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Optimization of the overseas packaging process in the automotive sector. The FCA case

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RINGRAZIAMENTI

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INTRODUCTION

The packaging in the logistic is one of the most important aspects because thanks to it the parts numbers inside of it can arrive in optimal conditions at destination. The packaging of items is an essential element for any firm in the world, because most of the products that constitute input and output for a company, need a covering able to protect, to transport and to contain the items. It is the packaging that give also the information that needs to move the product to the proper customer location.

The packaging process is important because a non-optimized or uncontrolled management causes large spills of space and consequently a high cost.

An analysis of the scientific literature about the packaging process was provided in the thesis, on this topic the main research is made about the marketing function of the packaging, that for an automotive company like FCA is not relevant. For this reason, the research gap that this thesis would cover is about the packaging process for an overseas flow and in specifically the use of returnable packaging.

This work of thesis was being developed in collaboration with FCA, in particular with the packaging division that manages the overseas flow from Italy to the plants around the world.

The thesis objective is to analyze new strategies for the optimization of the packaging costs, two solutions for costs reduction were mainly taken into consideration:

• Improving the saturation of the packaging and the container for having to carry out less transport.

• Use of returnable packaging for substitution of the actual disposable solution.

In particular, the thesis is focused on the analysis of the use of returnable packaging for the overseas flow because it is a solution that is not implemented nowadays and offers great margins from an economic point of view because. After an investment and a period of payback, you do not have to spend more money on disposable packaging that will be thrown away after the utilization.

This work would also analyze the advantages and the disadvantages that derive from the use of the returnable packaging because managing a returnable flow on long distance, without a good traceability, is very difficult.

The thesis is structured in the following way: the chapter one has the aim to provide a general overview of the overseas packaging through the description of packaging types and the material that is used. It also analyzed the reasons why the packaging process should be optimized, and it provides an analysis of the packaging literature.

The second chapter has the objective of describing the FCA Company, in detail the Inter Regional Flow division and the supplier of the logistic service or for the items.

The third chapter has the aim to describe in detail the packaging process in FCA for the overseas shipment through the description of the regulations, the packaging cycle, the development of new packaging and an overview of packaging types in IRF.

The chapter four has the objective to describe how it is possible to improve the saturation of the packaging by changing the dimensions of a package with a consequent economical saving.

In the chapter five is provide a general overview of the returnable packaging and after is show the business case of a standard dimension returnable packaging. Another objective of this chapter is to study how is possible to optimize the numbers of returnable packaging currently owned by FCA and which are not used nowadays.

The sixth chapter has the objective to describe the business case (economic advantages) and the design of a returnable metal rack for the doors and frames of the Ducato. The new metal rack was been develop in all its parts with a drawing software.

The final chapter shown the conclusions of the thesis, with a comparison between the two projects that are described and the future steps that the company performed based on the outcomes of this thesis work.

CHAPTER 1 PACKAGING

This first chapter has the aim to provide a general overview of the overseas packaging through the description of packaging types and the materials that are used. It also analysed the reasons why the packaging process should be optimized. In this chapter is also described the literature analysis about the packaging process.

1.1 OVERVIEW OF PACKAGING

The packaging of items is an essential element for any firm in the world, because most of the products that constitute input and output for a company, need a covering able to protect, to transport and to contain the items. Packaging has six main functions: containment, protection, apportionment, unitization, convenience and communication of the product [1]. In the packaging label there are all the information's necessary to transport the items. Furthermore, a packaging solution must be efficient to saturate the container, and this determines the number of journeys needed to transport the entire volume and able the possibility to facility the loading and unloading operations. It is important to understand that in logistical operations the package is the product that is stored and transported which means that in every possible occasion it should rather help than to be an obstacle to the logistical operations.

