and taxes costs $\mathbf{C_{Lic}}$

Each year, a company has to pay licenses and registration fee to travel on the road, business property taxes and compliance component for the annual inspection.

It is to be consider that this cost varies from year to year. Most notably, the property tax decreases as the unit age and unit value decrease independently from miles travelled.

The depreciation costs $\mathbf{C_{Depr}}$

The interest costs $\mathbf{C_{Int}}$

The interest costs are referred to the purchase price. The interest payment decreases according to the loan. It is a fixed cost because it is independent from how much you drive the unit.

The insurance costs $\mathbf{C_{Insur}}$

The insurance premium depends on various warranties as emergency towing (traino), windshield (parabrezza) coverage etc., chosen by the company. Usually the amount of the annual premium is based on the miles travelled.

Carrying costs can be divided into two main categories, time and distance dependent costs. Fixed costs are the main time dependent costs **(Cost per hour)** while variable costs are distance dependent costs **(Cost per km).**

3.3.11 Warehousing costs

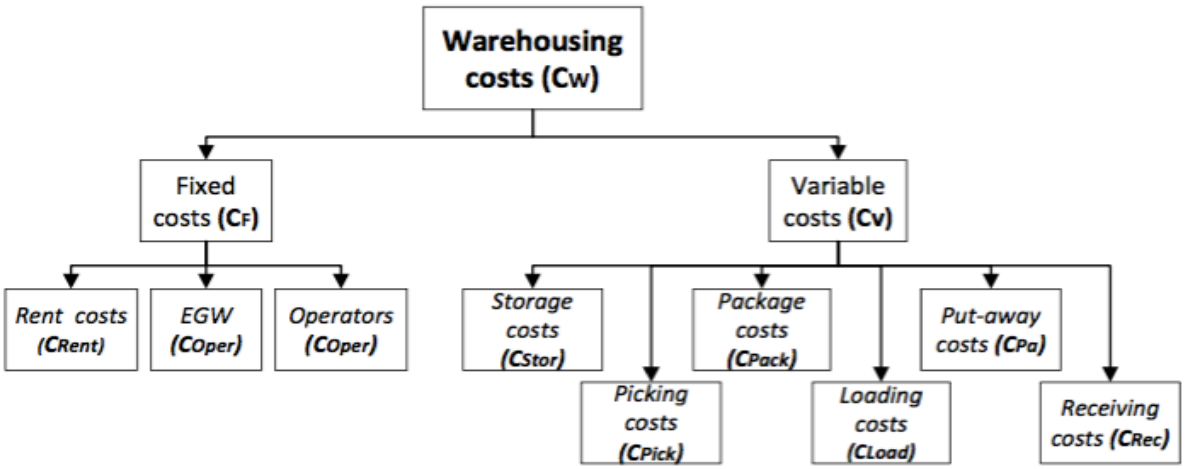


Figure 12: Warehousing costs

$$C_W = C_V + C_F$$

C_W= Warehousing costs
C_V = Variable costs
C_F= Fixed costs

Variable costs C_V

$$C_V = C_{Rent} + C_{EGW} + C_{Oper}$$

Rent costs C_{Rent}

Energy, gas and water consumption C_{EGW}

Operators wages C_{Oper}

Fixed costs

$$C_F = C_{Rec} + C_{Pa} + C_{Stor} + C_{Pick} + C_{Pack} + C_{Load}$$

Receiving C_{Rec}

Put- away C_{Pa}

Storage C_{Stor}

Picking C_{Pick}

Packaging C_{Pack}

Loading C_{Load}

3.4 Critical processes identification

Once the processes and activities were observed, the next step was to individuate a critical process inside the company that affects the efficiency of the service provided.

Thanks to meeting with sector managers and cooperation with members of the staff, it was possible to discuss about several points.

It was decided to analyse the Inbound process evaluating the cost issue affecting the product for the definition of its selling price.

This topic is delicate and complex because it is linked to various activities of the distribution chain.

The selling price (Sp) of the product represents the economic value the company uses on the market. This value has to include a margin of profit for the company (μ)
and at the same time cover all the expenses necessary for the provided service (C_{TOT}).

$$Sp = C_{TOT} * \mu$$

The total costs that weight on the company have been divided in three cost components: Company, Inbound and outbound cost.

$$C_{TOT} = C_{COMPANY} + C_{INB} + C_{OUT}$$

The inbound and outbound costs represent the direct and variable costs while the company cost component includes all the other components. The former are shown in the figure below:

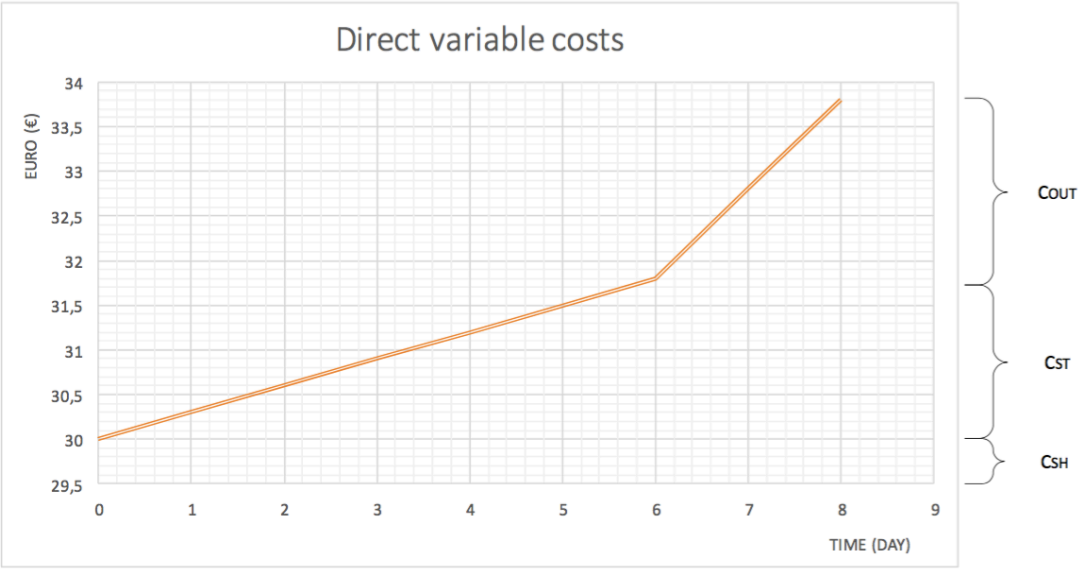


Chart 1: Company direct variable costs

The line is divided in three branches. The first one represents all cost components of inbound costs except for the storage. Indeed, the latter is represented by the second branch. It is function of time and its cost per item rises in a fixed value each day. The amount of this value depends on the article taken into account. The third branch represents the outbound cost.

$$C_{INB} = C_{SH} + C_{ST}$$

Shipping costs C_{SH}
Stocking costs C_{ST}

From the analysis of the present situation, the selling price fixed by the company does not consider the different influences and it is fixed with an approximate method based on the purchase price of the product from the supplier.

The purpose is to identify a calculation model to determine the selling price of the product considering the various expenses necessary for the product to get to the warehouse and to be available to the final customer. To this aim all the costs of the company have been identified. Starting from the purchase of the product to its final delivery to the customer every movement implies a cost.

As already said, entrusting third parts, the company pays them for the handling of the product for each phase (inbound, warehouse and outbound) each process goes with a cost, it has been divided per single unit. Obviously, the weight of the total cost on each single unit will depend on the product.

3.5 Re-engineering approach

The sensitivity analysis (SA) has been chosen to analyze the company process. It is a method to investigate on the potential status, changes and results of the latter. Thanks to it, it is possible to compare the real state of a company (As-Is) as it should be (To-Be).
Usually who makes decisions is unsure of the current value or parameter defined and even more about their future values. SA helps them to make decision and to prove their effectiveness.
The sensitivity analysis adopted consists on:

- defining parameters that affect the efficiency and the quality of the service provided by the company (As-Is) according to the cost model results
- Verifying sensitive or important parameters thanks to the Pearson's correlation coefficient: it is necessary evaluate the interdependency between the parameters
- Analyzing the unexpected interdependency: how an indicator influence the other
- Proposing possible changes to improve the defined critical process (To-Be) according to the analysis results.

4 Costs modelling

It is composed of an input (order), an output (total costs approach) and various activities distinguished in managed, operational (P) and shipping phases (S).

Each activity is characterized by a cost and each cost has been represented as function of different parameters. In this way, for each model, the total cost function has been evaluated and the parameters will be taken into account when the re-engineering process starts.

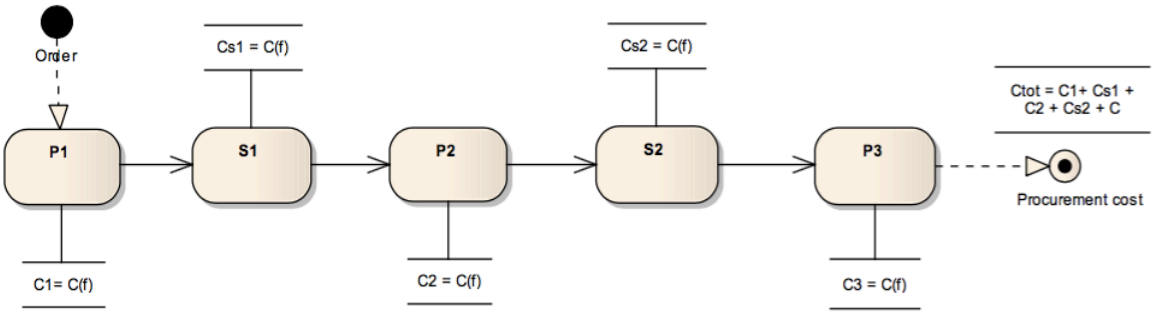


Figure 13: The cost model

P1: Manufacture phase

- C1: Purchase cost
- C1= *f* (Value, quantity, exchange rate) Order

S1: Trucking to origin port

- C2: Road transport (Cr).
- Cr= *f* (Fuel, distance, Toll, goods type, volume and quantity of loading units)

P2: Terminal operations at origin port

- C3: Terminal cost (Cto).
- Cto= *f* (Port fee, Pilotage service, Berth service, loading/unloading, handling, storage, security, inspection)

S2: Maritime transport

- C4: Maritime transport cost (Cm).
- Cm= *f* (Type of product, volume, quantity, route, voyage time, vessel volume,)

P3: Terminal operations at destination port

- C5: Terminal cost (Ctd).
- Ctd= *f* (Port fee, Pilotage service, Berth service, loading/unloading, handling, storage, security, inspection)

P4: Customs operation

- C6: Customs clearance (Cc).
- Cc= *f* (Goods value, Total cost up to destination port)

S3: Trucking to warehouse

- C7: Road transport (Cr).
- Cr= *f* (Fuel, distance, Toll, goods type, volume and quantity of loading units)

P5: Warehouse inbound operations

- C8: Warehousing cost Cw = Inbound costs (C_{Inb}) + storage costs (C_{Stor})
- C_{Inb} = *f* (Number and type of loading units, number of people in charge)
- C_{Stor} = *f* (Pallet place, volume and number of loading units, time)

Three different costs model are represented below.

FOB

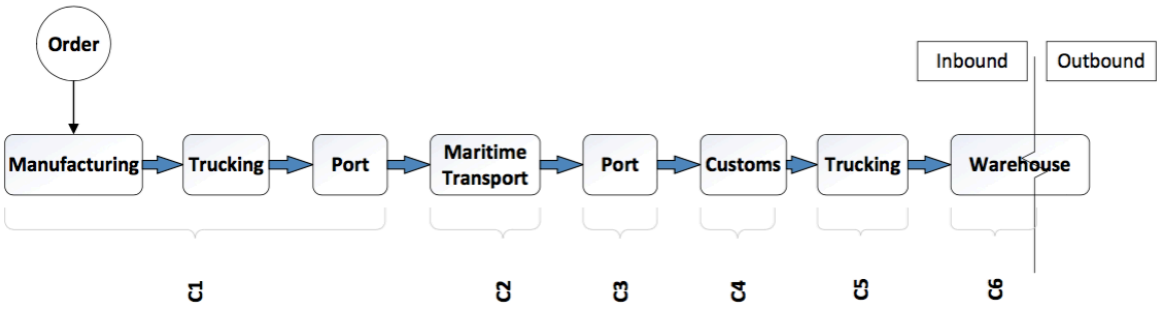


Figure 14:Free On Board (FOB) cost model

CIF

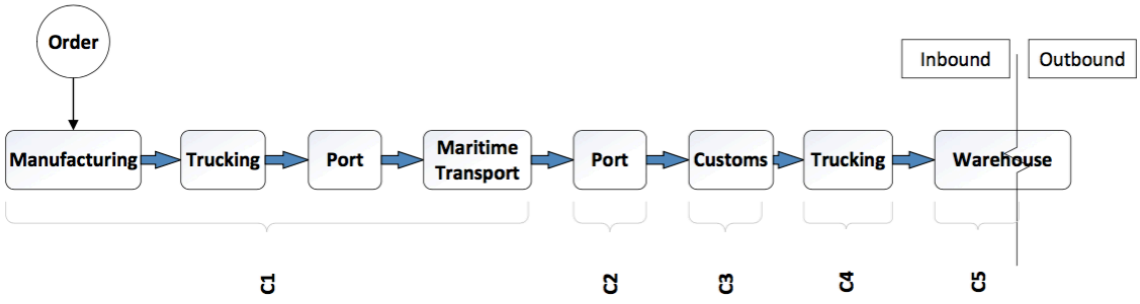


Figure 15: Cost, Insurance and Freight (CIF) cost model

EXW

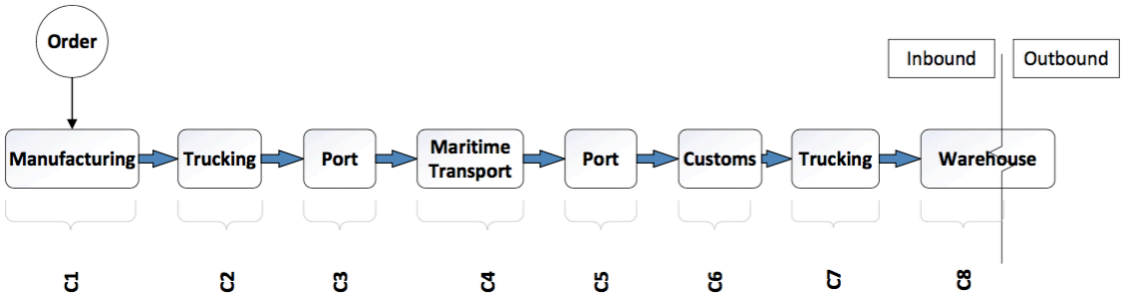


Figure 16: Ex Work (EXW) cost model

In this work, has been adopted the first one according to the company supply chain.
The costs model realized and adopted is shown below. It represents all the inbound costs that affect the company. It has been realized according to the service rates provided by the external partner. Indeed, the considered parameters are the only one linked to the orders.

4.1 Purchase cost

Invoice (FOB)
Calculation model:

- Unit cost: **Cu [€ /Unit]**
- Number of units per order: **q**
- Order cost: **Co = Cu * q [€]**

4.2 Maritime costs

Insurance cost
Calculation model

- Article code: **I, y, z ..**
- Units per order: **qi, qy, qz ..**
- Cost per unit: **Ci ($)**
- Cost per order: **Co = Ci*q (€)**
- Loading unit: **Qi, Qy, Qz ..**
- Shipping value: **Cs (€)**
- Order incidence on shipping value: **Rp = Co/Cs**
- Insurance premium per B/L: **Ca [€/Container]**
- Insurance premium per order: **Cao = Ca* Nc * Rp (€)**
- Insurance premium per loading unit: **Cau = Cao / Q ($)**
- Units per loading unit: **q**
- Insurance premium per unit: **Cap = Cai/q ($)**

Maritime transport

Calculation model

- Article code: **i,j ..**
- Loading unit per order: **Qi, Qj ..**
- Loading unit volume: **Vi, Vj .. [m³]**
- Container volume: **Vc [m³]**
- Occupated containers: **Nc**
- Shipment total value: **Vt = Vc * Nc [m³]**
- Order volume: **Vo [m³]**
- Goods volume in occupated container by the order: **Vsp [m³]**
- Order occupation rate: **To = Vo/ Vt**
- Container rental cost: **Cs = € /container *Nc**
- Order cost**: Co = Cs*Vo/Vsp [€]**
- Loading unit cost: **Cu = Co / Qi [€/loading unit]**
- Unit per loading unit: **q**
- Unit cost: **Ci = Cu/q [€/unit]**

4.3 Terminal costs

Entry Summary Declarations (ENS) Fee

Calculation model

- Article code: **i,j ..**
- Loading unit per order: **Qi, Qj ..**
- Loading unit volume: **Vi, Vj .. [m³]**
- Container volume: **Vc [m³]**
- Number of container: **Nc**
- Shipment total value: **Vt = Vc * Nc [m³]**
- Order volume: **Vo [m³]**
- Order occupation rate: **To = Vo/ Vc**
- ENS fee: **Cs [€/container] *Nc**
- Order cost**: Co = Cs*Vo/Vsp [€]**
- Loading unit cost: **Cu = Co / Qi [€/loading unit]**
- Units per loading unit: **q**
- Unit cost: **Ci = Cu/q [€/unit]**

Handling costs

Calculation model

- Services: **THC, Isps, Inspection, Delivery order, Security**
- Article code: **i,j ..**
- Loading unit per order: **Qi, Qj ..**
- Loading unit volume: **Vi, Vj .. [m³]**
- Container volume: **Vc [m³]**
- Number of container: **Nc**
- Shipment total value: **Vt = Vc * Nc [m³]**
- Order volume: **Vo [m³]**
- Order occupation rate: **To = Vo/ Vc**

- Services cost: **Cs [€/container] * Nc**
- Order cost**: Co = Cs*Vo/Vsp [€]**
- Cost per loading unit: **Cu = Co / Qi [€/loading unit]**
- Units per loading unit: **q**
- Cost per unit: **Ci = Cu/q [€/unit]**

Port release

Calculation model

- Article code: **i,j ..**
- Loading unit per order: **Qi, Qj ..**
- Loading unit volume: **Vi, Vj .. [m³]**
- Container volume: **Vc [m³]**
- Number of container: **Nc**
- Shipment total value: **Vt = Vc * Nc [m³]**
- Order volume: **Vo [m³]**
- Order occupation rate: **To = Vo/ Vc**
- Services cost: **Cs = [€/Bill of lading] * Nc/Nct**
- Order cost**: Co = Cs*Vo/Vsp [€]**
- Loading unit cost: **Cu = Co / Qi [€/loading unit]**
- Units per loading unit: **q**
- Cost per unit: **Ci = Cu/q [€/unit]**

4.4 Customs clearance

As goods are imported from a country out of the EU, they must pass through the customs control. It is necessary to check that the units in the container correspond to what is on the packing list. In order to break the seals the company has to pay the customs duty and the VAT (Value Added Tax).

T1 emission

Calculation model

- Article code: **i,j ..**
- Loading units per order: **Qi, Qj ..**
- Loading unit volume: **Vi, Vj .. [m³]**
- Container volume: **Vc [m³]**
- Number of container: **Nc**
- Shipment total value: **Vt = Vc * Nc [m³]**
- Order volume: **Vo [m³]**
- Order occupation rate: **To = Vo/ Vc**
- T1 emission: **Cs = [€/container] * Nc**
- Order cost**: Co = Cs*Vo/Vsp [€]**
- Loading unit cost: **Cu = Co / Qi [€/loading unit]**
- Units per loading unit: **q**
- Cost per unit: **Cp = Cu/q [€/unit]**

Customs clearance

Calculation model

- Article code: **i,j..**
- Order value (customs estimation): **Co [€]**
- Loading units per order: **Q**
- Units per order: **q**
- Occupated container value by the order affected by the custom clearance: **B [€]**
- Customs clearance per occupated container by the order: **Dsp [€]**
- Order incidence on B: **[%]**
- Customs clearance per order: **Do [€]**
- Customs clearance per loading unit: **Du = Do/Q[€]**
- Unit customs clearance: **Cu = Di/q [€/unit]**

Dues according to the seal

Calculation model

- Article code: i**,j..**
- Order value (customs estimation): **Co [€]**
- Good value in occupated container by the order (customs estimation): **Vsp [€]**
- Loading unit per order: **Q**
- Dues according to the seal per occupated container by the order: **Db**
- Order incidence on Vsp: **Inc**
- Dues according to the seal per order: **Dbo = Db * inc [€]**
- Dues according to the seal per loading unit: **Dbu = Dbo/Q [€]**
- Unit s per loading unit: **q**
- Dues according to the seal per unit: **Dbi = Dbu/q [€]**

4.5 Road transport cost

Port – Logistics Transportation (€/Km)

Calculation model

- Article code: **i,j ..**
- Loading units per order: **Qi, Qj ..**
- Loading unit volume: **Vi, Vj .. [m³]**
- Container volume: **Vc [m³]**
- Occupated container by the order: **Nc**
- Shipment total value: **Vt = Vc * Nc [m³]**
- Order volume: **Vo [m³]**
- Order occupation rate: **To = Vo/ Vt**
- Service cost: **Cs = € /container**
- Order cost: **Co= Cs*Vo/ Vsp**
- Cost per loading unit: **Cu = Co / Qi [€/loading unit]**
- Units per loading unit: **q**
- Unit cost: **Ci = Cu/q [€/unit]**

Transport from Port to the Logistics with stop D.IVA (€/Km)
Calculation model

- Service: **Movement CVV- S. Palomba or CVV-CVV with D. IVA**
- Article code: **i,j ..**
- Loading units per order: **Qi, Qj ..**
- Loading unit volume: **Vi, Vj .. [m³]**
- Container volume: **Vc [m³]**
- Occupated container by the order: **Nc**
- Shipment total value: **Vt = Vc * Nc [m³]**
- Order volume: **Vo [m³]**
- Order occupation rate: **To = Vo/ Vt**
- Service cost: **Cs = € /container**
- Order cost: **Co= Cs*Vo/ Vsp**
- Cost per loading unit: **Cu = Co / Qi [€/loading unit]**
- Units per loading unit: **q**
- Unit cost: **Ci = Cu/q [€/unit]**

4.6 Warehousing costs

The costs that will be considered are the necessary one to get a good service. Fixed costs, connected with the Brico Bravo company will be left to a company officer, but they will be included in the model too.