Distribution and logistics are largely structured around the concept of load utilization and the choice of a unit load, which are determined by the type and size, is very important. It is vital for the effectiveness and economics of logistics operation choosing the most appropriate type and size of a unit load for minimizing the rate of material movement. Packaging is a very important part of the total logistic function; and the design and use of the packaging has an impact to other functions such as production, marketing, warehousing and quality control, as well as the total logistic costs and performance.

The importance of the packaging is closely linked with quality and commercial aspects; any design and manufacturing activity of a quality product would not make sense if then the item does not arrive whole to the final client or to the production center if we talk about a raw material or a semi-finished product. Therefore, an adequate package is fundamental, in order to safeguard the characteristics of the product and to make easy to transport (Mazen, 2004).

The article 218 of D.Lgs 152/2006 describes the packaging word as “ the product, composed of materials of any nature, used to contain certain goods, from raw materials to finished products, to protect them, to allow their handling and their delivery from the producer to the consumer or user, to ensure their presentation.” (Gazzetta Ufficiale, 2006).

The packaging types could be divided into three categories Figure 1.1. [2][3]

- Primary packaging: it is the packaging in direct contact with the product itself and it is sometimes referred to as consumer or retail packaging. The main purpose of the primary packaging is to protect and preserve, contain and inform the consumer.
- Secondary packaging has a logistical purpose, to group several products together for ease of handling, transport and storage. This packaging is used to group various pre-packaged products together.
- Tertiary packaging (Transit packaging) facilitates the protection, handling and transportation of items, from raw materials to finished product, for a specific number of objects. This type of packaging is used for the shipment of items overseas. The containers are not included in this type of packaging.

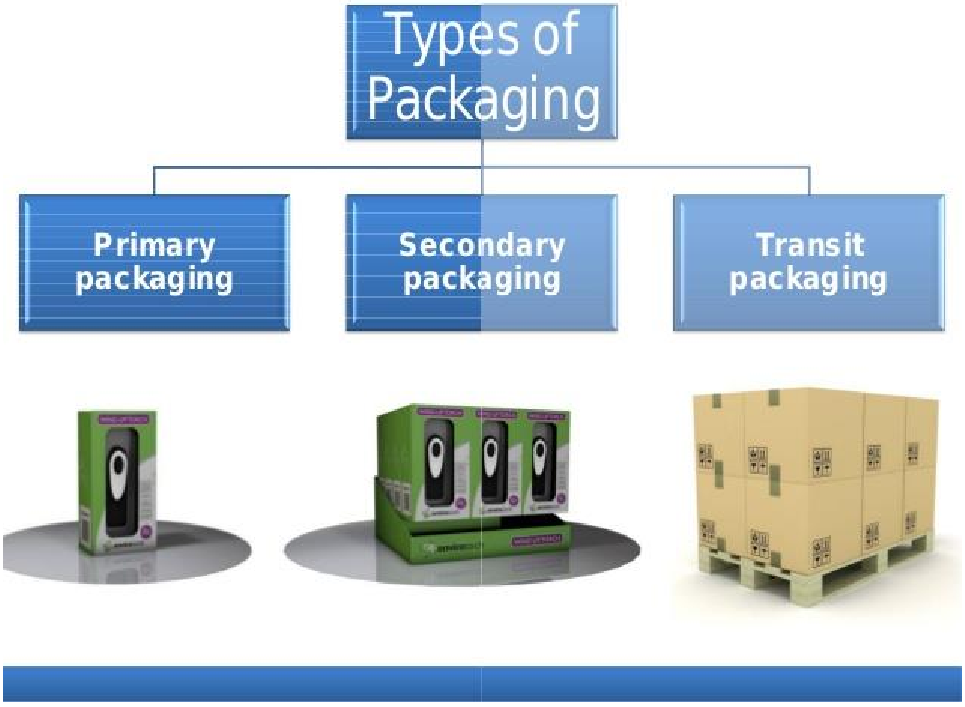

Figure 1.1 Types of packaging [4]

1.2 THE FUNCTIONS OF OVERSEAS PACKAGING

This work of thesis is focused on the overseas packaging for the needs of the company for which the research has developed but the functions of packaging that are described below are valid for any type of packaging.