To evaluate warehousing costs, it has been analyzed the contract that the company has signed with an external logistics about the services at the operator's structures referring to reception, quality control, warehousing, storing of the goods and transport in Italy and abroad. Each of these services includes a series of important activities to guarantee a quality service.

The expenses in the contract have been stated basing on the work hours.

The activity of unload is the passage of the goods from the container to the warehouse. It can imply the use of mechanical means, according to the unit transported.

Unloading containers of loose boxes

This kind of unit is typical of the import goods ad it allows to optimize the use of the space available. According to the size of the unit, the unloading will be done either by hand or by a mechanical means. It may happen that for big parcels may be placed small support to help the mechanical means to lift them up.

Calculation model

- Service: **Unloading containers of loose boxes**
- Article code: **i,j ..**
- Loading units per order: **Qi, Qj ..**
- Loading unit volume: **Vi, Vj .. [m³]**
- Container volume: **Vc [m³]**
- Occupated container by the order: **Nc**
- Shipment total value: **Vt = Vc * Nc [m³]**
- Order volume: **Vo [m³]**
- Order occupation rate: **To = Vo/ Vt**
- Service cost: **Cs = € /container**
- Order cost: **Co= Cs*Vo/ Vsp**
- Cost per loading unit: **Cu = Co / Qi [€/loading unit]**
- Units per loading unit: **q**
- Unit cost: **Ci = Cu/q [€/Unit]**

Storage

One of the most important and outstanding units of warehousing expenses is the rental cost of the warehouse, or of a space dedicated to the placement of the company goods.

The rental cost can be defined as €/m or €/pallet and can be linked to an interval in time as for the specific case. As a matter of fact, in this case the contract signed with the logistics warehouse includes a monthly rental cost.

The expense item related to the single unit is connected to the period of time it is kept in store.

In stock

Calculation model

- Commited space: **S [m²]**
- Pallet occupation: **Sp [m²]**
- Service cost: **Cs= S/Sp [€/pallet]**
- Occupated pallet per order: **np**
- Service cost per order: **Co**
- Units per order: **no**
- Loading units per pallet: **Nu**
- Loading unit cost: **Cu = Co/nu [€/month]**
- Unit cost: **Ci = Co/nc [€/month]**
- Loading unit cost per day: **Cu/30[€/day]**
- Unit cost per day: **Ci/30 [€/day]**

The stocking cost component referred to each unit is linked to the stocking time of the same in the warehouse.

Tab. 1 resumes the inbound cost components that affect the company procurement process. Both the parameters to define the service price and the effective parameter according to which the company pay are shown below:

Table 1: Inbound cost - FOB model

	Unit cost		Dependencies	Unit of measure
C1	Purchase and allocation	Purchase	Value, quantity, exchange rate, volume	€/ unit
C2	Maritime transport	Maritime costs	Type of product, volume, quantity, route, voyage time, vessel volume, empty containers way back	€ / container
		Insurance premium	Goods value; transport cost; customs clearance	€ / Bill of lading
C3	Terminal	ENS Fee	Port fee, Pilotage service, Berth service, loading/unloading, handling, storage, security, inspection	€ / container
		Handling costs		€ / container
		Port release		€ / Bill of lading
C4	Customs clearance	Customs clearance	Goods value, Total cost up to destination port	
		T1 emission		€ / container
C5	Trucking	Port to warehouse	Fuel, distance, Toll, goods type, volume and quantity of loading units	€ / container
C6	Warehouse	Unloading containers of loose boxes	Number and type of loading units, number of people in charge	€ / container
		Storage	Pallet place, volume and number of loading units, time in stock	€ / pallet place per month

5 The business case of the Brico Bravo company

5.1 Introduction to the company

Brico Bravo company was founded in 1959 as a family company. It has grown increasingly and now it works together with other external partners.

It sells products for Do-It-Yourself, satisfying each year more than 150000 customers.

It has its headquarter and its own retail store in Rome but its main asset is the online sale.

In addition, the company supplies many external retail stores in Italy.

It's working for an improvement in the e-Commerce sector taking into account details of all the processes of the supply chain through which its customers get their products.

While the headquarter deals with the administration services, commercial issues, marketing enterprising, sails management etc.., the logistics services are left to take care of external partners.

So Brico Bravo company adopts an Outsourcing model with more experienced partners.

The headquarter deals with research of the suppliers, the kind of products to deal with and carry out customer assistance services.

Between the company and the supplier there is another figure, the shipping agent. He contacts directly the company to represent his offers and services. The company choses the shipping agent basing on the quality of the service and the price to pay.

The price agreed upon for the purchase includes also the transportation of the goods to the port of shipping (FOB). So, the responsibility is of the supplier until the goods are loaded on the ship. In that moment the company controls the trip and the status of the containers through the shipping agent. There is a continuous exchange of information between the company, the shipping agent and the supplier in this first phase to organize the pick up in the port by the ship engaged by the shipping agent.

During the maritime transport, the company plans the arriving schedule of goods so that this information can be communicated to the warehouses. Often the warehouse can't get the goods and it is necessary a temporary stop in the port. Once the goods arrive at the destination port they are sent to the customs office to legalize the join in the country. From this moment, the good can be shipped directly to the warehouse.

Once the products are in the warehouses, they are available for the customers that can make the order. As said before, the company through the warehouse supplies also retail stores, some goods leave the warehouse towards the retail stores and others to the online

customers. The shipping, so the delivery of the products to the online customers is entrust to another external company which agrees the pick up directly with the warehouse, while the shipping to the retail is done by a carrier service provided by the warehouse.
The detailed representation of the processes inside the Company's supply chain will be described and shown below.

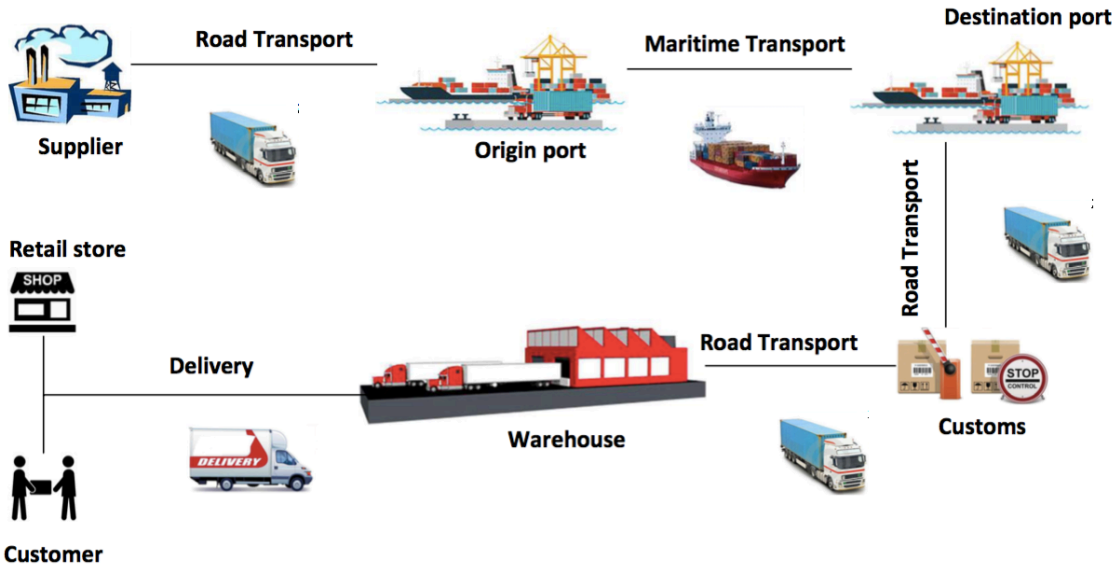


Figure 17: Brico Bravo supply chain

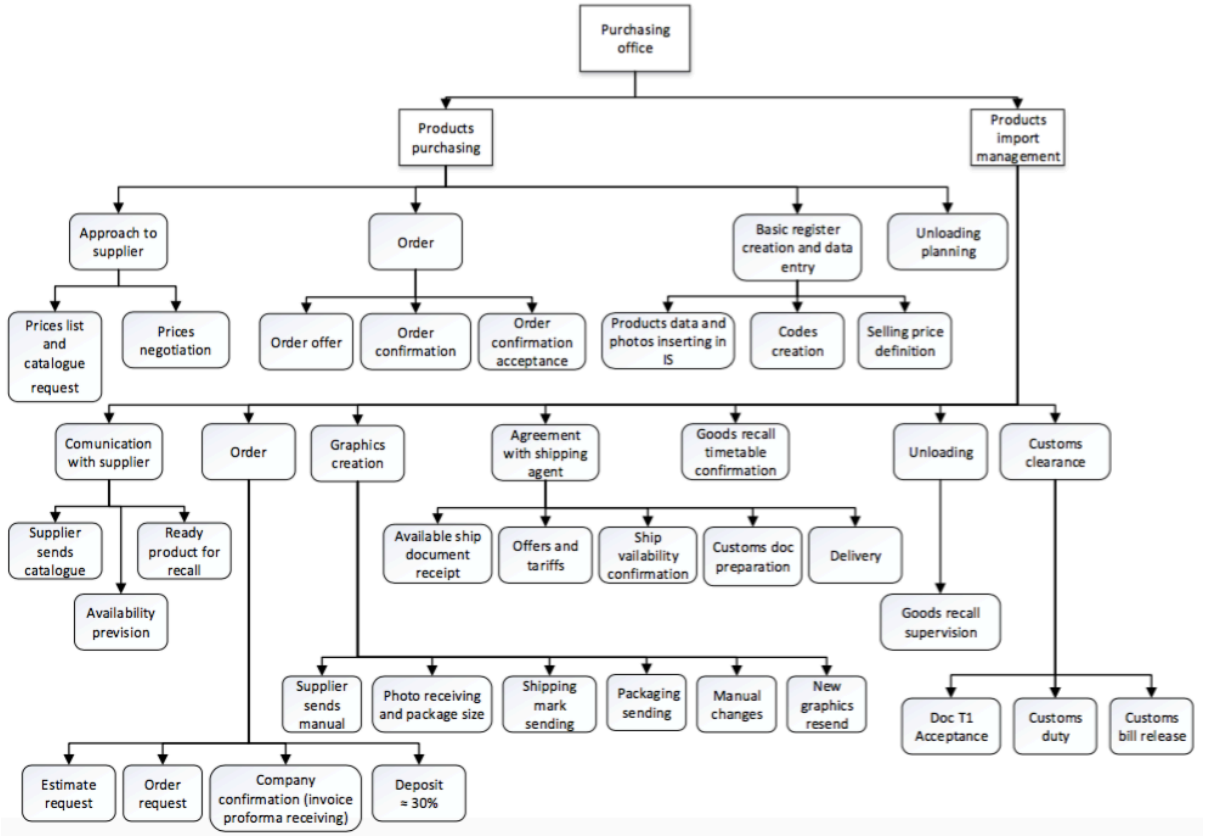
5.2 Brico Bravo Functional Decomposition Diagram

The aim of this phase is the reconstruction of the activity and data flows of all company operations with the final construction of process models allowing to identify connections among different areas which affect the handling of a product from the supplier to the final customer.
The company analysis has been done through interviews and meetings with managers and members of the staff. Thanks to these interviews, functions, processes and respective people in charge have been identified. A detailed explanation has been required about the activities, the information and the data flow necessary for the working of the process. An iteration improving work has been done and the diagram, later introduced, has been changed and adapted any time new information has been acquired. A periodical check from each person in charge and following meetings have allowed to get clear and detailed company view.

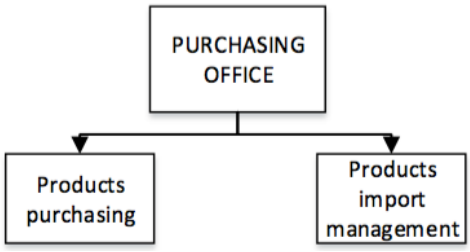
It has been obtained a general vision of the company both from the structural (supply chain network) and functional (processes and information flows) side.

Figure 18: Brico Bravo functional areas

PURCHAISING OFFICE



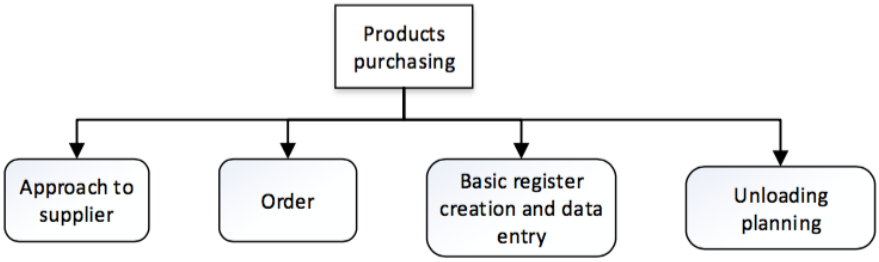
Nome: PURCHASING OFFICE
Tipo: FUNCTION
Description: It is the organization area that approaches with the national and international suppliers. It includes the agreement phase, the order planning and the creation of the item register. The imported items include a more complex and longer treatment introduced in "import management function". It also includes a first phase of unloading planning to update the logistics on the good arrival.



Decomposition functional diagram: Step 1: subfunctions of the Purchase Office

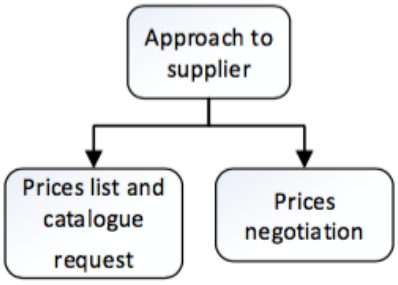
Nome: PURCHASE OF THE PRODUCT

Tipo: SUBFUNCTION
Description: It is the section concerning all the procedures of the purchase of a product. The first phase is the approach (first contact) of the supplier who is contacted after a market research. It deals with the placement of the order, from the customer's request to its fulfillment. The choice of the products implies that their data are included in a database and the registers are created. An additional and important issue is the planning of the unloading, so that the logistics will be ready to receive the goods.



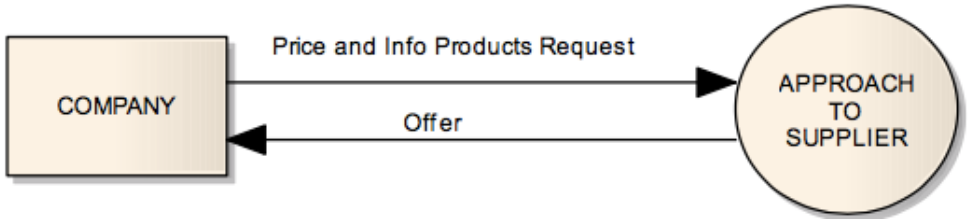
DFD, Step 2: Processes of the subfunction PURCHASE OF THE PRODUCTS of the main function PURCHASE OFFICE

Nome: APPROACH TO THE SUPPLIER
Tipo: PROCESS
Description: The company interested in the products asks the suppliers to get price lists, features and photos of their inventory. After an evaluation of the promotional, if any, and a following discussion on prices according to the quantity of goods required, they will proceed with the request

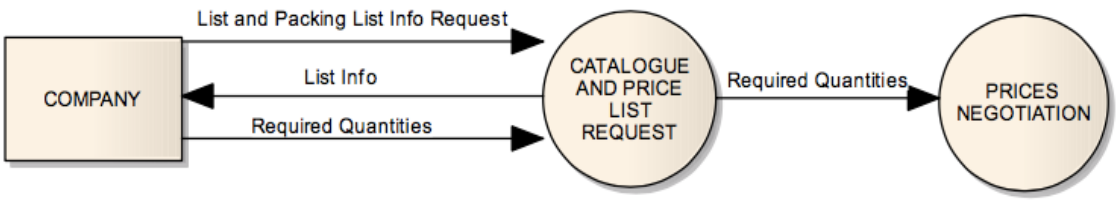


DFD Step 3: APPROACH TO THE SUPPLIER process

PROCESS MODEL

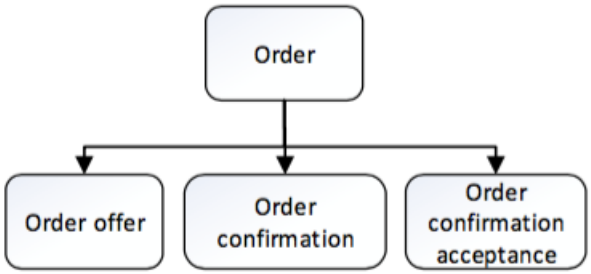


*Context diagram of **Approach to the supplier** process*



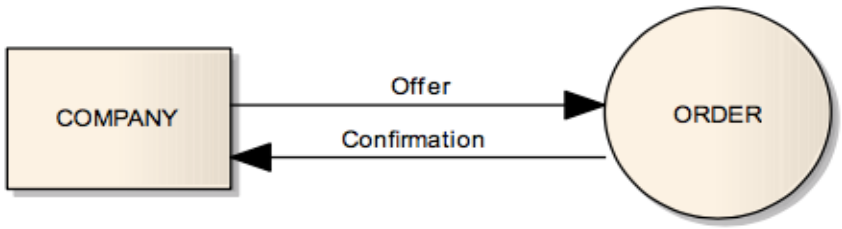
*Level 0, **Approach to the supplier** process*

Nome: ORDER
Tipo: PROCESS
Description: The company sends an order to the supplier. The latter sends a confirmation to the customer, to be verified and accepted.

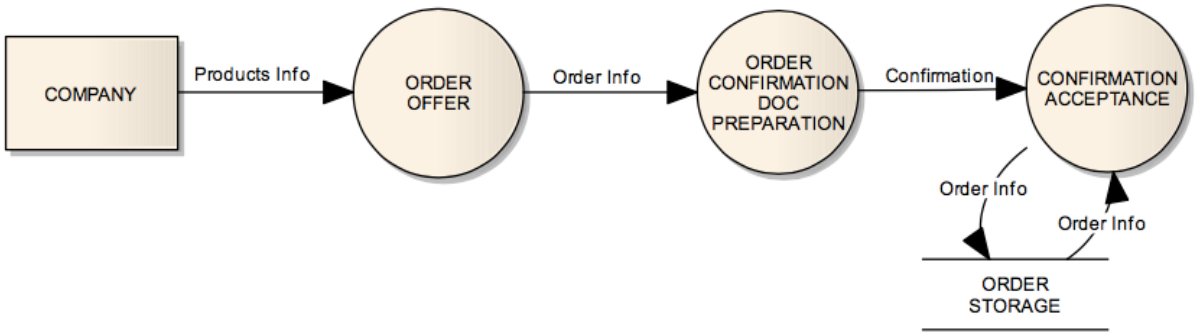


DFD, Step 3: Order process

PROCESS MODEL

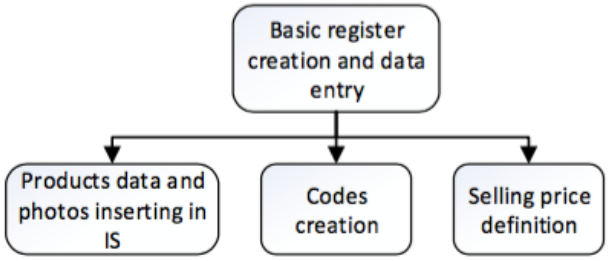


*Context diagram of the **Order** process*



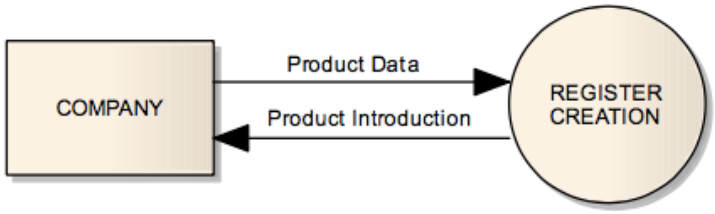
*Level 0, **order** process*

Nome: CREATION OF THE REGISTER
Tipo: PROCESS
Description: From the moment the products are chosen and the order is sent the input in the Database starts about the features of the items, with high definition photos received from the supplier. Each feature is identified with a code elaborated and stamped on a label stuck on each specific unit. During this process the selling price per each single unit is fixed.

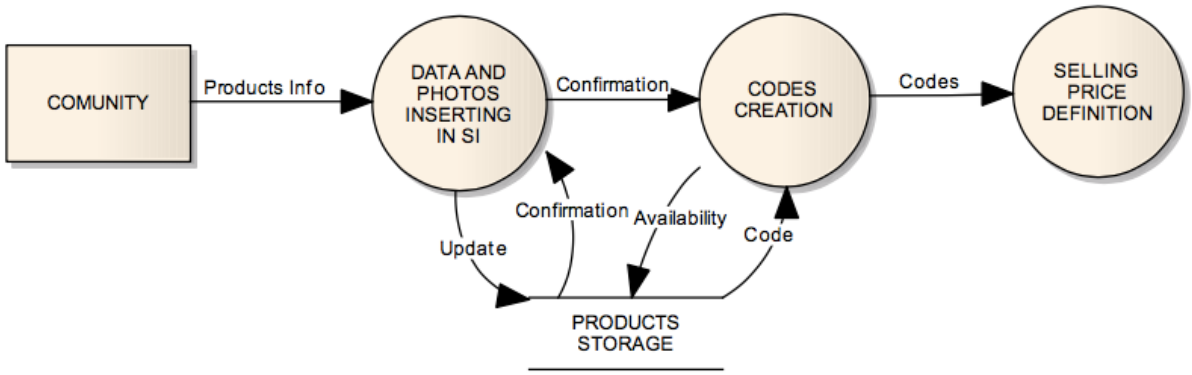


DFD, Step 3 CREATION OF THE REGISTER AND DATA ENTRY

PROCESS MODEL



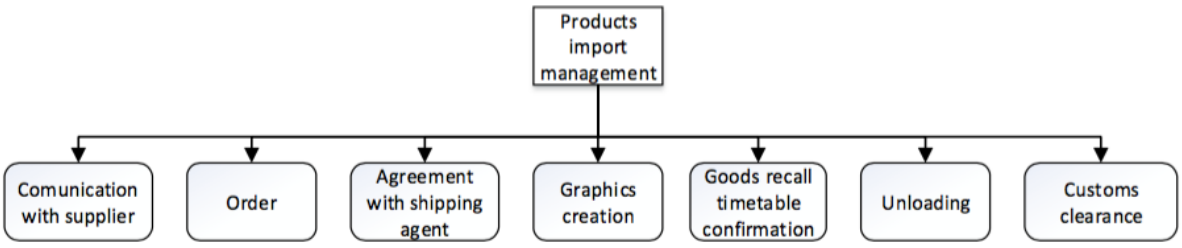
*Context diagram of the **Register creation** process*



*Level 0, **register creation** process*

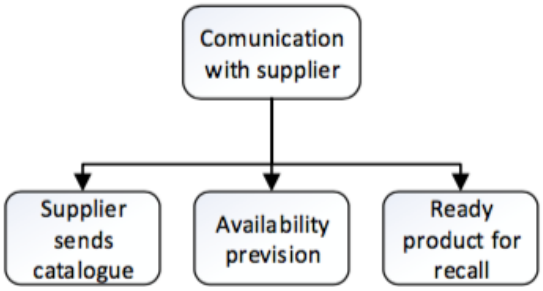
Nome: PLANNING OF THE UNLOADING
Tipo: PROCESS
Description: Basing on orders sent to various suppliers, it is likely do schedule the arrival of containers in order to prepare and handle the goods. The company agrees with the suppliers upon the receipt of the goods on the basis of the number of pallet both from the national purchase and from the import.

Nome: IMPORT MANAGEMENT
Tipo: SUBFUNCTION
Description: It is the section having contacts with international suppliers. Being a long and complex process, it implies a continuous exchange of information between the customer and the supplier about the phases of the order during the process. It manages all the procedures of the orders sent to the accepted confirmation. It includes the important choice of the shipping agent and of the signature of a contract including various handling clauses (terms). It deals also with the handling of the goods from the origin port to the customer logistics. It makes new graphics for each reference required by the customer and any modification of the manual, according to the necessities of the country. It is the shipping agent that must guarantee and control the procedures of the unloading of the containers to the clearing area once the goods have arrived at the destination port. This section manages the phases of the exit from the port and the customs clearance of the containers after the full payment to the supplier has been done. It include also the confirmation of the schedule of the arrival.



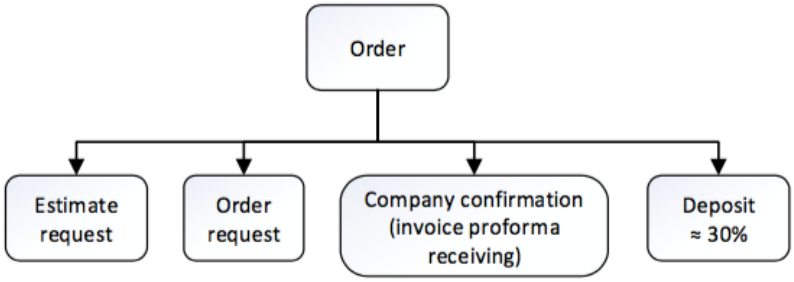
DFD, Step 3: Processes of the subfunction IMPORT MANAGEMENT of the main function PURCHASE OFFICE

Nome: COMMUNICATION WITH THE SUPPLIERS
Tipo: SUBFUNCTION
Description: During the whole process there is a continuous contact between the supplier and the shipping agent. There is the request of the catalogue to the supplier and the successive phases already mentioned in the subfunction “PURCHASE OF THE PRODUCT”. Then the supplier will inform the customer of the possible date of the availability of the goods and when they will be ready for the shipping agent. The same information will be given to the shipping agent by the company.



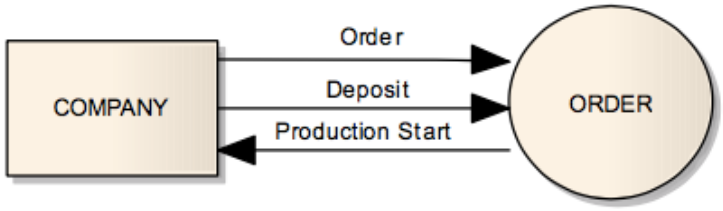
DFD Step 3: process COMMUNICATION WITH THE SUPPLIERS

Nome: ORDER
Tipo: PROCESS
Description: The process of the implementation of the order has got, as ste pone the request of a Proforma invoice to the supplier. Then the order is placed and confirmed. So the supplier asks for the payment of the 30% of the entire amount as a guarantee, before starting the production.

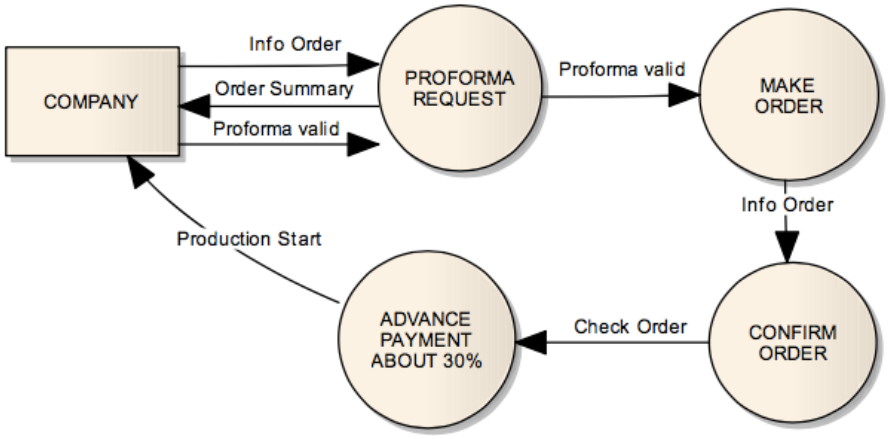


DFD, Step 3: ORDER process

PROCESS MODEL

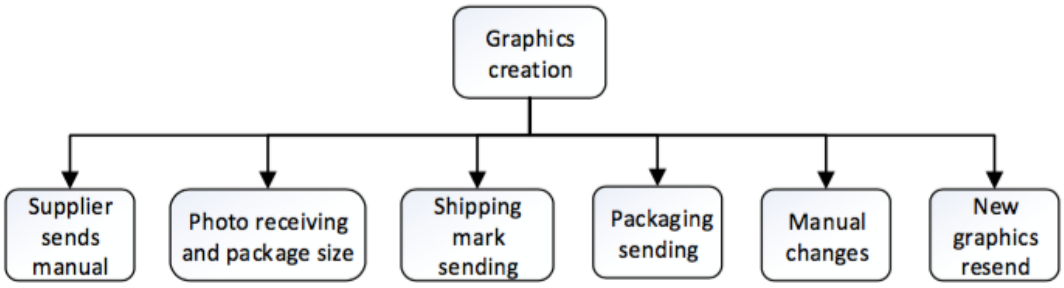


*Context diagram of the **Order** process*



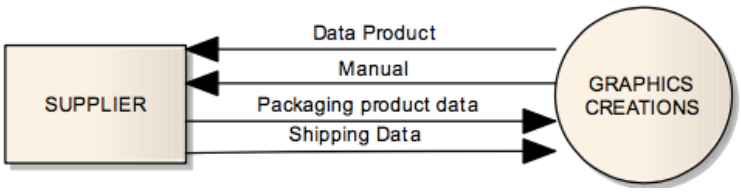
*Level 0, **order** process*

Nome: GRAFIC CREATION
Tipo: PROCESS
Description: During the time of the production, usually varying between 40 and 60 days, the company sends the manual of the references ordered to be translated and modified, according to specific needs. Along with it also the photos, and the size of the parcel containing each single unit will be sent. The company makes a new packaging with the various shipping marks. Then the supplier will be informed of the modifications so that the products will be made the way the company requires.

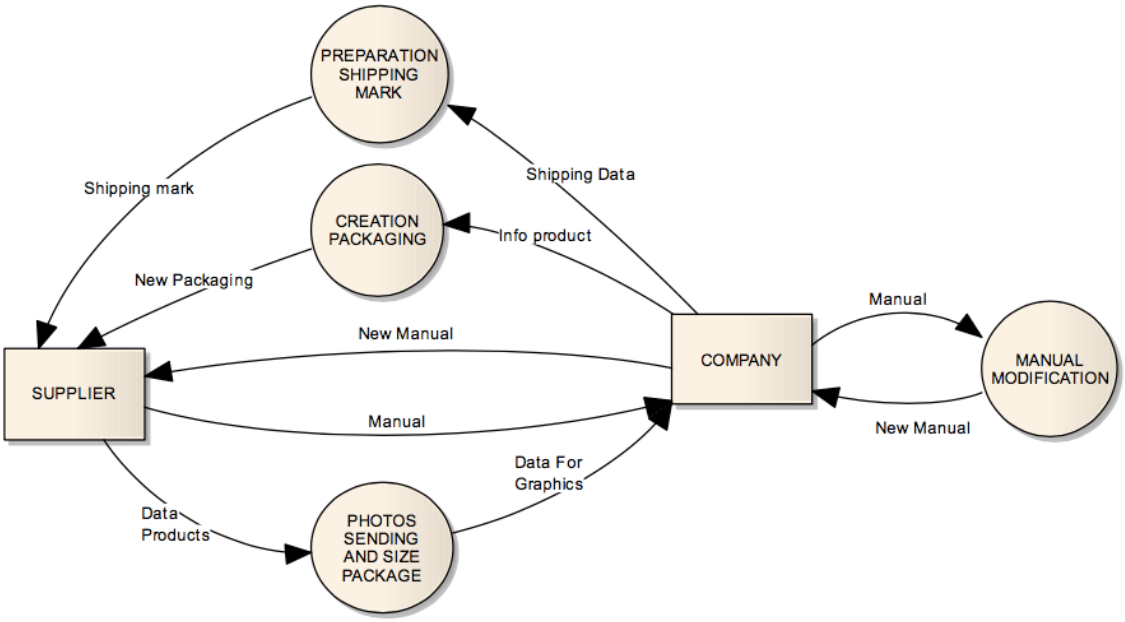


DFD, Step 3: GRAFIC CREATION process

PROCESS MODEL

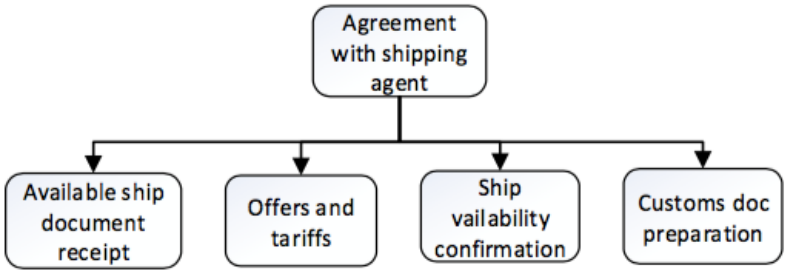


*Context diagram of the **GRAFIC CREATION** process*



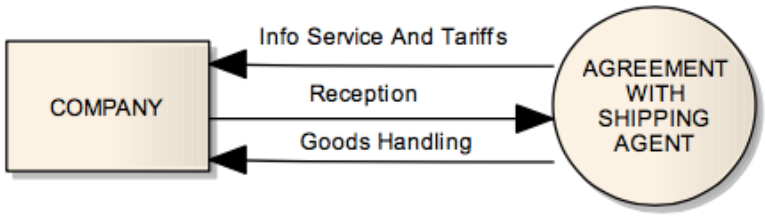
*Level 0, **GRAFIC CREATION** process*

Nome: CONTRACT WITH THE SHIPPING AGENT
Tipo: PROCESS
Description: The selection of the shipping agent is a delicate issue. The company entrusts to it the management and control of the goods from the moment they are loaded at the foreign country port to the company logistics. Shipping agents offer tariffs, services included, i.e. sea transport, loading and unloading, transport to the customs, customs clearance and companies they are used to work with for the handling of the goods. Once the shipping agent has been chosen. He sends a document to offer the ships available to take the goods, with tariffs and time of transport. It may happen that when the company has been chosen it is no longer available and thus it is necessary a confirmation by the shipping agent. He has also to prepare the customs documents to go with the containers, necessary to break the seals. In the contract with the shipping agent is also written the number of days the containers can stay in the clearing area (about 5 days) and at the customs (about 48 hours). Otherwise the company will have to pay for the over time.

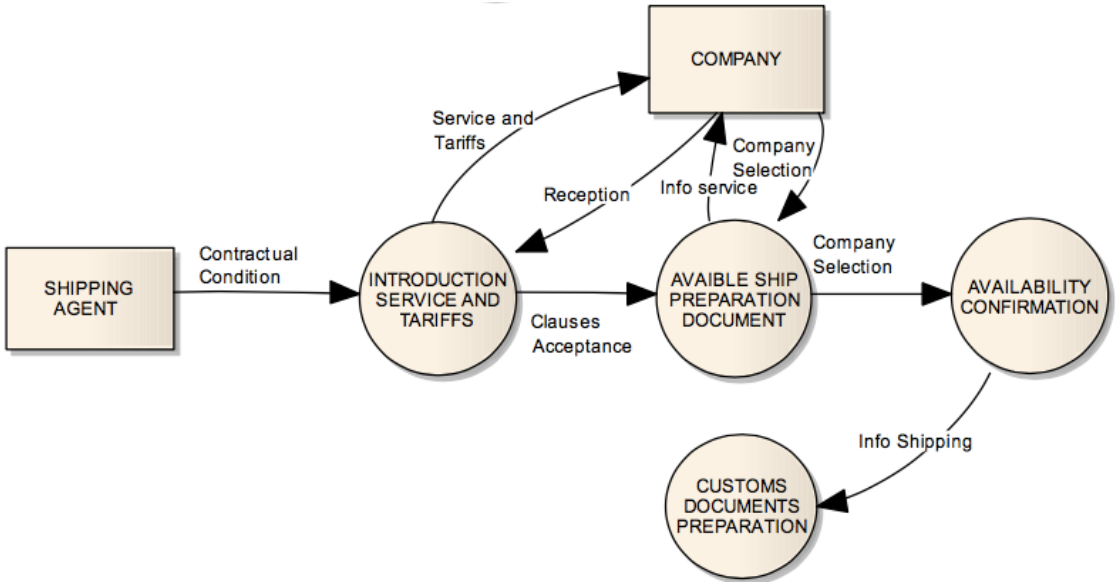


DFD, Step 3: AGREEMENT WITH THE SHIPPING AGENT process

PROCESS MODEL

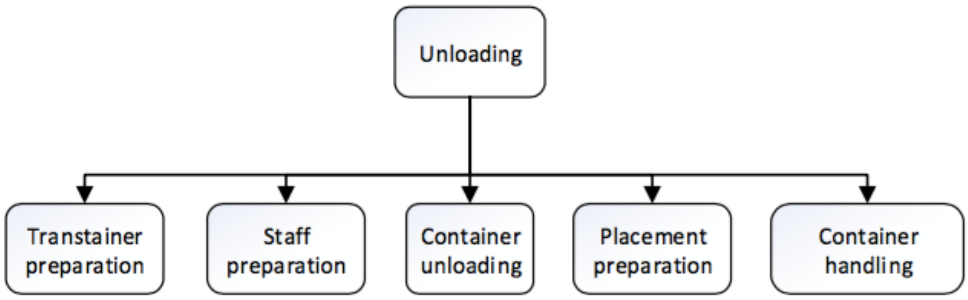


*Context diagram of the **AGREEMENT WITH THE SHIPPING AGENT** process*



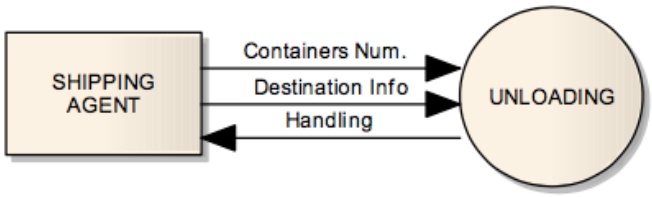
*Level 0, **AGREEMENT WITH THE SHIPPING AGENT** process*

Nome: UNLOADING
Tipo: PROCESS
Description: The process of unloading includes a series of activities to do when the ship is approaching the port. There is the preparation of the harbour personnel ready to control the and later the moving of the transtainers previously placed. Afterwards there is the actual unloading and the moving of the containers to the pre-assigned clearance area.

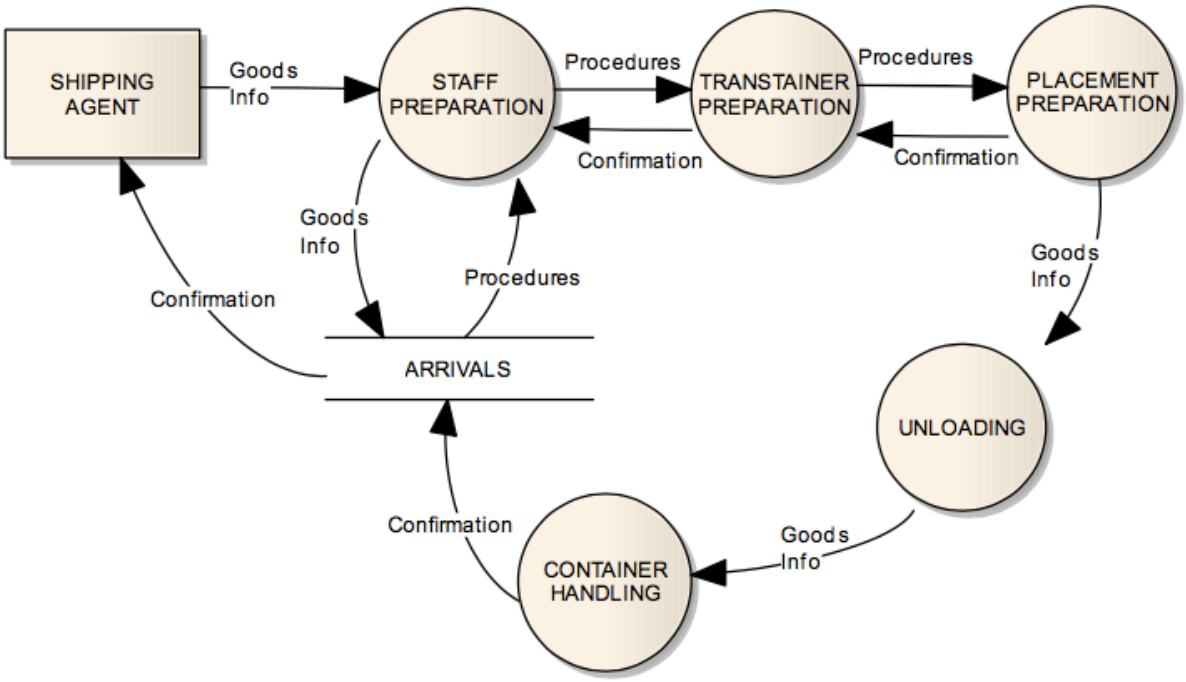


DFD, Step 3: UNLOADING process

PROCESS MODEL

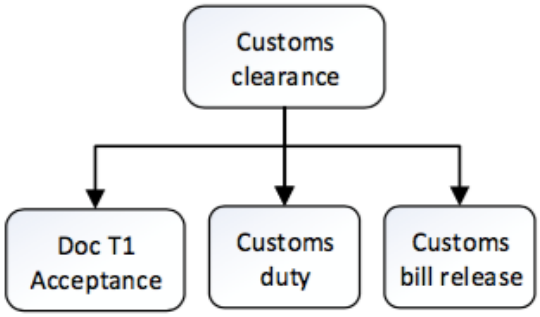


*Context diagram of the **UNLOADING** process*



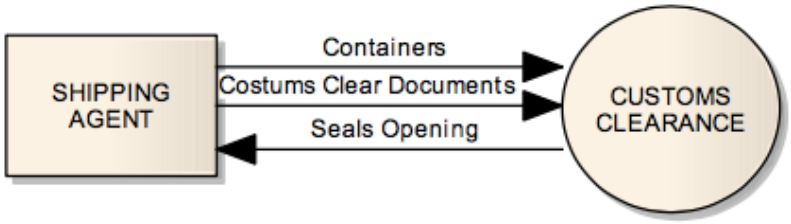
*Level 0, **UNLOADING** process*

Nome: CUSTOMS CLEARANCE
Tipo: PROCESS
Description: It is necessary the company pay the full amount of money so that the goods can leave the harbour. It is usual to pay some days before the arrival of the goods. It may happen that the payment arrives later and the containers stay longer. When the supplier gets the confirmation of the payment, he issues the document T1 that must be given to the customs office in order to get the breaking of the seals of the container. This process is an additional cost for the company, not included in the contract with the shipping agent. It is paid the customs duty based on the import material. At the end of the process the customs issues the bill of entry.