A packaging solution must have two principals' functions: technical and logistical. (Radosław, 2015).

TECHNICAL: the purpose of packaging is to protect the product during the transportation to maintain the integrity. In overseas transport, the packaging must guarantee the protection by external agents as high/low temperature, pressure, humidity or atmospheric agents in general.

The protection that packaging provides works on three aspects; the risk related to the transport (shocks or fluctuations, stackability of different loading units), the aggressions of ambiently or chemicals agents and the dispersion of product (in the case of liquid transport). The design of packaging must be studied keeping in high regard the item to which it will be assigned. The physical characteristic, the fragility, and the mobilizations that the items are exposed to must be taken into account. For overseas transportations, there are a series of complications that are not in track transport, for example, the corrosive action of saltiness or humidity variations or temperature variations. In the same case, the packaging could create the right environment when the external conditions are averse.

A poor packaging not only cause the loose of the cost of the original item and the cost of shipping it in the first time, but it generates an extra cost to send replacements.

LOGISTICS: The packaging must be transportable in an efficient and easy way. The first objective is the optimization of available spaces during the transportation and for the period of storage in the warehouse.

The packaging must, with a view to optimizing logistics efficiency, constitute a unit suitable for transport and have to facilitate the use of the product. The package must be opened/closed without difficulty, adopt expedients that facilitate the extraction of the content and must be designed in such a way that it is easy to take and move it. The products are packaged per unit weight or volume then grouped to form larger units.

1.3 PACKAGING MATERIAL

In overseas transportations, the most used material for the packaging is the cardboard, other materials that are utilized are wood, plastic, metal.

In overseas transport non-returnable packaging are used predominantly and this package is thrown away once they have reached their final destination. Materials that are utilized for this type of packaging are cardboard and wood.

Nowadays there are new trends that study the convenience to use a returnable package not only for short distance but also for overseas transport. Materials that are utilized for this type of packaging are metal and plastic.

1.3.1 CARDBOARD

One or more sheets of glued paper characterize this material. For packaging solutions is used corrugated cardboard. The corrugated paper is the union, through a suitable glue, between a ripple and a stretched sheet, this structure turns out to be flexible and suitable for wrapping and protecting objects with unusual shapes.

The surfaces of stretched paper are called cover then, we will have an outer cover and an inside cover plus the card for ripple which has the task of distancing the two stretched sheet and keeping them at the same distance for as long as possible during the life of the packaging.

This applies, as described above, to a single wave board, therefore, with the use of three cards, but if the board has two-waves, the cards will become five and the inner one, between the two waves, will no longer be called a cover but a stretched sheet (Figure 1.2).

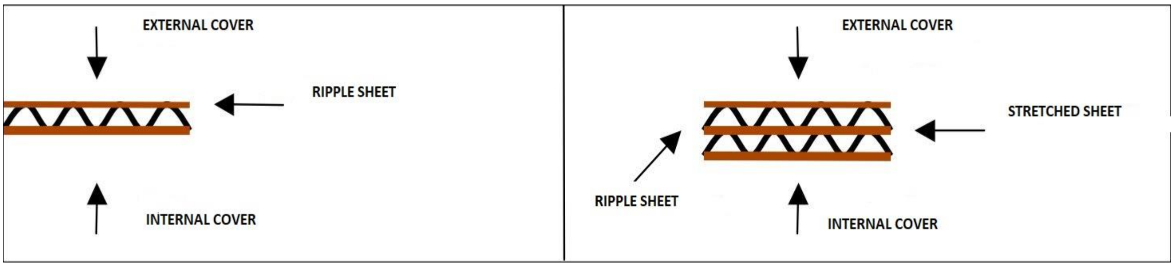

Figure 1.2 Cardboard composition [5]

The corrugated cardboard could be a single (2 stretched sheet and 1 corrugated sheet), double (3 stretched sheets and 2 corrugated sheets) or triple wave (5 stretched sheet and 3 corrugated sheet).