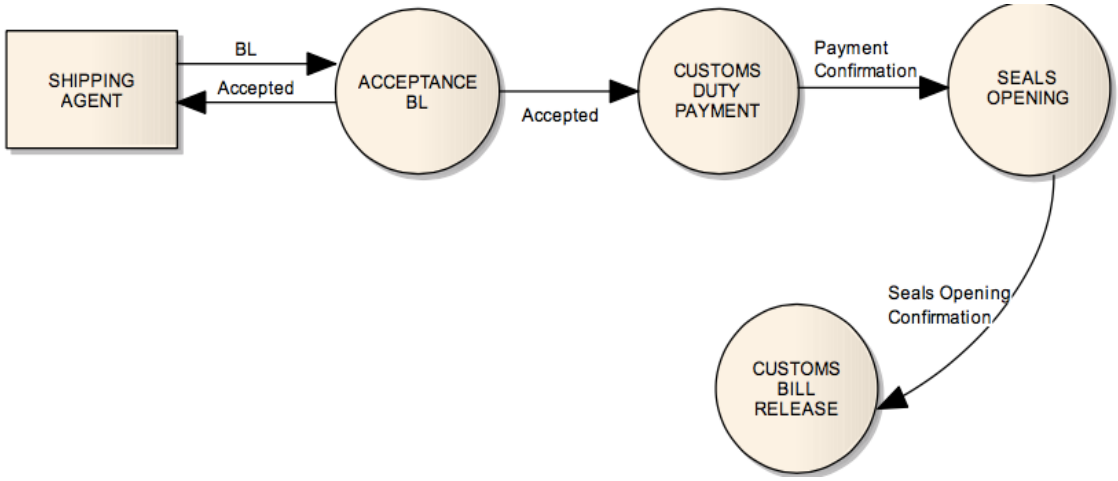


DFD, Step 3: CUSTOM CLEARANCE process

PROCESS MODEL

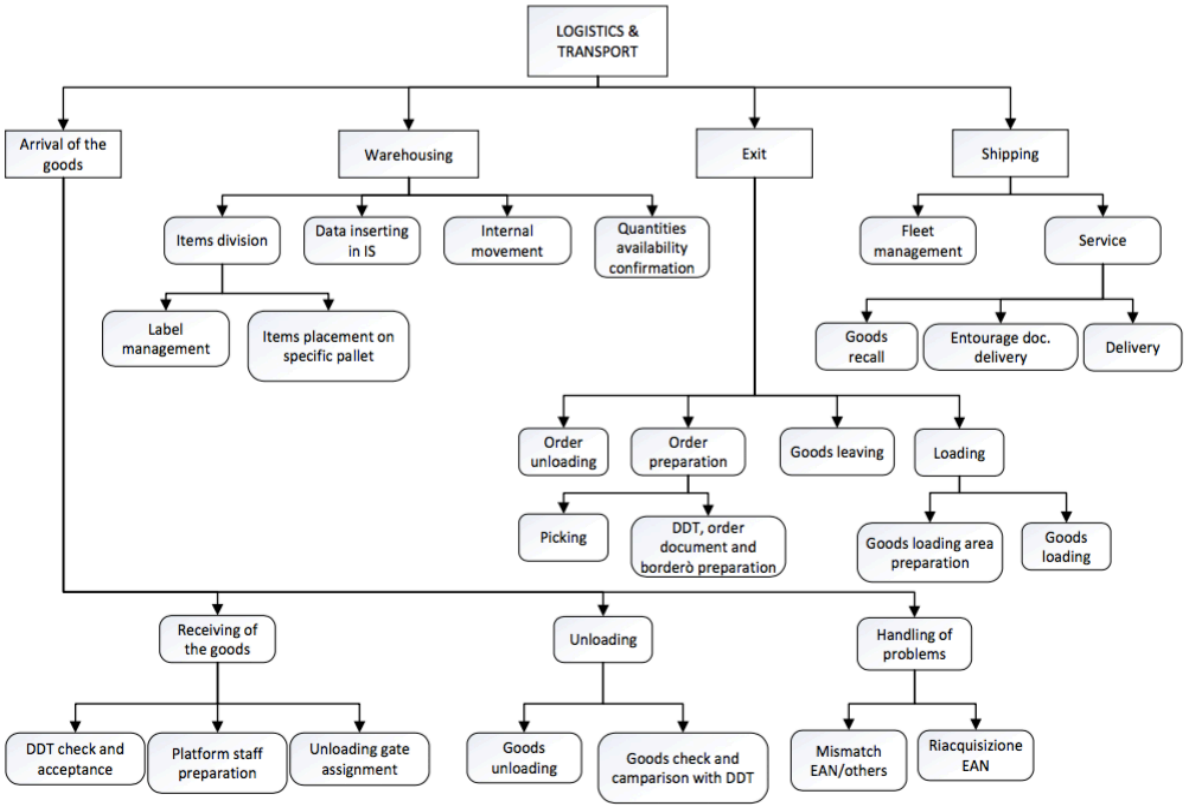


*Context diagram of the **CUSTOM CLEARANCE** process*

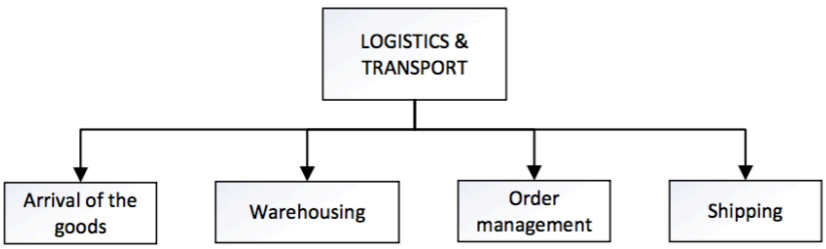


*Level 0, **CUSTOM CLEARANCE** process*

LOGISTICS E TRANSPORT

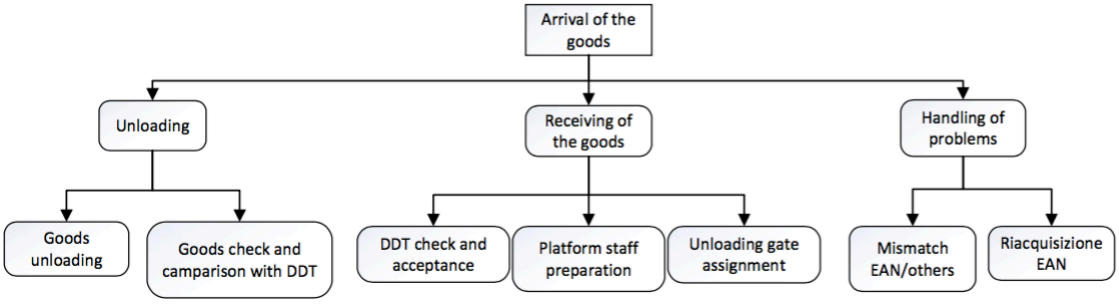


Nome: LOGISTICS & TRANSPORT
Tipo: FUNCTION
Description: It is the organization area dealing with the moving of the products. It states the ways of loading, unloading shipping and looks after LeadTimes according to the agreement with the customer. It organises goods from the moment they arrive at logistics. It handles both the physical and information storage of the goods and, when the order is placed, arranges the operations of the exit of the goods to the delivery to an external agency dealing with the distribution.



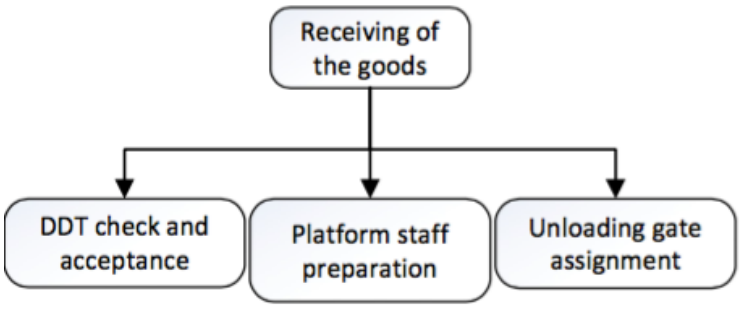
Decomposition functional diagram: Step 1: subfunctions of Logistics and Transport

Nome: ARRIVAL OF THE GOODS
Tipo: SUBFUNCTION
Description: It deals with the initial processes from the moment the lorries arrive at the logistics. The receiving phase shows the entrance of the lorry at the logistics, and the initial formalities of checking and preparation. When everything is ready the goods are unloaded and checks are started. It may happen there are no correspondences between the information on DDT and what is received, so it is necessary to sort out small problems (anomalies)



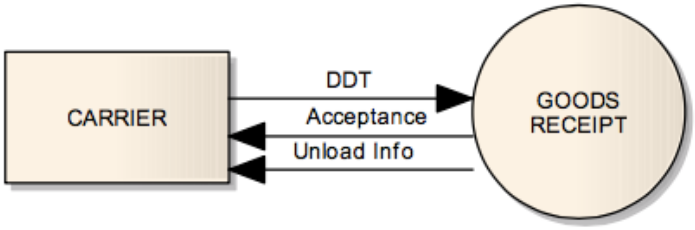
DFD, Step 2: Processes of the subfunction ARRIVAL OF THE GOODS of the main function LOGISTISCS AND TRANSPORT

Nome: RECEIVING OF GOODS
Tipo: PROCESS
Description: Once the lorry has reached the fixed unloading place, the actual unloading of the various platforms starts. Unloaded, the quality and the quantity of the goods are checked and the data are compared with the ones on the DDT.

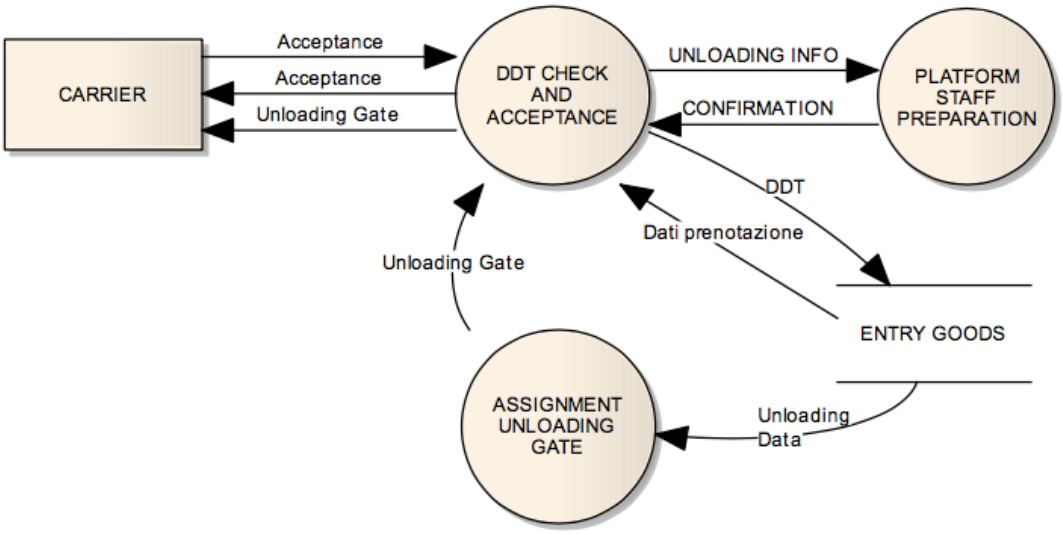


DFD, Step 3: RECEIVING OF THE GOODS process

PROCESS MODEL

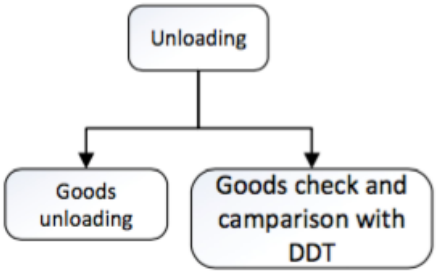


*Context diagram of the **receiving of the goods** process*



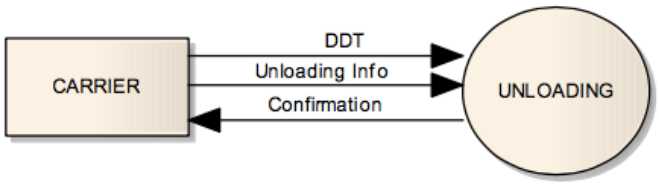
*Level 0, **RECEIVING OF THE GOODS** process*

Nome: UNLOADING
Tipo: PROCESS
Description: Once the lorry has reached the fixed unloading place, the actual unloading of the various platforms starts. Unloaded, the quality and the quantity of the goods are checked and the data are compared with the ones on the DDT.

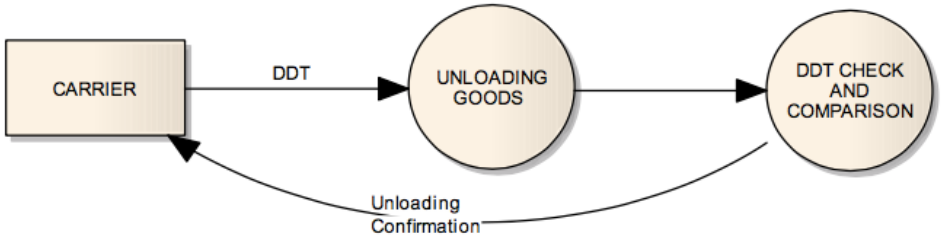


DFD, Step 3: UNLOADING process

PROCESS MODEL

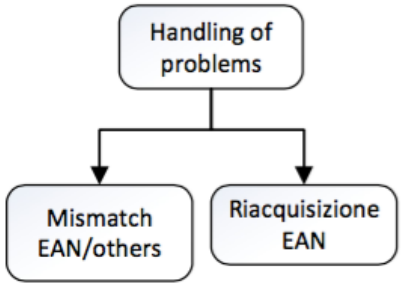


*Context diagram of the **UNLOADING** process*



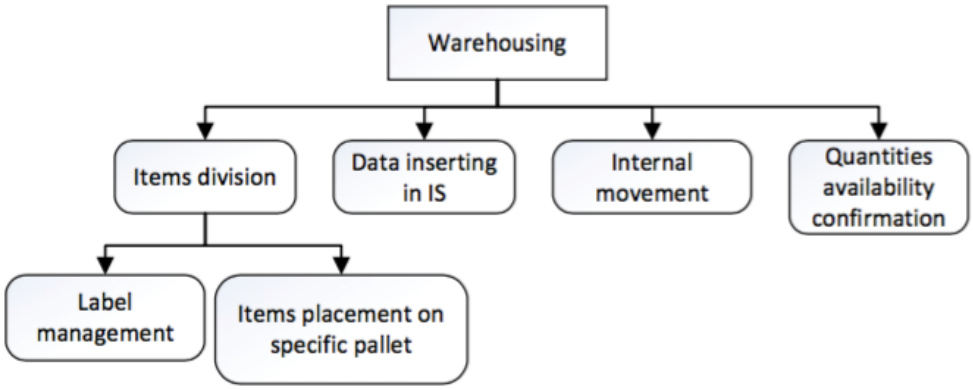
*Level 0, **UNLOADING** process*

Nome: HANDLING OF PROBLEMS
Tipo: PROCESS
Description: It is the phase where are dealt all the discrepancies between the goods the company have received and the data in the DDT. Every single item is thus analysed to see how many and which anomalies are found. There are often connected to the EAN code, but it may happen the order does not comply the required quantities. In this case there will be agreed with the supplier about receiving the missing goods with the next order or trying to get a discount.



DFD, Step 3: HANDLING OF PROBLEMS process

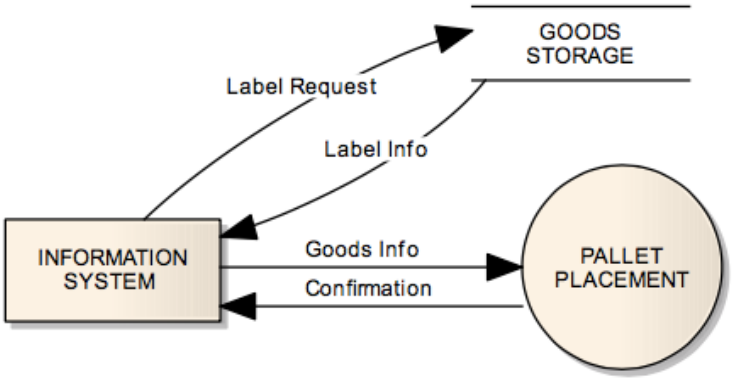
Nome: WAREHOUSING
Tipo: SUBFUNCTION
Description: It is the function to handle and organize the products inside the warehouse. After the checks, the items are separated according to the references and placed on dedicated platforms and moved to the respective placement. At this point the new product is inserted in the logistics database so that the inventory can is updated and a confirmation of availability is sent to the company database



DFD, Step 2: Processes of the subfunction WAREHOUSING of the main function LOGISTISCS AND TRANSPORT

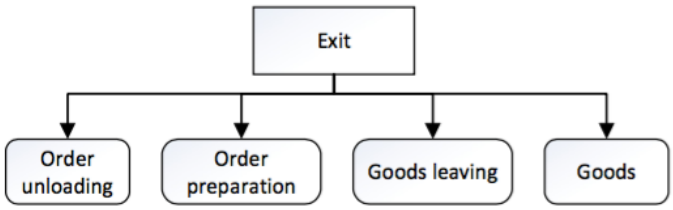
PROCESS MODEL

*Context diagram of the **ITEMS DIVISION** process*



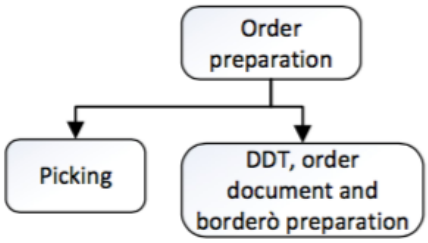
*Level 0, **ITEMS DIVISION** process*

Nome: EXIT
Tipo: SUBFUNCTION
Description: It deals with the download of the list of the items to be shipped during the day, usually three times a day. It manages the preparation of the goods according to the orders and ready to be loaded. It deals with the process of loading the goods on the lorry.



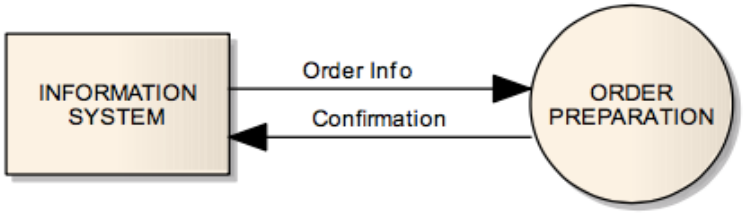
DFD, Step 2: Processes of the subfunction EXIT of the main function LOGISTISCS AND TRANSPORT

Nome: PREPARATION OF AN ORDER
Tipo: PROCESS
Description: The process of the preparation of an order is considered the phase to take the parcels, units and also bigger quantities from the shelves. In the same time for each shipping, the papers like the order form, DDT and list, the order cannot be accomplished without, are prepared. It may happen that logistics cannot dispatch an order as there are problems with the EAN code, so the company is contacted to sort them out. In this case it is the company that prepare DDT and list of the product sending every detail to the logistics.

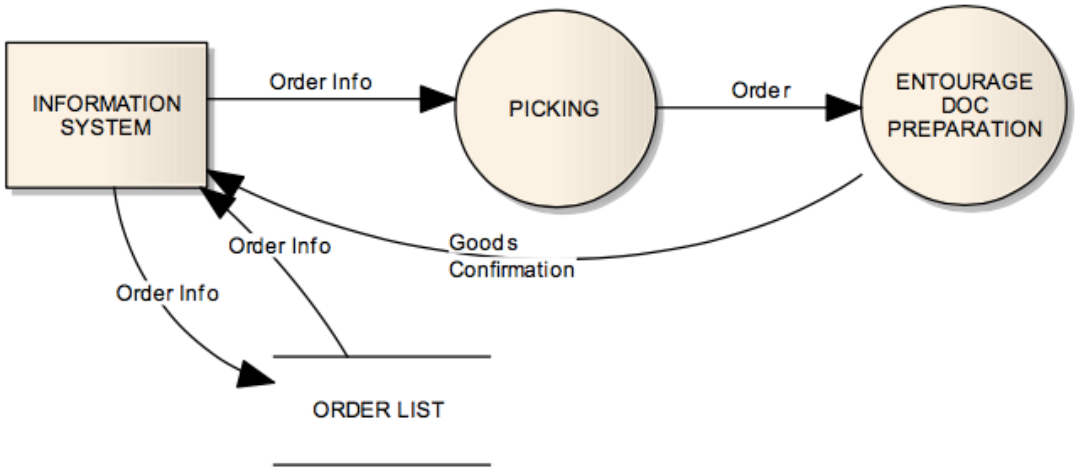


DFD, Step 3: ORDER PREPARATION process

PROCESS MODEL

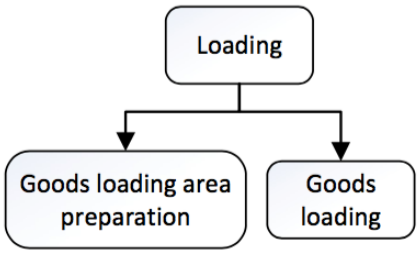


*Context diagram of the **ORDER PREPARATION** process*



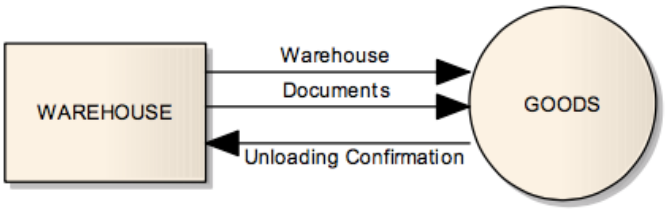
*Level 0, **ORDER PREPARATION** process*

Nome: LOADING
Tipo: PROCESS
Description: Taken the goods and prepared the papers to go with, everything is gathered in the loading area next to the platform where the lorry will stop. Usually the goods are taken by massive picking It may happen that with the last shipping it is unlikely to take all the remaining orders and this may be caused by a lack of preparation of the company or, more often, by the delivery company that has sent a smaller lorry. In these cases logistics informs the company that the will be shipping will be delayed.

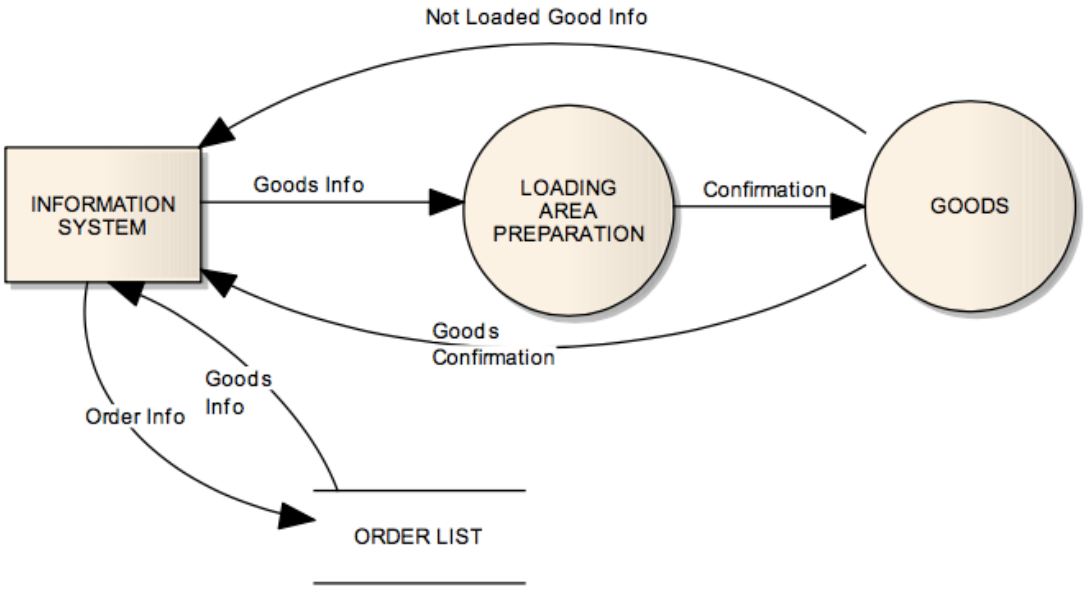


DFD, Step 3: UNLOADING process

PROCESS MODEL

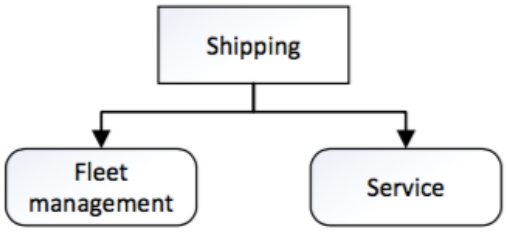


*Context diagram of the **UNLOADING** process*



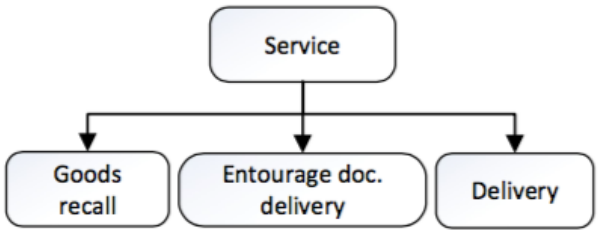
*Level 0, **UNLOADING** process*

Nome: SHIPPING
Tipo: SUBFUNCTION
Description: Together with the logistics it deals with the necessary fleet to take the goods and works with their distribution to the customers who can be both online users and resellers.



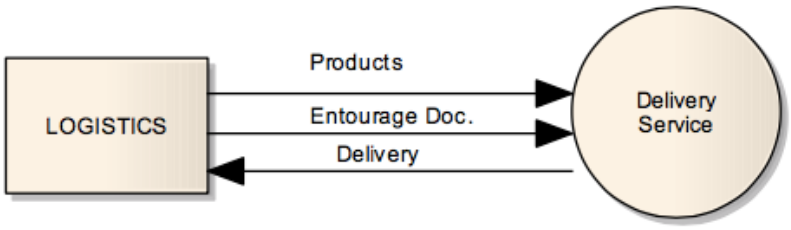
DFD, Step 2: Processes of the subfunction SHIPPING of the main function LOGISTISCS AND TRANSPORT

Nome: SERVICE
Tipo: PROCESS
Description: The shipping agent is immediately informed of each order the company receives. After agreeing with the logistics the necessary fleet, late in the morning the first collection is done. It is accompanied by documents. When the lorry leaves the harbour, the company is informed that the load has been entrusted to the shipping agency: The latter will manage the delivery to the customer.

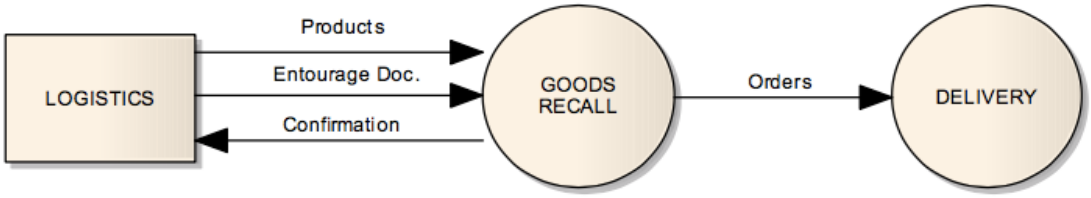


DFD, Step 3: SERVICE process

PROCESS MODEL

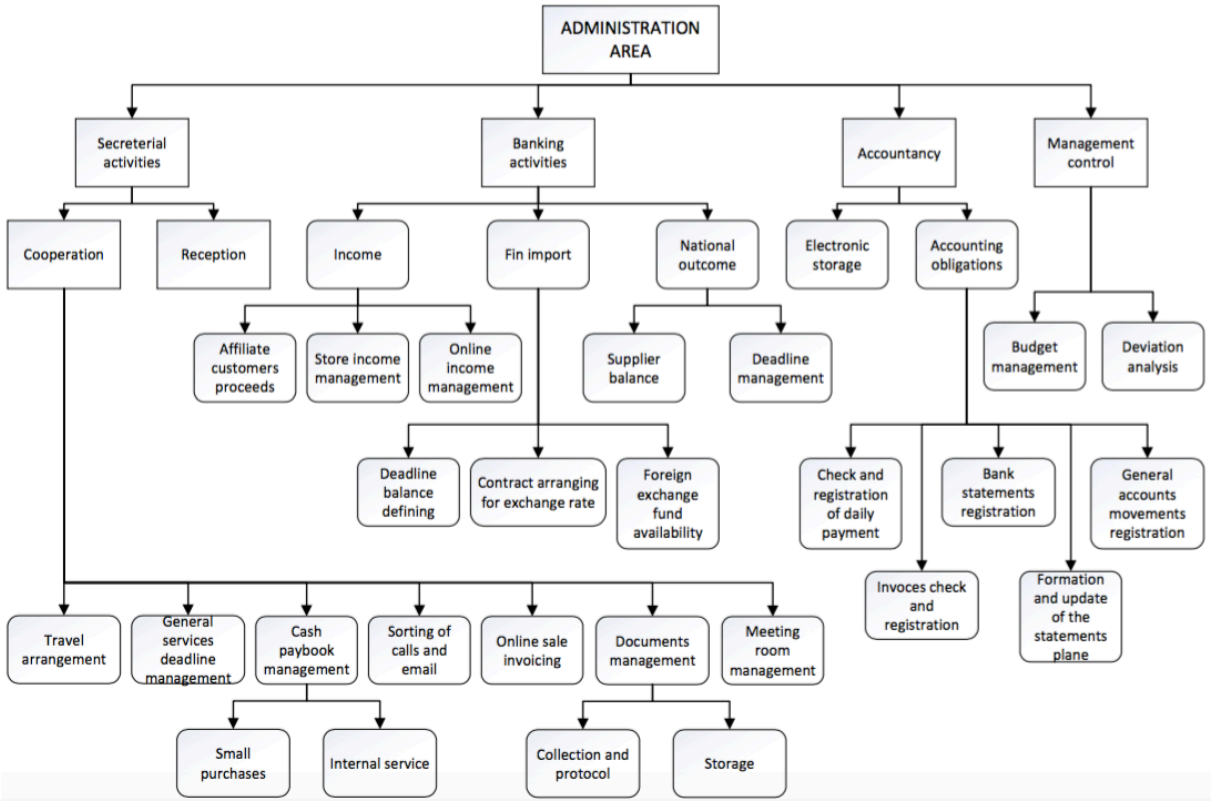


*Context diagram of the **SERVICE** process*

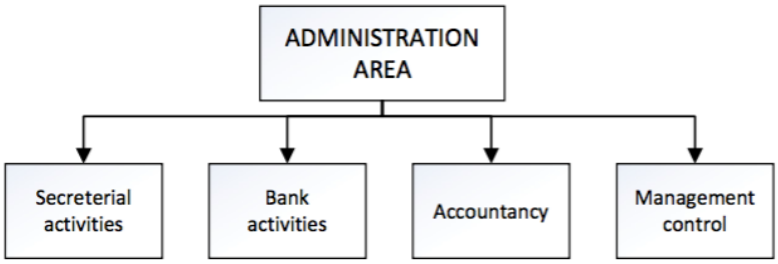


*Level 0, **SERVICE** process*

ADMINISTRATION AREA

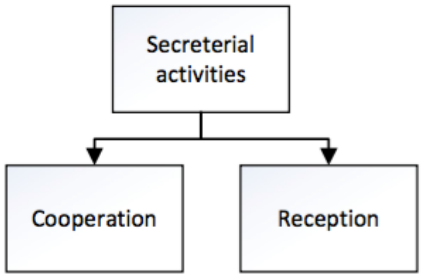


Nome: ADMINISTRATION AREA
Tipo: FUNCTION
Description: It is the organisation field dealing with different activities of the company management, supported also by external consultants. It manages a secretarial activity cooperating with the management and the functionality of the company. It deals with the financial side, so the relationship with the bank and the company account office.



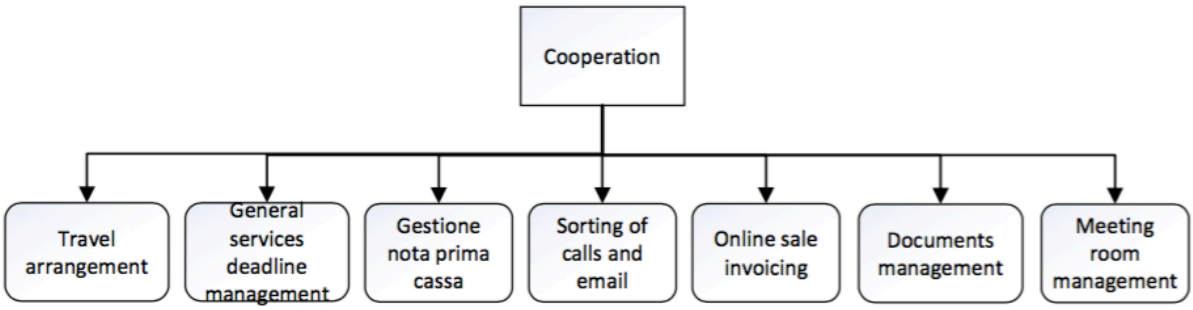
Decomposition functional diagram: Step 1: subfunctions of ADMINISTRATION AREA

Nome: SECRETARIAL ACTIVITY
Tipo: SUBFUNCTION
Description: It co-operates to the realization of management functions within the company organization. It deals with welcoming customers or external co-operators waiting for being received by company managers.



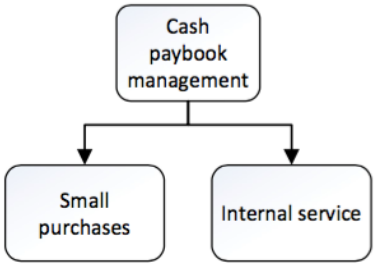
DFD, Step 2: Processes of the subfunction SECRETARIAL ACTIVITIES of the main function ADMINISTRATION AREA

Nome: COOPERATION
Tipo: SUBFUNCTION
Description: It deals with the organization and booking of business travels. It checks and organizes the expiry dates about the payment of bills, condominium, etc… It runs a cash daybook about the company internal expenses. It handles phone calls and emails sorting them out to the people involved. It issues invoices about online sales and orders company papers. It runs the availability of the meeting room, fixing appointments with the customers and external co-operators.



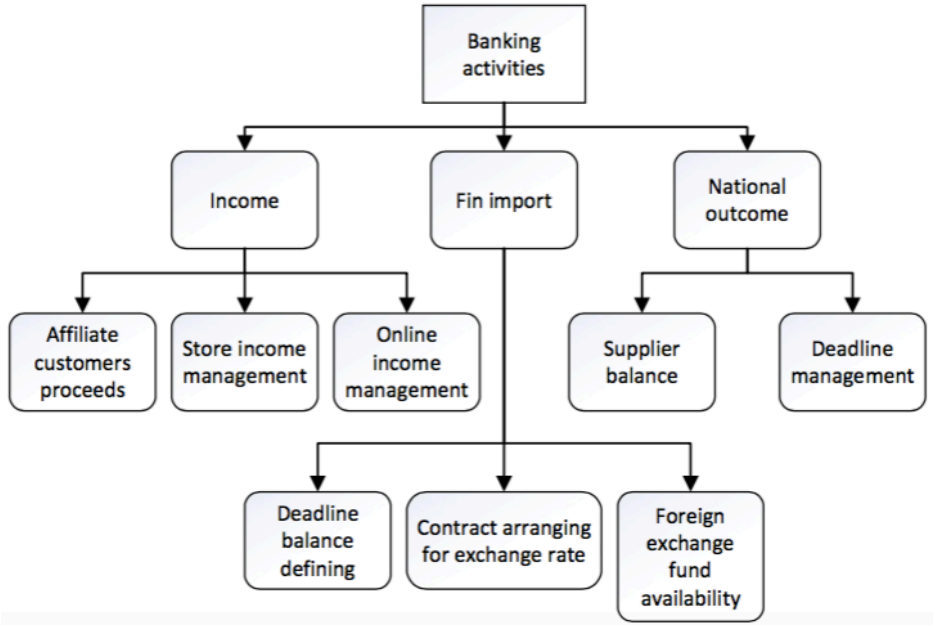
DFD, Step 2: Processes of the subfunction COOPERATION of the main function ADMINISTRATION AREA

Nome: CASH PAYBOOK MANAGEMENT
Tipo: PROCESS
Description: To the secretary it is given a small account used for internal purchase, like stationery, gadgets and office accessories. It is necessary to take note of the expenses for refund and for the final company balance.



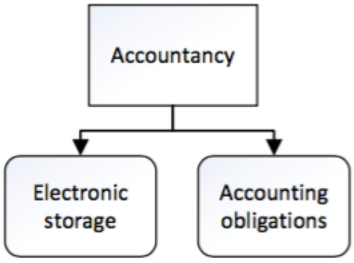
DFD, Step 3: CASH PAYBOOK MANAGEMENT process

Nome: BANK ACTIVITIES
Tipo: SUBFUNCTION
Description: It is made up by three processes connecting the bank to the company management: they are: takings management, fin import activities and the management of national outflow. The national takings and outflows are divided into sub-processes. Takings include the management of the income from the customers and the management of the money earned from online and shop sales. National outflows deal with managing the expiry dates of the payments to the supplier, the balance of the purchase and the payment of the commissions to the Market Place. As far as fin import process is concerned banks arrange for an account in foreign currency that the company will use to pay the supplier. Afterwards, through the study of the trend of the currency, the company chooses whether to fix an exchange rate based on the expiry or on the contract. Then the dates within which the company has to refund will be fixed.



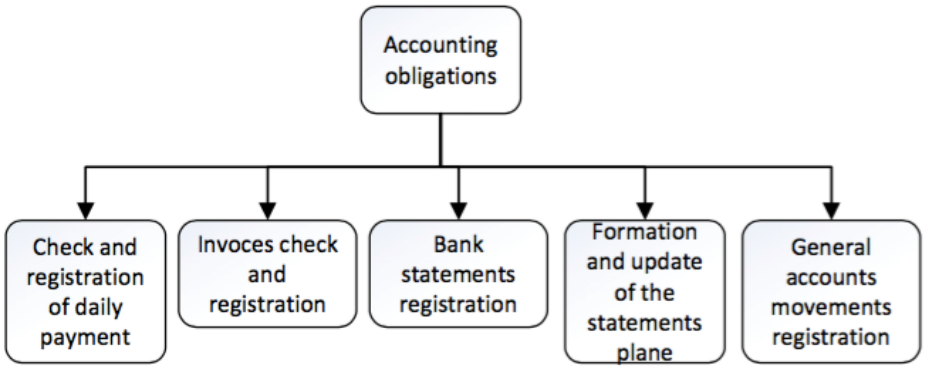
DFD, Step 2: Processes of the subfunction BANK ACTIVITIES of the main function ADMINISTRATION AREA

Nome: ACCOUNTANCY
Tipo: SUBFUNCTION
Description: It deals with checking and organizing the moving of the company money so that to have a fast access to the information and be able to evaluate the trend of the company. It runs the process of electronic storage of the data and gathers data to fulfil fiscal and account actions like incomes from the sales, VAT register, inventory book, etc.



DFD, Step 2: Processes of the subfunction ACCOUNTANCY of the main function ADMINISTRATION AREA

Nome: BOOK-KEEPING ACCOMPLISHMENT
Tipo: PROCESS
Description: It envisages the identification and note of the day remuneration coming from the point of sale. The note is made referring to the day the operation have been done within the following weekday.



DFD, Step 3: ACCOUNTING OBLIGATIONS process

5.3 Critical processes of the company (As-Is)

For privacy reasons in this study only the problem we have dealt with will be mentioned. As said in the previous chapter, one of the most important features connected with the company competitiveness and success are the costs necessary for a service.

It has been important a revision of the costs of the process of distribution of a product from the supplier to the customer to evaluate how much they affect the final selling price. In this way the company will also be able to declare whether the planned income fulfills the expectation.

In figure n. 19, thanks to the previous analysis, it was represented the order process, from the moment that the company gets in touch with the supplier to the stoking process in the warehouse, highlighting the costs involve.

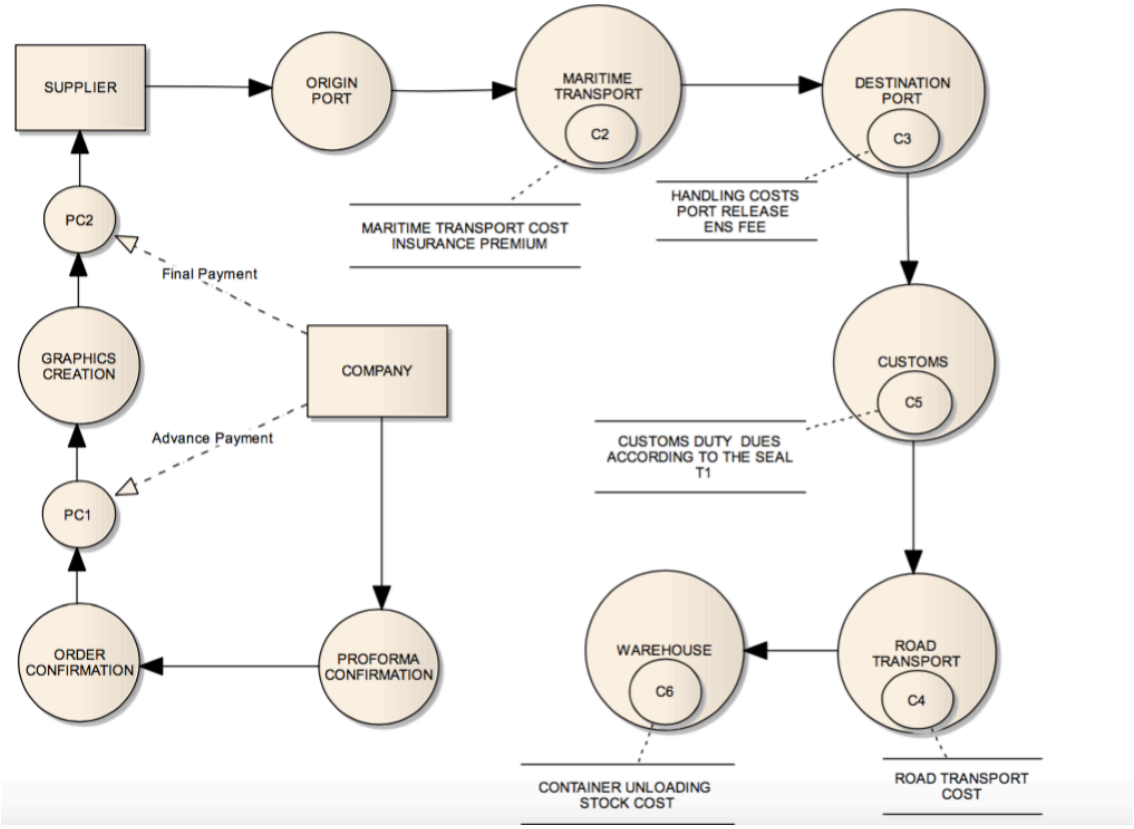


Figure 19: Order process with inbound costs

5.4 Application of the costs model developed

5.4.1 Overview

As said above, the aim of this work is the re-Engineering of the supply chain of a company in the e-Commerce sector. First of all, an analysis of the company was done to evaluate its processes and its management. With the collaboration of the company managers, it was decided to analyse the inbound process for a product purchase and the costs affecting it because It is important for a company to know the correct costs that affect a single unit before defining its selling price.

Then, according to the cost services offered to the company by external partners, a costs model was realized to estimate the inbound costs that affect a single item purchase by the company.

In the next paragraphs an article sample will be analysed through the costs model.

5.4.2 Imported articles sampling

The considered data for this work represent all the import articles ordered by the company in the last 5 months. It was not possible to adopt the model to each order so it was decided

to work on an article sample. it was selected a sample of twenty-four articles more or less the 20% of the data. The aim was to consider a representative for each category at least. The figure below shows the imported articles category that the company deals with.

Table 2 Sample of the articles considered in the analysis.

Article	Purchase cost	Volume (m^3)	Unit	Picture
Tool cabinet	44,42€	0,1876	1750	
Tiny Tots Baby Bathtub	2,84€	0,0035	360	
Rectangular Steel Frame pool	95,00€	0,297	125	
Pool Cover	3,40€	0,004	102	
Hydrium Pool Set	339,16€	0,831	30	
Dining table	24,99€	0,071	186	
Beach Ball	0,72€	0,0009	72	
Hydro force motor mount	10,34€	0,0077	24	
Sports car Ball Pit	10,07€	0,0193	12	

Castle	23,90€	0,01475	12	
Pocket fashion lounge	2,03€	0,00233	480	
Beer set	41,65€	0,1872	712	
Bench foot	3,33€	0,00202	104	
BBQ	50,90€	0,1489	1380	
Garage C	476,63€	0,533	44	
Kayak	28,89€	0,0562	120	
Gallon sand filter pump	51,99€	0,0797	400	
Spa Cup Holder	1,17€	0,00604	240	
Swim vest	1,58€	0,001208	24	
Polywood set	276,72€	1,0156	64	
Brite solar led	7,97€	0,012	120	

Hydrium oval pool set	472,06€	0,887	60	
Steel pro frame set	100,14€	0,189	100	
Pool set	254,62€	0,596	20	

5.4.3 Calculation of costs and analysis

The costs model was applied to each order obtaining the percentage and the costs of each inbound cost components involved in the inbound process.

To allow the cost model to work, it is necessary to submit the information linked to the order taken into consideration inside it. At the end, the total inbound cost for each article unit is defined.

The first data required in Tab.1 are about the time period considered. It is important because according to it, the services rate and the exchange rate are different.

Indeed, the warehousing service rate can change month by month, the exchange rate changes day by day and the shipping service rate week by week.

As we can see, the tab.1 need of the day in which the commercial invoice was signed and the day when the good was unloaded in the warehouse.

The exchange rate changes during the shipping process, indeed, it is different from the moment of the purchase, the maritime transport and in the custom.

INPUT

Table 3: Time period input data

Commercial Invoice		Scarico in Magazzino		
20/06/17		24/04/17		
Exchange				
Currency available	Currency required	Exchange rate		Fonte
Dollar (USA)	Euro	1,0805	Purchase cost	Bank
		0	Insurance premium	Shipping invoice
		1,0815	Maritime transport cost	Shipping invoice
		1,0815	ENS fee	Shipping invoice
		1,1193	Customs	Customs invoice

In Tab.4 there are four section divided in order, shipping, customs and warehouse.
In each of them should be put in data about respectively: the interested order, that means units, volume per unit, loading unit .., the shipping characteristics as container number, container type.., customs data as article material, customs clearance.. and about the order in the warehouse so how pallet it involves how many units per pallet..
Other important data for the model are the service rate. This are represented for each section.