Single wave: consists of two stretched sheets outdistance from each other by a wavy surface and held together by special glue (Figure 1.2).

Double wave: in this case the covers are always two, the external one and the internal one, but the wavy surfaces become two connected to each other by a third plane surface (Figure 1.2).

Triple wave: the production of this cardboard type is much more complicated, inside the two outer flat surfaces the undulations become three, joined together by two theses sheets. It is often called heavy three-wave cardboard and it is a product intended for specific uses, especially suitable for containing and transporting objects of big size and weight (Figure 1.3) *[6] [7].*

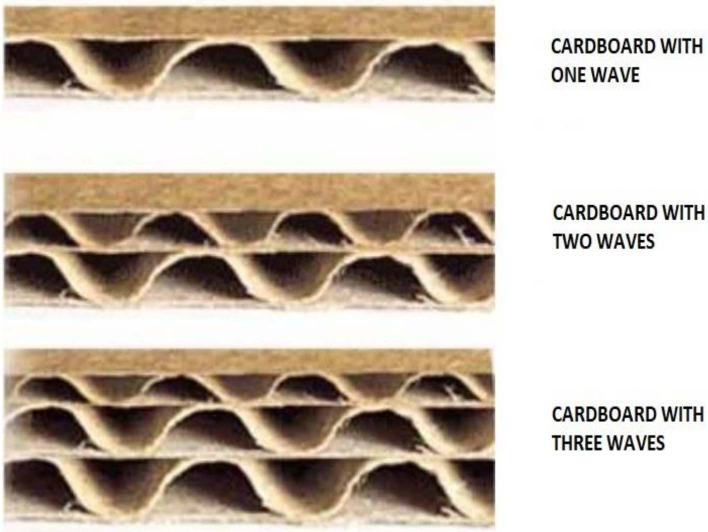

Figure 1.3 Cardboard with one, two or three waves [5]

1.3.2 WOOD

Packaging solution with wood is used when the items need a strong protection. This material guarantees more protection in comparison to cardboard packaging.

In general, the wood packaging is expectable and is not reused. In the last few years wooden reusable packaging has been developed for a limited number of times.

The types of wood that are used for packaging solution are plywood, a panel in OSB (Oriented Strand Board), panel in fibers and panel in chipboard.

This type of material is not only utilized for the construction of a wooden chest or cages but also for pallet the most utilized standard in logistic.

The wood material that is utilized for packaging needs to follow ISPM_15 regulation ("Regulation of wood packaging material in international trade") (Food and Agriculture Organization of the United Nations IPPC Secretariat,2006).

Wood originating from living or dead trees may be infested by pests. The wood packaging material is frequently made of raw wood that may not have undergone sufficient processing or treatment to remove or kill pests.

The ISPM_15 regulation provides two methods of treatment:

- Heat treatment (code "HT"), which involves bringing the temperature to the heart of wood at least 56°C for a minimum time of 30 minutes.
- Fumigation with methyl bromide (code "MB") for an exposure time at least 24 hours and a concentration of 48 gr / m^3 to one temperature of 21° C.

The use of methyl bromide in the European Union is prohibited since March 2010, while in other countries, such as in Brazil, the phytosanitary treatment with methyl bromide it is still admitted.

These two methods of treatment allow the elimination of any type of pests in wood material.

The standard provides for wood packaging treated in accordance with ISPM_15, get certification through the application of a mark, directly on the packaging, preferably on the two opposite sides.

The mark includes:

• The IPPC / FAO logo

• The ISO code (XX in the Figure 3), consisting of two letters, related to the country of production / processing of wood packaging material.