Table 4:Costs model input data

Order				
			Note	Fonte:
Supplier	Frontier			Commercial Invoice
Shippings	1			Bill of Lading
N° of the order	1			Commercial Invoice
Article code	XTB220			Commercial Invoice
Article description	Tool cabinet			Commercial Invoice
Cost per unit	$48,000		FOB	Commercial Invoice
Unit per order	1750			Commercial Invoice
Order total cost	$84.000,00	€ 77.741,79	FOB	Commercial Invoice
Occupated container by the order	5			Packing list
Containers number	1,2,3,4,5		Ci,Cj,Cz..	Packing list
Loading unit	Box			Packing list
Loading units per orders	1750			Packing list
Units per loading unit	1			Packing list
Order total volume	328,83		m^3	Packing list
Loading unit volume	0,1876		m^3	Packing list
Shipping				
Shipping number	1			Packing list
Occupated container	5		Nc	Packing list
Container typology	40 HC			Bill of Lading
Contaiener volume	70		m^3	Known
Goods volume in occupated container by the order	328,83		Vi+Vj+VZ..	
Valore totale spedizione	$ 84.000,00	€ 77.741,79		Commercial Invoice
Maritime transpor cost	$ 1.300,00	€ 1.202,03	€/container	Shipping invoice
Service cost (about the order)		€ 6.010,17		
Insurance premium per B/L	$ -	€ -	€/Bill of lading	Shipping invoice
Road transport cost(CVV - S. Palomba)		€ -		Shipping invoice
Terminal				
ENS Fee	$ 50,00	€ 46,23	€/container	Shipping invocie
Handling costs		€ 650,00	€/container	Shipping invocie
Port release		€ 55,00	€/Bill of lading	Shipping invocie
Port release per occupated container by the order		€ 55,00		
Customs				
Material category				Customs invoice
Order value (custom estimation)		€ 75.046,90		
Good value in occupated container by the order (custom estimation)		€ 77.727,40		Customs invoice
Custom clearance percentage	0,00%			Customs invoice
Occupated container value by the order affected by the custom clearance		€ 88.368,65		Customs invoice
Dues according to the seal per occupated container by the order		€ 95,00		Customs invoice
T1 emission		€ -	€/container	Customs invoice
Custom clearance per occupated container by the order		€ -		Customs invoice
Warehouse				
Total rented space	12300	m^2	Logistics contract	
Cost per month	30000	€/m^2	Logistics contract	
Pallet number	175		Logistics contract	
Units per pallet	10		Logistics contract	
Pallet occupation	1	m^2	Known	
Unloading containers of loose boxes	200	€/container	Logistics contract	
Cost per pallet	2,43902439	€/pallet	Logistics contract	

The following tables will show how the model works. Each cost component calculation will be represented.

While the purchase cost, the premium insurance, the customs duties are dependent from the value and the material of the article, the stocking costs from the units number, all the other cost components are dependent from the volume.

Calculation process

Maritime costs

Table 5: Insurance premium calculation

Insurance			
Units per article	qi,qy,qz..	1750	
Cost per unit	Ci=	€	44,42
Cost per order	Co = Ci*q =	€	77.741,79
Loading unit per order	Qi, Qj..	1750	
Shipping value	Cs	€	77.741,79
Order incidence on shipping value	Rp = Co/Cs	100%	
Insurance premium per B/L	Ca	€	-
Insurance premium per order	Cao=Ca * Nc*Rp =	€	-
Insurance premium per Loading unit	Cau = Cao / Q=	€	-
Units per loading unit	qi		1
Insurance premium per unit	Cap = Cau / q =	€	-

Table 6: Maritime transport cost calculation

Maritime transport cost			
Article code	i,j..	XTB220	
Loading unit per order	Qi, Qj..	1750	
Loading units volume	Vi,Vj..	0,1876	[m³]
Container voume	Vc	70	[m³]
Occupated containers by the order	Nc	5	
Shipping total volume	Vt = Vc * Nc	350	[m³]
Order volume	Vo	328,83	[m³]
Goods volume in occupated container by the order	Vsp	328,83	[m³]
Order occupation rate	To = Vo/ Vt	94%	
Service cost	Cs =	€ 6.010,17	[€/service]
Order cost	Co= Cs*Vo/Vsp	€ 6.010,17	[€/order]
Loading unit cost	Cu = Co / Qi	€ 3,43	[€/Loading unit]
Units per loading unit	q	1	
Cost per unit	Ci = Cu/q	**€ 3,43**	[€/item]

Terminal costs

Table 7: Port release calculation

Port release			
Article code	i,j..	XTB220	
Loading unit per order	Qi, Qj..	1750	
Loading units volume	Vi,Vj..	0,1876	[m³]
Container voume	Vc	70	[m³]
Occupated containers by the order	Nc	5	
Shipping total volume	Vt = Vc * Nc	350	[m³]
Order volume	Vo	328,83	[m³]
Goods volume in occupated container by the order	Vsp	328,83	[m³]
Order occupation rate	To = Vo/ Vt	94%	
Service cost	Cs =	€ 55,00	[€/service]
Order cost	Co= Cs*Vo/Vsp	€ 55,00	[€/order]
Loading unit cost	Cu = Co / Qi	€ 0,03	[€/Loading unit]
Units per loading unit	q	1	
Cost per unit	Ci = Cu/q	**€ 0,03**	[€/item]

Table 8: Handling costs calculation

Handling costs			
Article code	i,j..	XTB220	
Loading unit per order	Qi, Qj..	1750	
Loading units volume	Vi,Vj..	0,1876	[m³]
Container voume	Vc	70	[m³]
Occupated containers by the order	Nc	5	
Shipping total volume	Vt = Vc * Nc	350	[m³]
Order volume	Vo	328,83	[m³]
Goods volume in occupated container by the order	Vsp	328,83	[m³]
Order occupation rate	To = Vo/ Vt	94%	
Service cost	Cs =	€ 3.250,00	[€/service]
Order cost	Co= Cs*Vo/Vsp	€ 3.250,00	[€/order]
Loading unit cost	Cu = Co / Qi	€ 1,86	[€/Loading unit]
Units per loading unit	q	1	
Cost per unit	Ci = Cu/q	**€ 1,86**	[€/item]

Table 9: ENS fee calculation

ENS fee			
Article code	i,j..	XTB220	
Loading unit per order	Qi, Qj..	1750	
Loading units volume	Vi,Vj..	0,1876	[m³]
Container voume	Vc	70	[m³]
Occupated containers by the order	Nc	5	
Shipping total volume	Vt = Vc * Nc	350	[m³]
Order volume	Vo	328,83	[m³]
Goods volume in occupated container by the order	Vsp	328,83	[m³]
Order occupation rate	To = Vo/ Vt	94%	
Service cost	Cs =	€ 231,16	[€/service]
Order cost	Co= Cs*Vo/Vsp	€ 231,16	[€/order]
Loading unit cost	Cu = Co / Qi	€ 0,13	[€/Loading unit]
Units per loading unit	q	1	
Cost per unit	Ci = Cu/q	**€ 0,13**	[€/unit]

Customs costs

Table 10: T1 emission calculation

T1			
Article code	i,j..	XTB220	
Loading unit per order	Qi, Qj..	1750	
Loading units volume	Vi,Vj..	0,1876	[m³]
Container voume	Vc	70	[m³]
Occupated containers by the order	Nc	5	
Shipping total volume	Vt = Vc * Nc	350	[m³]
Order volume	Vo	328,83	[m³]
Goods volume in occupated container by the order	Vsp	328,83	[m³]
Order occupation rate	To = Vo/ Vt	94%	
Service cost	Cs =	€ -	[€/service]
Order cost	Co= Cs*Vo/Vsp	€ -	[€/order]
Loading unit cost	Cu = Co / Qi	€ -	[€/Loading unit]
Units per loading unit	q	1	
Cost per unit	Ci = Cu/q	**€ -**	[€/unit]

Table 11: Customs duty calculation

Custom clearance			
Article code		XTB220	
Order value (custom estimation)	Co	€ 75.046,90	
Loading unit per order	Q	1750	
Units per order	q	1750	
Occupated container value by the order affected by the custom clearance	B	€ 88.368,65	
Custom clearance per occupated container by the order	Dsp	€ -	
Order incidence on B	Inc	85%	
Custom clearance per order	Do	€ -	
Custom clearance per loading unit	Du = Do / Q	€ -	
Custom clearance per unit	Di = Du/ q	**€ -**	[€/unit]

Table 12: Dues according to the seal calculation

Dues according to the seal			
Article code		XTB220	
Order value (custom estimation)	Co	€ 75.046,90	
Good value in occupated container by the order (custom estimation)	Vsp	€ 77.727,40	
Loading unit per order	Q	1750	
Unis per order	q	1750	
Dues according to the seal per occupated container by the order	Db	€ 95,00	
Order incidence on Vsp	Inc	97%	
Dues according to the seal per order	Dbo = Db*Inc	€ 91,72	
Dues according to the seal per loading unit	Dbu= Dbo/Q	€ 0,05	
Units per loading unit	q	1	
Dues according to the seal per unit	Dbp= Dbu/q	**€ 0,05**	[€/unit]

Road transport cost

Table 13: Road transport cost calculation

Trucking cost			
Article code	i,j..	XTB220	
Loading unit per order	Qi, Qj..	1750	
Loading units volume	Vi,Vj..	0,1876	[m³]
Container voume	Vc	70	[m³]
Occupated containers by the order	Nc	5	
Shipping total volume	Vt = Vc * Nc	350	[m³]
Order volume	Vo	328,83	[m³]
Goods volume in occupated container by the order	Vsp	328,83	[m³]
Order occupation rate	To = Vo/ Vt	94%	
Service cost	Cs =	€ -	[€/service]
Order cost	Co= Cs*Vo/Vsp	€ -	[€/order]
Loading unit cost	Cu = Co / Qi	€ -	[€/Loading unit]
Units per loading unit	q	1	
Cost per unit	Ci = Cu/q	**€ -**	[€/unit]

Warehousing costs

Table 14: Container unloading cost calculation

Container Unloading			
Article code	i,j..	XTB220	
Loading unit per order	Qi, Qj..	1750	
Loading units volume	Vi,Vj..	0,1876	[m³]
Container voume	Vc	70	[m³]
Occupated containers by the order	Nc	5	
Shipping total volume	Vt = Vc * Nc	350	[m³]
Order volume	Vo	328,83	[m³]
Goods volume in occupated container by the order	Vsp	328,83	[m³]
Order occupation rate	To = Vo/ Vt	94%	
Service cost	Cs =	€ 1.000,00	[€/service]
Order cost	Co= Cs*Vo/Vsp	€ 1.000,00	[€/order]
Loading unit cost	Cu = Co / Qi	€ 0,57	[€/Loading unit]
Units per loading unit	q	1	
Cost per unit	Ci = Cu/q	**€ 0,57**	[€/unit]

Table 15: Stocking cost calculation

Stocking cost			
Total rented space:	S	12300	[m²]
Pallet occupation	Sp	1	[m²]
Service cost	Cs	€ 2,44	[€/pallet]
Occupated paller per order	np	175	
Service cost per order	Co	€ 426,83	
Units per order	nc	1750	[m²]
Loading units per order	nu	1750	
Loading unit cost per month	Cu = Co/nu	€ 0,24	€/loading unit per month]
Cost per unit per month	Ci = Co/nc	€ 0,24	[€/unit per month]
Loading unit cost per day	Cu(day)=Cu/30	€ 0,01	[€/loading unit per day]
Cost per unit per day	Ci(day)=Cp/30	€ 0,01	[€/unit per day]

The last table shows the model output data. It resumes some data of the article and all the costs per unit and per Unloading unit and their percentage respect to the total inbound cost.

OUTPUT

Table 16: Output data - Inbound costs

	Order	1					
	Article	XTB220					
	Items	1750					
	Loading Unit	Box					
				€/unit	€/UdC	%per unit	Notes
C1	Purchase and Placement		Purchase cost	€ 44,42	€ 44,42	92,77%	FOB
C2	Maritime costs		Maritime transport cost	€ 0,57	€ 0,57	1,19%	
			Insurance premium	€ -	€ -	0,00%	
	Terminal costs		ENS Fee	€ 0,13	€ 0,13	0,28%	
C3			Handling costs	€ 1,86	€ 1,86	3,88%	
			Port release	€ 0,03	€ 0,03	0,07%	
	Custom costs		Custom clearance	€ -	€ -	0,00%	
C4			Dues according to the s	€ 0,05	€ 0,05	0,11%	
			T1 emission	€ -	€ -	0,00%	
C5	Road transport costs		CVV - S. Palomba	€ -	€ -	0,00%	
C6	Warehouse costs		Containers unloading	€ 0,57	€ 0,57	1,19%	
			Stocking cost	€ 0,24	€ 0,24	0,51%	€/month
			Total cost	€ 47,88	€ 47,88		
C7	Variable cost		Occupation	€ 0,01	€ 0,01	Day increment	

6 Re-engineering of critical processes

6.1 Sensitivity analysis

As said above, each article was ordered in different time periods, the rates affecting the shipping process and the Warehousing activities were different. So, each article was normalized respect to the same time period in order to have common service costs. So, the only variables are those linked to the articles.

According to the results obtained for each article, a normalized matrix was realized putting in the columns the articles and in the lines the cost components of the inbound process.

As regard as the normalized matrix, an average value of the percentages was calculated for each cost component to have an idea of which of them has a major effect on the total inbound costs.

The results show that the cost components with a major influence are naturally the price and those one linked to the volume. A minor influence is linked to the customs and the stoking costs.

Table 17: Inbound costs percentages

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Media
Purchase cost	87,54%	92,88%	86,71%	90,28%	89,94%	88,15%	89,93%	96,71%	92,44%	94,80%	90,47%	87,38%	95,56%	88,89%	93,94%	91,20%	86,63%	77,80%	91,45%	87,90%	90,94%	91,79%	95,74%	90,46%	**90,4%**
Maritime transport cost	6,77%	2,52%	5,96%	1,92%	4,01%	4,52%	1,95%	1,31%	3,20%	1,06%	2,01%	7,06%	2,08%	4,56%	1,86%	3,33%	6,13%	8,65%	1,50%	6,48%	3,14%	3,14%	0,82%	3,87%	**3,7%**
Insurance premium	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	**0,0%**
ENS Fee	0,26%	0,08%	0,20%	0,07%	0,15%	0,17%	0,08%	0,05%	0,12%	0,04%	0,08%	0,27%	0,08%	0,18%	0,07%	0,12%	0,22%	0,31%	0,06%	0,22%	0,12%	0,12%	0,03%	0,15%	**0,1%**
Handling costs	3,66%	1,31%	3,11%	1,04%	2,17%	2,44%	1,06%	0,71%	1,73%	0,57%	1,08%	3,82%	1,13%	2,47%	1,00%	1,80%	3,31%	4,68%	0,81%	3,17%	1,70%	1,70%	0,44%	2,09%	**2,0%**
Port release	0,06%	0,03%	0,24%	0,02%	0,05%	0,21%	0,02%	0,02%	0,04%	0,05%	0,09%	0,16%	0,05%	0,21%	0,08%	0,15%	0,02%	0,40%	0,02%	0,27%	0,04%	0,04%	0,01%	0,04%	**0,1%**
Customs duty	0,00%	2,49%	2,33%	5,67%	2,34%	0,00%	2,35%	0,00%	0,00%	2,47%	5,68%	0,00%	0,00%	2,32%	2,45%	2,38%	2,26%	4,88%	0,00%	0,00%	3,25%	2,39%	2,50%	2,36%	**2,0%**
Dues according to the seal	0,10%	0,09%	0,15%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,06%	0,07%	0,09%	0,08%	0,03%	0,04%	0,01%	0,00%	0,04%	0,07%	0,00%	0,00%	0,00%	**0,0%**
T1 emission	0,00%	0,00%	0,00%	0,04%	0,02%	0,28%	0,04%	0,03%	0,06%	0,02%	0,03%	0,06%	0,02%	0,09%	0,07%	0,18%	0,17%	0,47%	0,03%	0,37%	0,00%	0,06%	0,02%	0,08%	**0,1%**
CVV - S. Palomba	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	**0,0%**
Container unloading	1,13%	0,36%	0,86%	0,32%	0,67%	0,75%	0,33%	0,22%	0,53%	0,18%	0,33%	1,18%	0,35%	0,76%	0,31%	0,55%	1,02%	1,44%	0,25%	0,98%	0,52%	0,52%	0,14%	0,64%	**0,6%**
Stocking costs	0,48%	0,22%	0,44%	0,63%	0,65%	3,47%	4,25%	0,95%	1,86%	0,81%	0,23%	0,01%	0,67%	0,43%	0,13%	0,26%	0,21%	1,36%	5,88%	0,57%	0,23%	0,24%	0,30%	0,30%	**1,0%**

According to the sensitivity analysis it was necessary to define the indicators with higher influence. The previous analysis just gave to us an idea but to be sure it was used the Pearson's correlation coefficient which defines the correlations among the indicators and between the indicators and the inbound cost components.

First of all, a rectangular matrix was realized. The columns represent the articles of the sample, while the chosen indicators and the inbound cost component that define the inbound process are represented on the lines.

Table 18: Cost components and indicators

	1	2	3	4	5	6	7	8	9	10	11	12
Units	1750	360	125	102	30	186	72	24	12	12	480	712
Price	44,42 €	2,84 €	95,00 €	3,40 €	339,16 €	24,99 €	0,72 €	10,34 €	10,07 €	23,90 €	2,03 €	41,65 €
Volume	0,1876	0,0035	0,297	0,004	0,831	0,071	0,0009	0,0077	0,0193	0,01475	0,00233	0,1872
Ordine volume	328,3	1,26	37,125	0,408	24,93	13,206	0,0648	0,1848	0,2316	0,177	1,1184	133,2864
Purchase cost	44,42 €	2,84 €	95,00 €	3,40 €	339,16 €	24,99 €	0,72 €	10,34 €	10,07 €	23,90 €	2,03 €	41,65 €
Maritime transport cost	3,43 €	0,07 €	5,72 €	0,07 €	15,13 €	1,28 €	0,02 €	0,14 €	0,35 €	0,27 €	0,04 €	3,37 €
Insurance premium	- €	- €	- €	- €	- €	- €	- €	- €	- €	- €	- €	- €
ENS Fee	0,13 €	0,00 €	0,22 €	0,00 €	0,58 €	0,05 €	0,00 €	0,01 €	0,01 €	0,01 €	0,00 €	0,13 €
Handling costs	1,86 €	0,04 €	3,09 €	0,04 €	8,18 €	0,69 €	0,01 €	0,08 €	0,19 €	0,14 €	0,02 €	1,82 €
Port release	0,03 €	0,00 €	0,26 €	0,00 €	0,17 €	0,06 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,08 €
Customs duty	- €	0,07 €	2,48 €	0,21 €	8,84 €	- €	0,02 €	- €	- €	0,62 €	0,13 €	- €
Dues according to the seal	0,05 €	0,00 €	0,17 €	- €	- €	- €	- €	- €	- €	- €	- €	0,03 €
T1 emission	- €	- €	- €	0,00 €	0,08 €	0,08 €	0,00 €	0,00 €	0,01 €	0,01 €	0,00 €	0,03 €
CVV - S. Palomba	- €	- €	- €	- €	- €	- €	- €	- €	- €	- €	- €	- €
Container unloading	0,57 €	0,01 €	0,95 €	0,01 €	2,52 €	0,21 €	0,00 €	0,02 €	0,06 €	0,04 €	0,01 €	0,56 €
Stocking costs	0,24 €	0,01 €	0,49 €	0,02 €	2,44 €	0,98 €	0,03 €	0,10 €	0,20 €	0,20 €	0,01 €	0,00 €
Total cost	50,75 €	3,04 €	108,38 €	3,77 €	377,09 €	28,35 €	0,80 €	10,69 €	10,90 €	25,20 €	2,24 €	47,66 €

	13	14	15	16	17	18	19	20	21	22	23	24
Units	104	1380	44	120	400	240	24	64	120	60	100	20
Price	3,33 €	50,90 €	476,63 €	28,89 €	51,99 €	1,17 €	1,58 €	276,72 €	7,97 €	472,06	100,14 €	254,62 €
Volume	0,00202	0,1489	0,533	0,0562	0,0797	0,00604	0,001208	1,0156	0,012	0,887	0,189	0,596
Ordine volume	0,21008	205,482	23,452	6,744	31,88	1,4496	0,028992	64,9984	1,44	53,22	18,9	11,92
Purchase cost	3,33 €	50,90 €	476,63 €	28,69 €	51,99 €	1,17 €	1,58 €	276,72 €	7,87 €	472,06 €	100,14 €	254,62 €
Maritime transport cost	0,07 €	2,61 €	9,43 €	1,05 €	3,68 €	0,13 €	0,03 €	18,78 €	0,27 €	16,14 €	3,43 €	10,89 €
Insurance premium	- €	- €	- €	- €	- €	- €	- €	- €	- €	- €	- €	- €
ENS Fee	0,00 €	0,10 €	0,36 €	0,04 €	0,13 €	0,00 €	0,00 €	0,72 €	0,01 €	0,62 €	0,13 €	0,42 €
Handling costs	0,04 €	1,41 €	5,10 €	0,57 €	1,99 €	0,07 €	0,01 €	10,16 €	0,15 €	8,73 €	1,85 €	5,89 €
Port release	0,00 €	0,12 €	0,43 €	0,05 €	0,01 €	0,01 €	0,00 €	0,86 €	0,00 €	0,18 €	0,04 €	0,12 €
Customs duty	- €	1,33 €	12,42 €	0,75 €	1,35 €	0,07 €	- €	- €	0,28 €	12,30 €	2,61 €	6,64 €
Dues according to the seal	0,00 €	0,05 €	0,40 €	0,01 €	0,02 €	0,00 €	- €	0,14 €	0,01 €	- €	- €	- €
T1 emission	0,00 €	0,05 €	0,35 €	0,06 €	0,10 €	0,01 €	0,00 €	1,17 €	- €	0,32 €	0,07 €	0,22 €
CVV - S. Palomba	- €	- €	- €	- €	- €	- €	- €	- €	- €	- €	- €	- €
Container unloading	0,01 €	0,43 €	1,57 €	0,17 €	0,61 €	0,02 €	0,00 €	3,13 €	0,05 €	2,69 €	0,57 €	1,81 €
Stocking costs	0,02 €	0,24 €	0,67 €	0,08 €	0,13 €	0,02 €	0,10 €	1,83 €	0,02 €	1,22 €	0,32 €	0,85 €
Total cost	3,49 €	57,26 €	507,35 €	31,46 €	60,01 €	1,50 €	1,73 €	313,51 €	8,65 €	514,28 €	109,15 €	281,45 €

The matrix was analysed and evaluated through the software Matlab. It transformed the rectangular matrix in a square matrix. The latter shows the parameters and the activities both on lines and columns.

Each point in the matrix represents the Pearson's correlation coefficient but only the unexpected correlations were considered and shown by charts later.

The satisfying level correlation was chosen between 0,8-1,0 because, considering the sample, only the 21% of the total population (articles deal with) was evaluated so we need of high correlation.