• The code of the company that made the production or the treatment of wooden packaging (three digits,000 in the Figure 1.4)

• The code concerning the processing methods (YY in the Figure 3): "HT" for heat treatment and "MB" for treatment with bromide methyl.

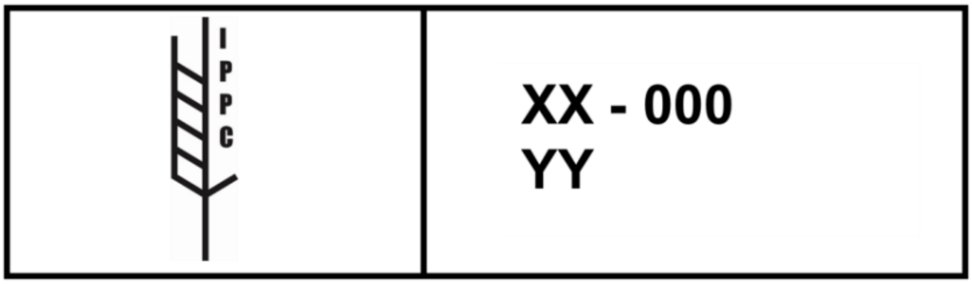

Figure 1.4 Mark of ISPM_15 regulation (Regulation of wood packaging material in international trade,2006)

1.3.3 PLASTIC

This type of material unlike cardboard and wood which are not expendable is returnable, that means that it is reused *[8].*

There are 5 types of plastic that are used in packaging solution:

- PETE – Polyethylene Terephthalate has good chemical resistance and electrical properties, hardand tough material with water absorption, very good resistance to dynamic stress, thermal and dimension stability.
- HDPE – High density Polyethylen. This type of plastic is most prevalent in packaging goods that need protection from light and a stiff container. This material is endowed with great strength and rigidity.
- PVC – poly-vinyl-chloride has good resistance to chemical and solvent attack. Its vinyl
  content gives it good tensile strength and a good flexibility.
- LDPE Low-density Polyethylene thanks to the branching it is a light, ductile and flexible material.
- PP – Polypropylene is extremely chemically resistant and almost completely impervious to
  water. When recycled, polypropylene is used to make automobile products like signal light covers, ice scrapers and oil funnels.

- PS – Polystyrene

1.3.4 METAL

This type of material like plastic is used for returnable packaging solution like chest or cages. Packaging in metal guarantees the best protection and preservation of the items. The metal packaging could be made of steel or aluminium.

1.4 TYPE OF INDUSTRIAL PACKAGING

The definition of unit load is the following: *"A number of individual packages bonded, palletised or strapped together to form a single unit for more efficient handling by mechanical equipment"*.

A unit load could be created allocating more pieces in a packaging, by stacking collection means on pallets or placing items in appropriate collectors.

This technic is utilized for the logistic efficiency because the unit load is possible to reduce the manipulations during the phase of handling, storage and transport *[9] [10] [11].*

Characteristics of a Unit Load:

1. There should be a necessary minimum number of handlings.

2. Manual handling should be eliminated.

3. Materials are assembled into a unit loadings for an economy of handling, storage and transport.

4. Redesign packages, containers for better assembly into unit loads and retain them to prevent product damage.

5. Stacking and forkable.

There are a lot of units loads depending on the characteristics of the items: the dimension, weight, volume utilization, period of storage in the warehouse.

In industrial packaging, the unit load are called collection means (Mdr in Italy Mezzo di Raccolta). And there are three categories of collections means:

- forkability collections mean
- No forkability collections means
- Container

1.4.1 FORKABILITY COLLECTIONS MEANS

This type of unit load has the characteristic that the handling can be performed from an automated machine-like forklift.

In logistic operations, the pallet is the most used tool and the dimension of it is standardized in all the word.

The pallet is a flat structure used as a base for the unitization of goods in the supply chain. The MH1-2016 standard defines the pallet as a "portable, horizontal, rigid, composite platform used as a base for assembling, storing, stacking, handling and transporting goods as a unit load".

Pallets are used to stack, store, protect, and transport materials in the course of being handled by materials handling equipment such as forklifts, pallet jacks or conveyors, being stored in the warehouse or being positioned in transport vehicles.

Pallets are manufactured from a variety of materials. The wood pallet dominates the marketplace, providing an excellent value regarding price and performance. It is stiff, inexpensive, and easily fabricated into various sizes as required. Pallets manufactured from other materials also play important roles. Plastic pallets are prized for several reasons, including durability, ease of cleaning, exemption from ISPM 15 requirements. Metal pallets also have a presence, especially in applications where pallet strength and durability are required.

Internationally, ISO recognizes six pallet sizes [mm]. These standards include: *[12].*

- 1219×1016 – North America
- 1000×1200 – Europe and Asia
- 1165×1165 – Australia

- 1067×1067 – North America, Europe, and Asia
- 1100×1100 – Asia
- 800×1200 – Europe

In Italy the dimension of the pallet follow the regulation UNI 4121 that defines the following dimensions [mm]:

- 800 x 1000
- 800 x 1200
- 1000 x 1200

Another type of fork ability unit load is the container/box this packaging is designed to allow the stacking of the unit load (Figure 1.5). The characteristic of the container (dimension, payload, capacity) could be very different depending on the type of items or unit loads that they must transport.

Figure 1.5 Fork ability box [FCA photo]

1.4.2 NO FORKABILITY COLLECTIONS MEANS

In this category of unit, load includes all the packaging that cannot be moved by forks. The most important packaging solution with this characteristic is the box, generally made of cardboard. The dimension of these boxes they can be infinitesimal, and they are designed according to the type of object they have to carry.

To optimize the numbers of movements related to the transport / storage, containers with these characteristics are grouped into pallet thus originating the load unit.

Figure 1.6 Example of no fork ability box [13] [14]

1.4.3 CONTAINER

For the transportation of the unit load described in the last two paragraphs are used the containers. These are designed for the intermodal transportation (trucks, ships, railway wagons). The containers can be built in steel or in aluminium.

The ISO International Standards Organization defines the following characteristics: *[Logimar]*

	Interior Dimensions	Door Opening	Max. Gross Weight	Payload	Cubic Capacity
20′ Dry Freight Containers	L: 5,919 mm W:2,340 mm H: 2,380 mm	W:2,286 mm H: 2,278 mm	24,000 kg	22,100 kg	33.0 cbm
40′ Dry Freight Containers	L: 12,045 mm W:2,309 mm H: 2,379 mm	W:2,289 mm H: 2,278 mm	30,480 kg	27,396 kg	67.3 cbm

Table 1.1 Container standard characteristics [15]

1.5 REASON TO OPTIMIZE PACKAGING

The packaging challenges faced by the automotive industry have been well documented, as for example, by DHL: *[16].*

"the automotive industry faces a number of packaging-related issues. One is that poorly packaged products do not fully utilize the capacity of sea containers, increasing the likelihood of in-transit damage. But such issues aren't limited to ocean voyages. Other problems include the inconsistent availability of containers and associated materials used in manufacturing, warehousing, and distribution; a lack of asset visibility; product contamination from dirty receptacles; and inefficient returns management for reusable packaging."

And as noted by Deloitte, *"Industry surveys have consistently shown that suppliers and OEM's (original equipment manufacturers) frequently face difficulty in getting the right packaging to the right place at the right time." [16].*

Package optimization has many different benefits, from not wasting money on unnecessary materials to creating a more sustainable package (Nichols, 2017) [17].