Table 19: Pearson's correlation coefficient

	Units	Price	Volume	Ordine volume	Purchase cost	Maritime transport cost	Insurance premium	ENS Fee	Handling costs	Port release	Customs duty	Dues according to the seal	T1 emission	CVV - S. Palomba	Container unloading	Stocking costs	Total cost
Units		-0,2	-0,1	0,9	-0,2	-0,1	-	-0,1	-0,1	-0,1	-0,2	0,0	-0,2	-	-0,1	-0,2	-0,2
Price	-0,2		0,9	0,0	1,0	0,9	-	0,9	0,9	0,6	0,9	0,5	0,6	-	0,9	0,7	1,0
Volume	-0,1	0,9		0,1	0,9	1,0	-	1,0	1,0	0,8	0,7	0,4	0,8	-	1,0	0,9	0,9
Ordine volume	0,9	0,0	0,1		0,0	0,1	-	0,1	0,1	0,1	0,0	0,1	0,1	-	0,1	0,0	0,0
Purchase cost	-0,2	1,0	0,9	0,0		0,9	-	0,9	0,9	0,6	0,9	0,5	0,6	-	0,9	0,7	1,0
Maritime transport cost	-0,1	0,9	1,0	0,1	0,9		-	1,0	1,0	0,8	0,7	0,4	0,8	-	1,0	0,9	0,9
Insurance premium	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-
ENS Fee	-0,1	0,9	1,0	0,1	0,9	1,0	-		1,0	0,8	0,7	0,4	0,8	-	1,0	0,9	0,9
Handling costs	-0,1	0,9	1,0	0,1	0,9	1,0	-	1,0		0,8	0,7	0,4	0,8	-	1,0	0,9	0,9
Port release	-0,1	0,6	0,8	0,1	0,6	0,8	-	0,8	0,8		0,3	0,7	0,9	-	0,8	0,6	0,7
Customs duty	-0,2	0,9	0,7	0,0	0,9	0,7	-	0,7	0,7	0,3		0,5	0,3	-	0,7	0,6	0,9
Dues according to the seal	0,0	0,5	0,4	0,1	0,5	0,4	-	0,4	0,4	0,7	0,5		0,4	-	0,4	0,2	0,5
T1 emission	-0,2	0,6	0,8	0,1	0,6	0,8	-	0,8	0,8	0,9	0,3	0,4		-	0,8	0,6	0,6
CVV - S. Palomba	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-	-
Container unloading	-0,1	0,9	1,0	0,1	0,9	1,0	-	1,0	1,0	0,8	0,7	0,4	0,8	-		0,9	0,9
Stocking costs	-0,2	0,7	0,9	0,0	0,7	0,9	-	0,9	0,9	0,6	0,6	0,2	0,6	-	0,9		0,8
Total cost	-0,2	1,0	0,9	0,0	1,0	0,9	-	0,9	0,9	0,7	0,9	0,5	0,6	-	0,9	0,8	

So, thanks to the sensitivity analysis, we can confirm the previous analysis saying that the volume is the most important parameter.

Below, Its unexspected relation will be represented in the charts.

Volume per unit – Purchase cost

The two charts represented below show the trend of the volume and the purchase costs. It is possible to note that they have the same behaviour, in fact when the first goes up the second one goes up as well and viceversa.

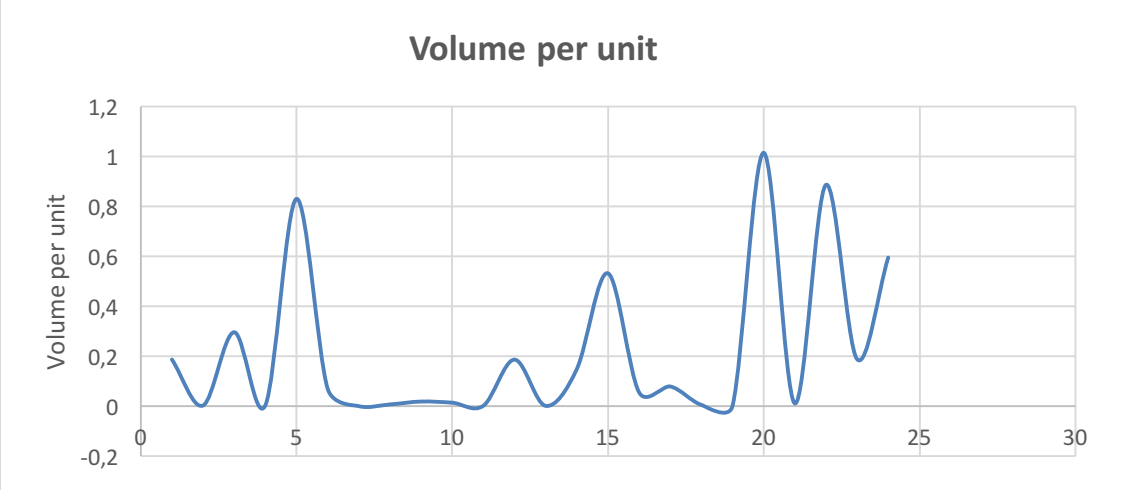


Chart 2: Volume per unit behaviour

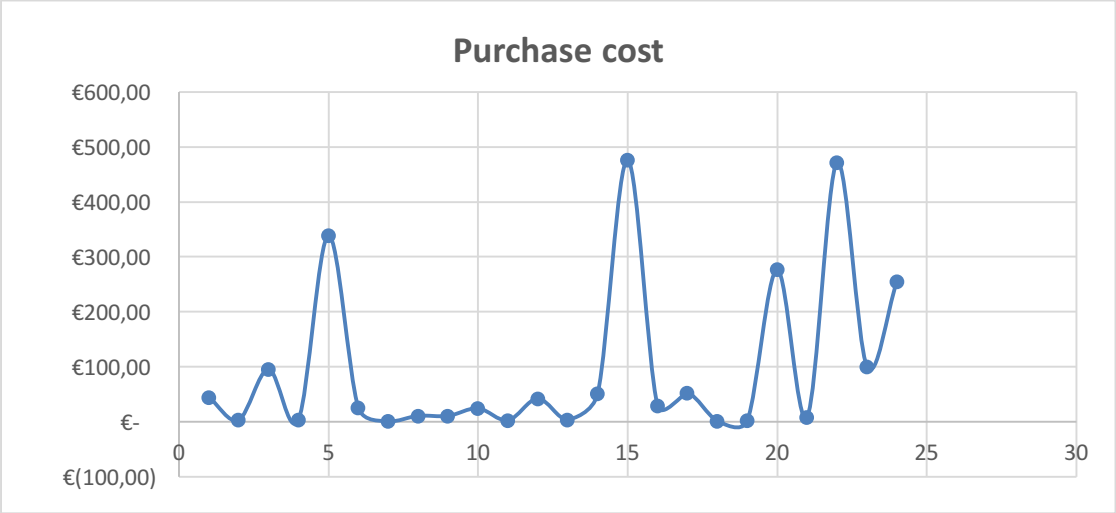


Chart 3: Purchase costs behaviour

As we can see in chart n°3 , the company purchases products that have a cost proportional to the volume. Of course, it can be a particular case or can be normal for all the companies that deal with this kind of products. Naturally this relation can not be associated to the electronic products for example.

The best correlation is represented by a potential equation.

In this case this correlation allows to do important considerations we will see later.

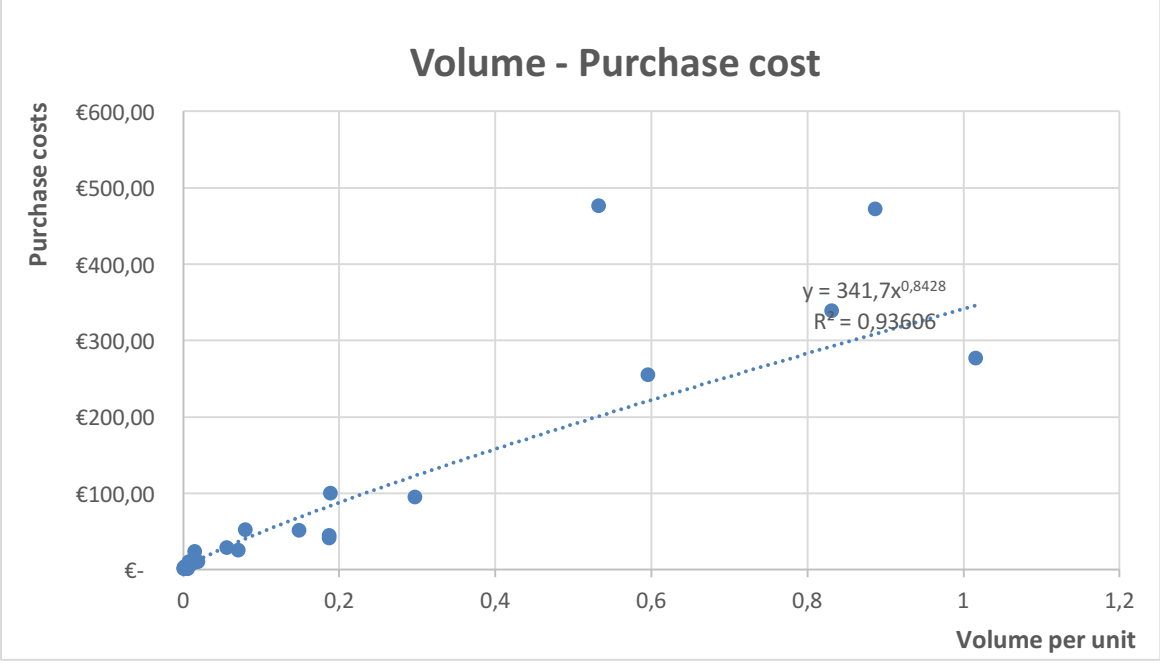


Chart 4: Volume-Purchase costs correlation

Purchase costs - Maritime costs

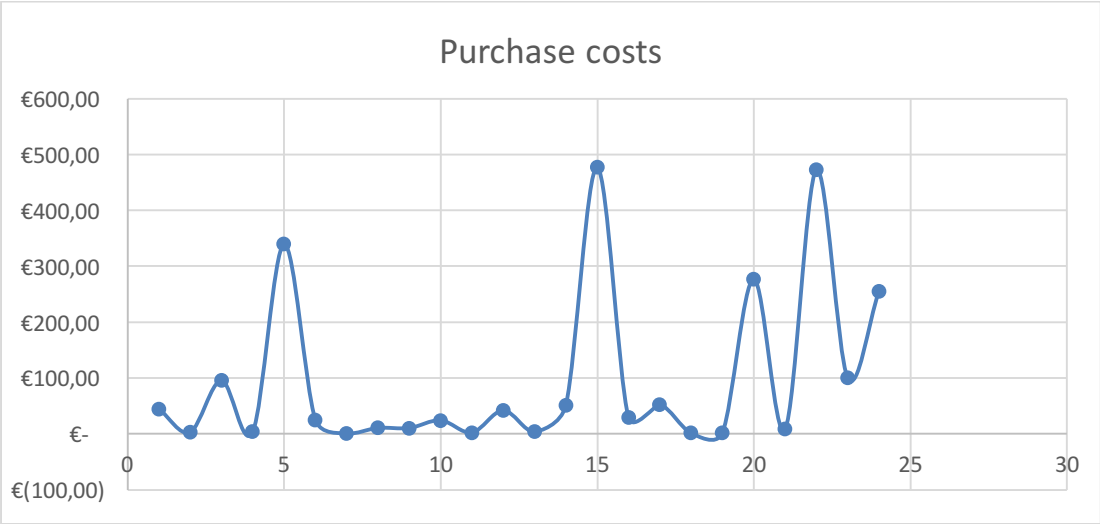


Chart 5:Purchase costs behaviour

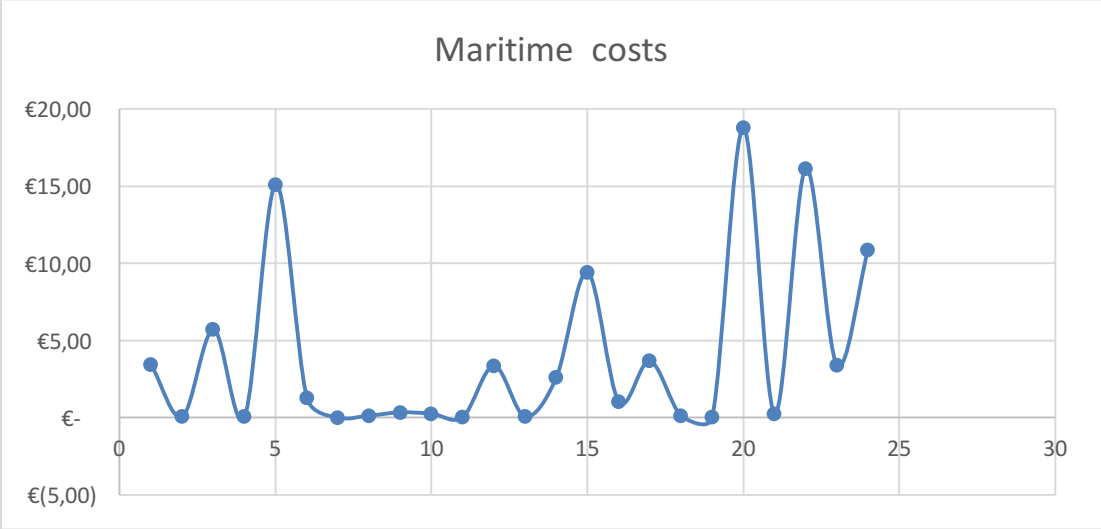


Chart 6:Maritime costs behaviour

As the correlation Volume-Purchase cost, also this one is represented by a power. Indeed, the correlation that links the purchase costs and the maritime costs is based on the volume. The volume is strictly linked with maritime costs and has correlation with the purchase costs as seen before.

The difference between the two correlations is the slope of the line. Indeed, the latter has a higher incline. This means that maritime costs increase more proportionally than the purchase costs.

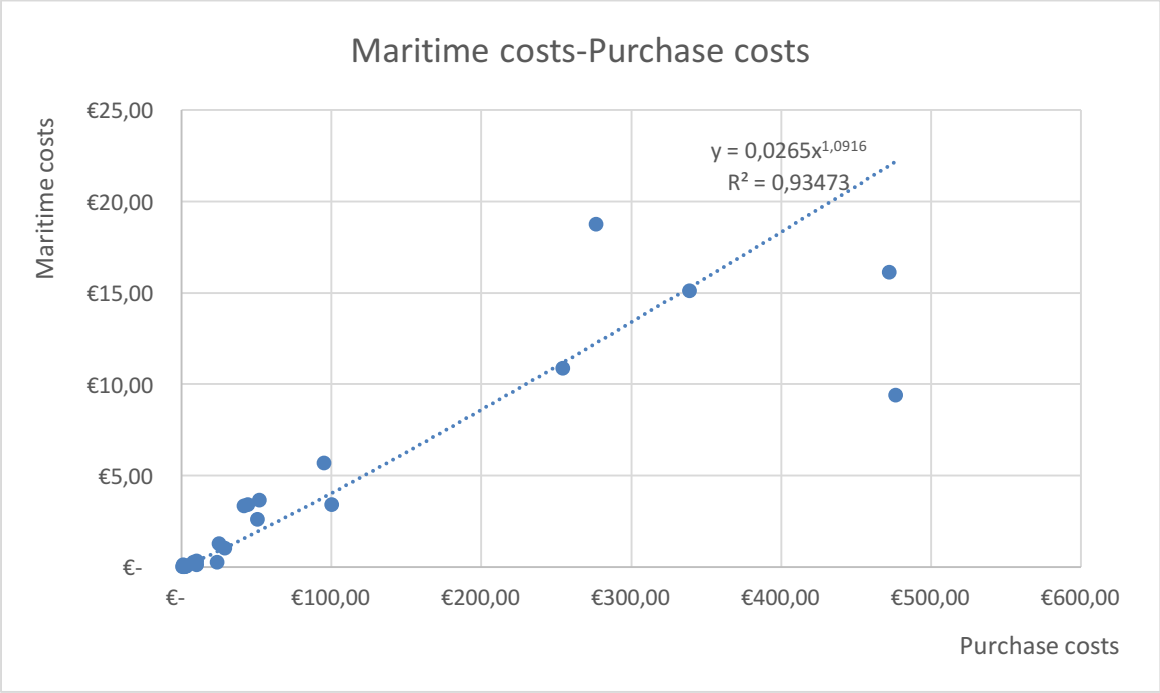


Chart 7: Maritime costs-Purchase costs correlation

Stoking cost – Volume per unit

As for the purchase costs, also stocking costs behaviour was compare to the volume. Chart n°8 and n°9 represents for each aricles respectively the stocking cost and its volume. The charts show that the two indicators are directly proportionally in most case.

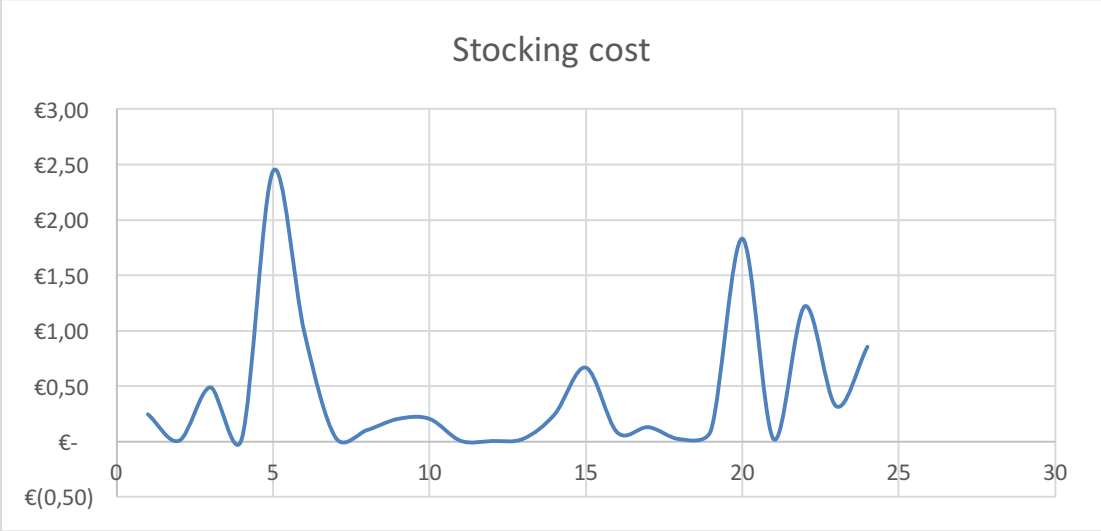


Chart 8: Stocking costs behaviour

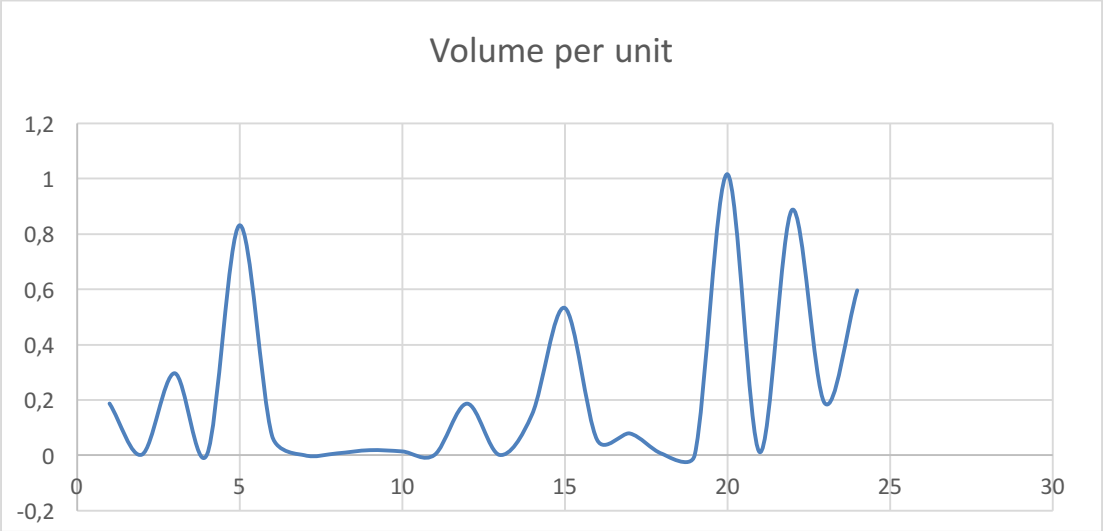


Chart 9: Volume per unit behaviour

As we can see in the chart n°10, the volume is correlated also with the stocking costs. It is easy to notice that the bigger the volume is, the higher the stocking costs are. The relation is shown by a second-degree equation. The slope seems to be growing more and more with the increase of the volume. Initially the stocking costs increase slowly but over a point they seem to increase more. Then, a company has to consider that buying big articles implies higher stocking costs.

The motivation of this behaviour is due to the fact that the bigger is the product, the lower is the number of units a pallet can hold up. It can depend also on the form of the loading units. They can be slim but long and they need more than one pallet for one unit. This increases considerably the costs.

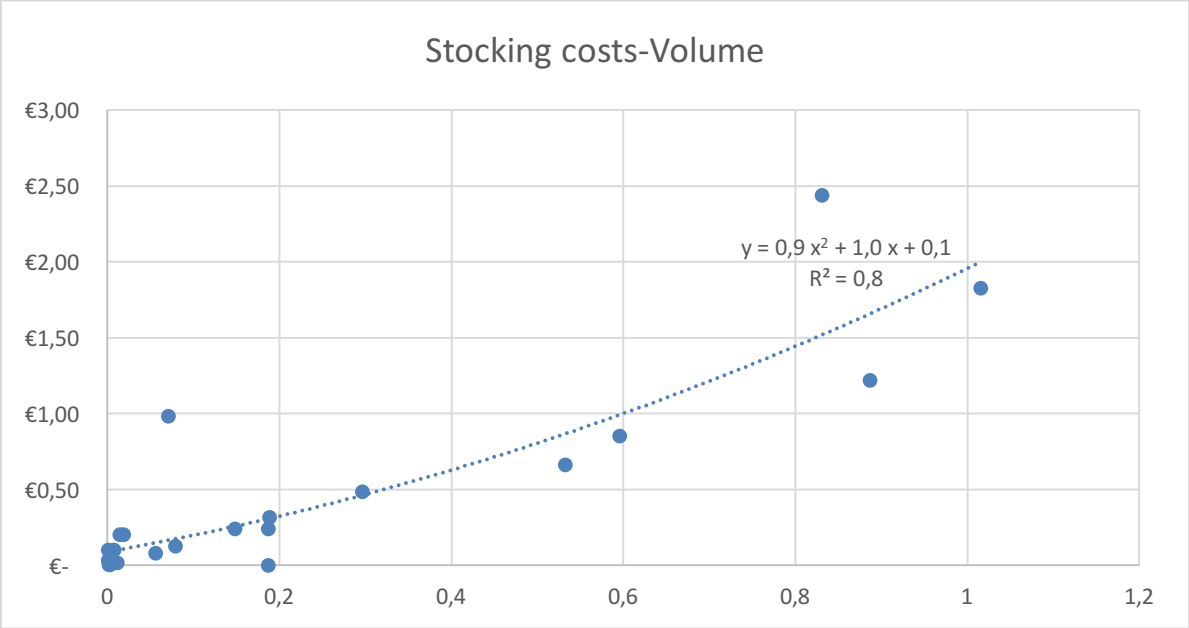


Chart 10: Stocking costs - Volume per unit

How it is possible to observe in the scatter plot, the parameters are not always linked through a linear relation, so, we decided to use another correlation coefficient known as Spearman's coefficient. Indeed, it assess monotonic relationships instead of linear ones. The Spearman correlation between two variables is equal to Pearson correlation between the rank values of those two variable. Usually, if the correlation shown by Spearman coefficient is high, the Pearson's coefficient is high.