1. **Optimize the Materials**. The materials that are used for packaging could hold the supply chain down. If products that are expensive, wasteful or difficult to use, are used to adding time and money is a consequence that the supply chain can't afford.
   Optimizing the packaging means making smarter decisions about the packaging of the product itself and the shipping materials used to get the product from Point A to Point B.
2. **Package Optimization Allows for Sustainability.** Creating plastic containers or cardboard boxes can have serious consequences on the environment. Package optimization can be one of the best ways to promote sustainable business practices.
   Companies can look for ways to use fewer materials and reduce their carbon footprint. This not only helps companies to save money but will get bonus points with customers for being environmentally friendly.

3. **Make Transportation Easier.** When preparing a cargo for shipment, it is important to consider things like the size and weight of boxes of product. Not only the size and weight of the product itself but also the size and the weight of the packaging it is in. If an optimized packaging is not used there could be a wasting of space and weight that could be occupied by more products.
   Optimizing product package allows eliminating the unnecessary excess that could lead to a wasting money. By reducing the amount or changing the shape and size of the packagings that are used, it is possible to transport more products and saving both time and money.
4. **Finding the Right Package Optimization.** When you are looking for the appropriate way to package items, it is important to consider both complexity and efficiency. To reduce complexity, it is appropriate to have as many similar packages as possible but to improve efficiency, it is desirable that each item has its best package. For companies with a wide variety of products, this can be difficult to balance. Finding the optimal level of complexity and efficiency is crucial. When the right balance is found it, is possible to reduce the shipping costs, save space and weight with each shipment.

1.6 OPTIMIZATION OF PACKAGING COST

The optimization of packaging process generates a reduction of costs (direct and indirect). (Pålsson and Hellström, 2016) (Ampuja, 2009) (Andersson and Wallin, 2015).

Direct costs:

- **Purchasing materials**. Primary raw materials are becoming increasingly scarce and costly. By reducing the quantity of materials used, it is possible to save on purchasing costs.
- **Waste processing**. Reducing the amount of packaging material lowers the cost related to waste processing
- **Handling costs**. Reduction in handling costs by designing packaging in order to minimize the packing time for a given package is minimized. Employees can pack

goods more quickly and efficiently, meaning less money spent on handling the product and its packaging.

- **Transport and storage**. Make sure the packaging and the product are perfectly aligned. Less weight and less volume also mean lower costs for transport and storage. This is certainly true for products that need to be transported over great distances.
- **Reduced losses due to damage or deterioration**. Packaging optimization ensures that the products are better protected and preserved. This means that the risk of damage or deterioration during transport and storage is reduced as well as any costs associated with the latter.

Indirect costs:

- **Simplified production processes**. Packaging optimization often leads to an optimization of production processes as well. The less varied packaging materials are used, the simpler the production process will become.
- **Fewer safety risks**. The use of less harmful materials increases the employees' safety and reduces the risk of accidents.

General Motor has been a leader in promoting waste elimination efforts. In the list below are showing some of the best practices that the company use for the optimization of the packaging costs *[18]:*

- **Reduce Packaging Weight**. Light-weighting has become a very popular strategy towards reducing the amount of packaging used, resulting in reduced packaging expenditure, and less packaging waste generation. Heavier shipping materials such as wood pallets can translate into greater fuel consumption and greater carbon emissions. In some cases, wood pallets have been replaced by reusable recycled-content plastic containers, which reduce weight and overall transportation costs.
- **Increase Part Density**. The automotive industry has been a leader in designing packaging to increase part density in containers, in other words, optimizing space utilization by shipping more parts in the same amount of space. Greater part density translates into the need for fewer containers, fewer shipments, and

ultimately, transport cost reduction. In global supply chains, the payback for improved part density is particularly attractive. Examples of increasing density include a GM team in Brazil which managed to add an extra layer of parts per container, thus eliminating the necessity for 23 extra containers. In another pack they rearranged the packaging design from a linear grid to a geometric pattern, thereby reducing the shipping requirement by 38 boxes.