Table 20: Spearman's correlation coefficient

	Units	Price	Volume	Ordine volume	Purchase cost	Maritime transport cost	Insurance premium	ENS Fee	Handling costs	Port release	Customs duty	Dues according to the seal	T1 emission	CVV - S. Palomba	Container unloading	Stocking costs	Total cost
Units		-0,1	-0,1	0,5	-0,1	-0,1	-	-0,1	-0,1	0,0	-0,1	0,5	-0,3	-	-0,1	-0,4	-0,1
Price	-0,1		1,0	0,7	1,0	1,0	-	1,0	1,0	0,9	0,6	0,3	0,7	-	1,0	0,8	1,0
Volume	-0,1	1,0		0,8	1,0	1,0	-	1,0	1,0	0,9	0,5	0,3	0,7	-	1,0	0,8	1,0
Ordine volume	0,5	0,7	0,8		0,7	0,8	-	0,8	0,8	0,8	0,3	0,6	0,4	-	0,8	0,4	0,7
Purchase cost	-0,1	1,0	1,0	0,7		1,0	-	1,0	1,0	0,9	0,6	0,3	0,7	-	1,0	0,8	1,0
Maritime transport cost	-0,1	1,0	1,0	0,8	1,0		-	1,0	1,0	0,9	0,5	0,4	0,7	-	1,0	0,8	1,0
Insurance premium	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-
ENS Fee	-0,1	1,0	1,0	0,8	1,0	1,0	-		1,0	0,9	0,5	0,4	0,7	-	1,0	0,8	1,0
Handling costs	-0,1	1,0	1,0	0,8	1,0	1,0	-	1,0		0,9	0,5	0,4	0,7	-	1,0	0,8	1,0
Port release	0,0	0,9	0,9	0,8	0,9	0,9	-	0,9	0,9		0,5	0,5	0,7	-	0,9	0,7	0,9
Customs duty	-0,1	0,6	0,5	0,3	0,6	0,5	-	0,5	0,5	0,5		0,1	0,4	-	0,5	0,4	0,6
Dues according to the seal	0,5	0,3	0,3	0,6	0,3	0,4	-	0,4	0,4	0,5	0,1		0,0	-	0,4	0,0	0,3
T1 emission	-0,3	0,7	0,7	0,4	0,7	0,7	-	0,7	0,7	0,7	0,4	0,0		-	0,7	0,6	0,7
CVV - S. Palomba	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-	-
Container unloading	-0,1	1,0	1,0	0,8	1,0	1,0	-	1,0	1,0	0,9	0,5	0,4	0,7	-		0,8	1,0
Stocking costs	-0,4	0,8	0,8	0,4	0,8	0,8	-	0,8	0,8	0,7	0,4	0,0	0,6	-	0,8		0,8
Total cost	-0,1	1,0	1,0	0,7	1,0	1,0	-	1,0	1,0	0,9	0,6	0,3	0,7	-	1,0	0,8	

According to latest analysis, another consideration was done.
Three articles, a big one (article 21), a medium one (article 1) and a small one (article 7) were evaluated in detail.

	Vi	Pc	Ctot	n	CNTR occ.
Ordine 1	0,1876	44,42 €	50,75 €	1750	65,8
0rdine 7	0,0009	0,72 €	0,80 €	72	66,03
Ordine 21	1,0156	276,72 €	313,51 €	64	65

For each one, the number units ordered were varied and it was defined as the stocking costs change according to it. The chart n°11 shows a similar behaviour but with different periods and amplitude. It is possible to notice that in the three cases, increasing the number of units, the higher stocking costs of each oscillation are lower and the behaviour tends to a constant value. This is due to the fact that the number of pallet increase less proportionally than the number of units per article. Then, we need consider that for a higher demand we have lower stocking costs per article.
The smaller the article is, the higher the number of units needed to reach the stabilization is.

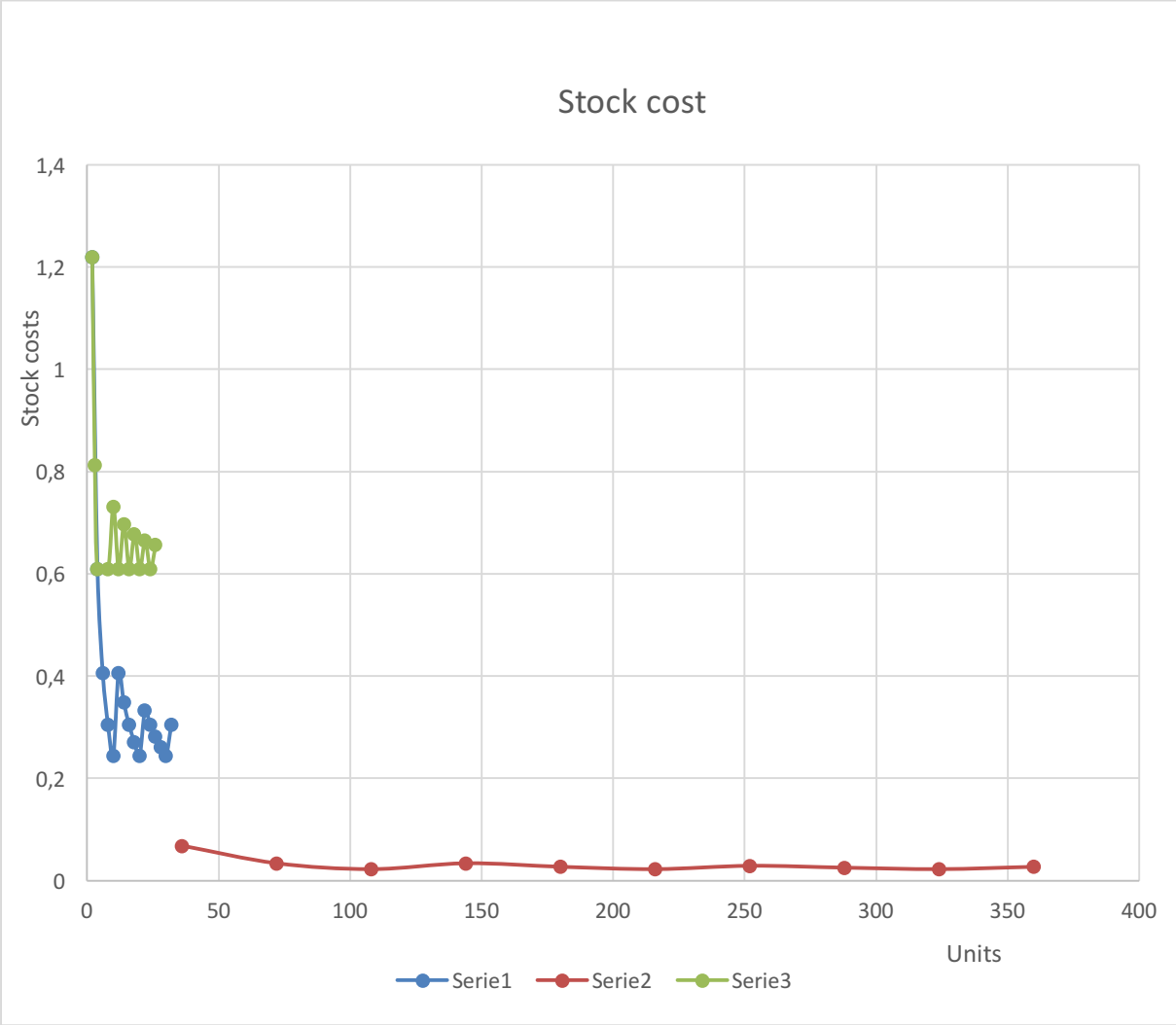


Chart 11: Stocking costs-units correlation

Maritime Costs-Container occupation

Another analysis was done about the container utilization volume. For the same articles it was analyzed the container utilization volume indicator.

KPI	Formulation	Measure
Container utilization	$\frac{Occupied\ volume\ \ per\ container}{Contaiener\ volume}$	%

$$\text{CU (article 1)} = \frac{65{,}8}{75} = 0{,}877 = 88\%$$

$$\text{CU (article 7)} = \frac{66{,}03}{75} = 0{,}88 = 88\%$$

$$\text{CU (article 21)} = \frac{65}{75} = 0{,}866 = 87\%$$

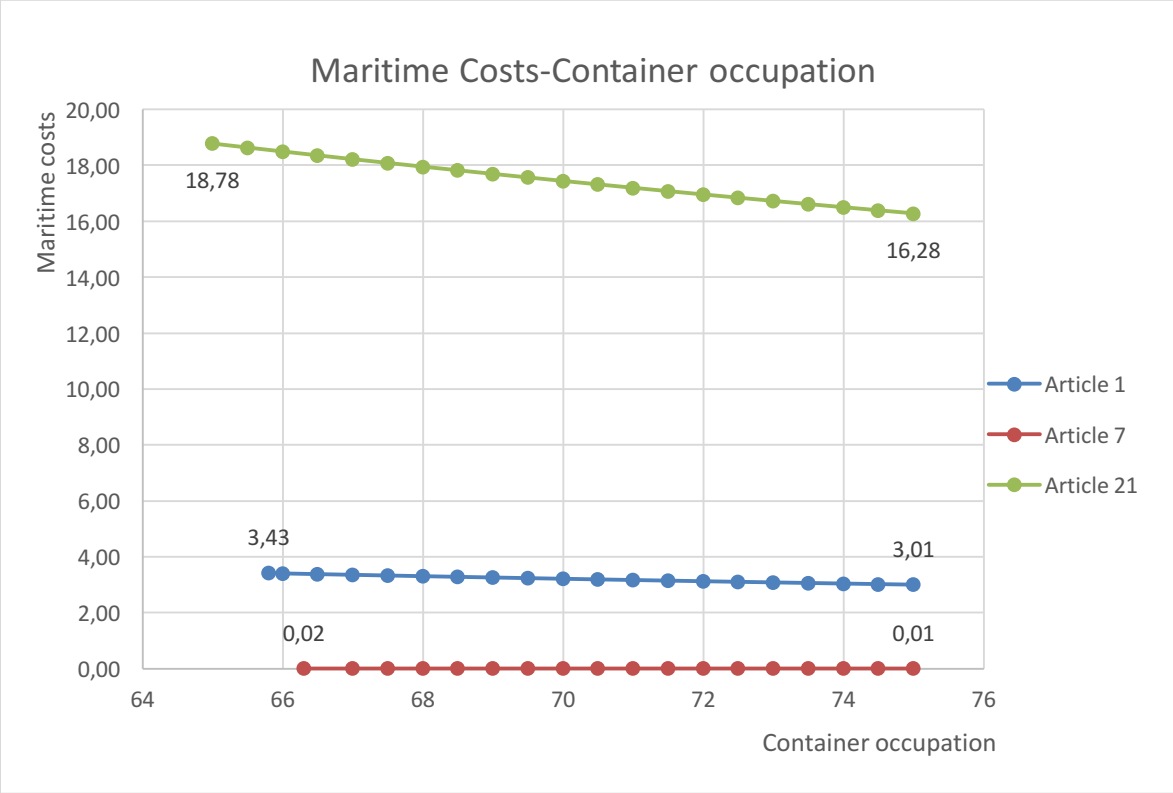


Chart 12: Maritime costs - Container occupation behaviour

As the volume affects in the same way different cost components according to the rate per service, it was decided to define the total landed costs variation increasing the volume of goods inside the container.

The aim should be to reach the 100% container utilization to divide all the shipping costs among a higher number of units, yet considering the container configuration and the impossibility to fill it up totally in order to move the loading unit, the total landed costs with 95% (72 m³) container occupation were defined.

	Article 1	
Container occupation (m^3)	65,8	72
Purchase cost	€ 44,42	€ 44,42
Maritime transport cost	€ 3,43	€ 3,14
Insurance premium	€ -	€ -
ENS Fee	€ 0,13	€ 0,12
Handling costs	€ 1,86	€ 1,70
Port release	€ 0,03	€ 0,03
Customs duty	€ -	€ -
Dues according to the seal	€ 0,05	€ 0,05
T1 emission	€ -	€ -
CVV - S. Palomba	€ -	€ -
Container Unloading	€ 0,57	€ 0,52
Stocking cost	€ 0,24	€ 0,24
Total cost	**€ 50,75**	**€ 50,22**

Table 21: Inbound costs - Article 1

	Article 7	
Container occupation (m^3)	66,03	72
Purchase cost	€ 0,716	€ 0,716
Maritime transport cost	€ 0,016	€ 0,014
Insurance premium	€ -	€ -
ENS Fee	€ 0,001	€ 0,001
Handling costs	€ 0,008	€ 0,008
Port release	€ 0,000	€ 0,000
Customs duty	€ 0,019	€ 0,019
Dues according to the seal	€ -	€ -
T1 emission	€ 0,000	€ 0,000
CVV - S. Palomba	€ -	€ -
Container Unloading	€ 0,003	€ 0,002
Stocking cost	€ 0,034	€ 0,034
Total cost	**€ 0,797**	**€ 0,794**

Table 22: Inbound costs - Article 2

	Article 21	
Container occupation (m^3)	65	72
Purchase cost	€ 276,72	€ 276,72
Maritime transport cost	€ 18,78	€ 16,96
Insurance premium	€ -	€ -
ENS Fee	€ 0,72	€ 0,65
Handling costs	€ 10,16	€ 9,17
Port release	€ 0,86	€ 0,78
Customs duty	€ -	€ -
Dues according to the seal	€ 0,14	€ 0,14
T1 emission	€ 1,17	€ 1,06
CVV - S. Palomba	€ -	€ -
Container Unloading	€ 3,13	€ 2,82
Stocking cost	€ 1,22	€ 1,22
Total cost	**€ 312,90**	**€ 309,52**

Table 23: Inbound costs - Article 21

6.2 Improvements to critical processes (To-Be)

Finally, I'd like to express some personal ideas to explained how critical process can be improved.

In my opinion what should be changed in the company inbound process are some decisions in the procurement process.

The latest analysis about the container utilization coefficient showed how important the optimization of the container volume is. Of course, the more the units in the container are, the lower the transport cost per unit is. Furthermore, the analysis on the number purchased units showed that the higher the number of units is, the lower the unit stocking costs are.

In the actual process, the company doesn't have a direct control on goods allocation, it sends the parcel characteristic to the supplier and the latter plans the container fulfilling. Then, it doesn't know when it is time to restock the unit in the warehouse. The company need to estimate the reorder point to avoid the products unavailability and according to it to define the number of units needed.

This number can be modified according to a parallel analysis among optimal container utilization, number of units and parcel modifications.

Managing the loading phase directly from the headquarter could be a good solution. Before making the order, the company could plan the container fulfilment knowing the unit dimensions and the articles. That means, it should analyse the units and articles needed and manage the position in the container to find the optimal collocation also modifying the loading units.

More or less, the company purchases the same articles during the years taking the cycle of the seasons into consideration. So, it knows the typology, the dimensions of the articles and can try to find a perfect combination of articles inside a container even modifying their parcels when possible.

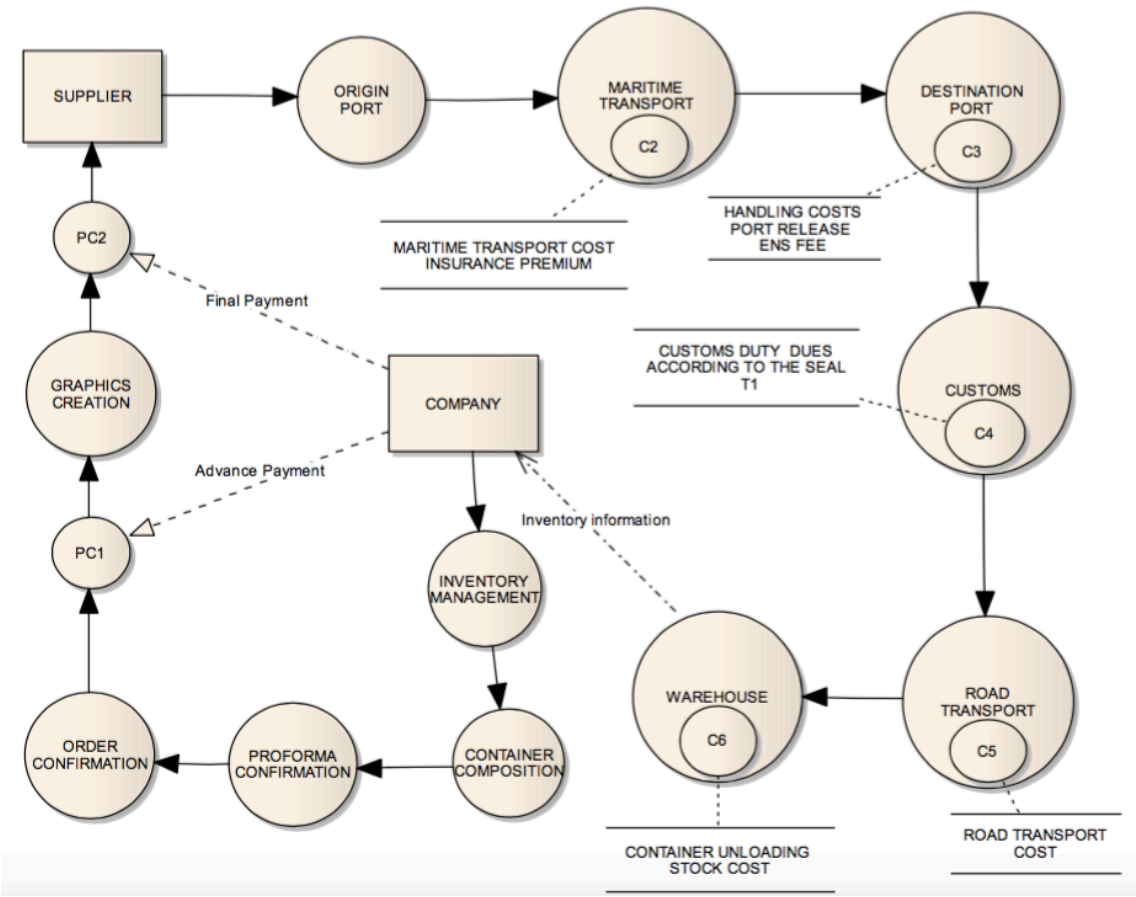


Chart 13:Proposed improvements

7 Conclusions

The aim of the work was to find a critical process in the supply chain of a company in the e-Commerce sector trying to define a possible improvement in its management.
Before studying a real case, it was necessary to examine how a standard company of the sector works and which are its main features.
A re-engineering process was done starting from the company analysis to understand how it works and then to identify the critical process that affects its efficiency. The critical process regards the inbound process, that is the procurement process of the company. The inbound costs that affect a company were analyzed. Then, a cost model was developed to calculate the effective inbound cost component. It estimated the total inbound cost per article unit and per loading unit and evaluated the percentage of each inbound cost component in comparison with the total cost per unit.
Later, a sensitivity analysis was done using the Pearson's coefficient correlation.
Thanks to it, it was possible to observe parameters that have higher influence on total cost estimation.
The unexpected correlations were studied and shown in charts.
The sensitivity analysis involves also the container utilization indicator definition. The indicator shows in part the efficiency of the shipping process. Modifying it according to an optimal value (72mc), the total inbound cost of three articles was estimated and was compared with that real one.
The analysis of the inbound costs allowed to observe a direct proportionality between the price of a single article and its volume for a company that deals with this kind of products. Thanks to this result, it is possible to say that the volume is directly linked to all the inbound cost components except for the customs costs that are linked to the article material and price, so in this case the volume has an indirect correlation with them.
As the volume is correlated to the major cost components, indirectly also the purchase cost is.
So, for this kind of companies it is possible to evaluate the possible costs that affect the article they are interested in before buying it.
Finally, it is possible to deduce that bigger articles have more incidence on total costs.
The last charts, focused on the stocking costs, show how a bigger article needs higher stocking costs per units always with a power relation with the volume. But as seen above, it's possible to reduce these costs importing more units. It can be useful to understand the

right quantity of units for each article to reduce the stocking costs, yet considering the other variables inside an order without increasing the inbound costs.
The container utilization volume indicator, as shown above, is one of the aspects that a company should optimize. As shown in the table below, It leads to a minimum decrease for each unit but a considerable saving for the order when the number of units is high.

	Article 1		Article 7		Article 21	
Container utilization	88 %	95 %	88 %	95 %	87%	95 %
Unit	€ 50,75	€ 50,22	€ 0,797	€ 0,794	€ 312,90	€ 309,52
Number of units	1750		72		64	
Order	€ 88812,5	€ 87885	€57,38	€ 57,168	20025,6	19809,3
Differences per unit	€ 0,53		€ 0,003		€ 3,38	
Differences per order	€ 927,5		€ 0,21		€ 216,3	

It could be interesting to analyze the sensitivity analysis results for the single unit. In this way, it could be possible to find the best combination between the volume and the number of units in order to optimize the costs.
Thanks to the cost model realized the company can estimate the effective costs that affect each unit in the inbound process.
Then, considering the company fixed costs, the VAT and the outbound costs (picking, packaged, delivery) the company can estimate the correct selling price and compare it with the fixed one. It will allow to evaluate if the estimated mark-up is equal, minor or major respect to what is expected.

8 References

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