- **Design Packaging for Ease of Recycling**. If packaging materials are mixed, like a cardboard liner with a wood frame, stapling the two pieces together makes recycling inconvenient. Materials must be separated first. Stapled materials should allow for "breakaway," the easy separation of the two parts. On the other hand, separation is not required if a cardboard post is stapled to a cardboard box.
- **Make the Best Packaging Decision at the Source**. By getting the packaging right at the part producer, extra handling can be avoided. In some cases, parts being shipped from overseas in non-sustainable or single-use packaging must be repackaged at a domestic facility to reusable packaging before being sent to the assembly plant.
- **Coordinate with Suppliers and Optimize.** Collaboration is critical to packaging success. GM works closely with its suppliers to develop uniform shipping specifications before a new production program begins. This approach permits a better alignment of processes and greater efficiency. Additionally, GM provides guidelines with respect to maximizing freight utilization of delivery vehicles, with an eye to saving overall fuel and reducing the cost of part shipment. Reviewing packaging plans up front helps to avoid such potential inefficiencies.
- **Packaging Design to Prioritize Safety.** GM helps to create a safer workplace through requiring materials to be shipped in boxes with lids. This idea, like a shoe box, eliminates the need for box tape. The use of tape dictates that employees will have to use knives, which creates a safety risk. By designing out the need for tape, cut wounds from box knives are eliminated. Automotive has been innovative in several other respects regarding improved safety, such as the move to smaller, lightweight containers with handholds, and drop doors in intermediate bulk containers to provide ease of material handler access to parts.

1.6.1 RETURNABLE PACKAGING

The researches that are made in the last period about the optimization of the overseas packaging costs are concentrated on using a returnable package instead of disposable solutions. Reusable packaging upsets the traditional cost allocation balance. It requires a large initial investment in containers, additional transport costs, an infrastructure for empty container sorting, and systems for tracking, management and quality control. The advantages of the returnable packaging are that the cost of purchasing and discarding packages for every shipment is eliminated and there are potential productivity improvements for operations like packing, shipping, order picking, handling, stocking and unpacking. When considering a switch from using expendable corrugated fibreboard boxes to durable reusable containers, it is important to anticipate and plan how the change will affect the organizations involved, and to predict what the cost will be (Twede and Clarke,2004).

Two trends in logistics have fuelled the growing use of reusable containers. The first was the 1980s trend towards just-in-time (JIT) production, which by minimizing the number of days in the inventory replenishment cycle, also minimizes the number of reusable containers required for a system. JIT strategies consolidate the number of suppliers and reduce their geographical distance from the customer, which improves the ability to control empty containers and reduce return transport costs. The second trend is the 1990's emphasis on supply chain management, streamlining the supply chain to perform only those activities which add value, rather than each firm sub optimizing parts of the system for its own profit. There is an increased reliance on third-party logistics providers.

In the US, the most significant industry using reusable packaging is the automotive industry, metal racks and plastic pallets, bins and crates are increasingly used to deliver parts to the assembly line. One of the most significant benefits has been the improvement in the productivity on the assembly line because the containers are specially designed to facilitate manufacturing operations. As a result, assembly plants are cleaner, and workspaces are more tidier. But the automobile industry has found that the operational costs can spiral when the container logistics are not well managed. Investment costs can also spiral when supply chain workers find an increasing number of useful things to do with the containers (including personal appropriation) and the cycles become longer. The industry has had trouble controlling container logistics, getting the right number of the right kind of empty containers to the right place at the right time. Inefficient allocation and ineffective tracking increase the number of containers needed in a system (Twede and Clarke, 2004).

Reusable packaging can be a profitable investment–or a costly mistake. Over time, some reusable container systems can cost substantially less than expendable corrugated boxes. On the other hand, sometimes the investment required and/or logistics costs are prohibitive. The Figure 1.7 summarizes the logistics and package factors that impact the investment and operational costs of returnable solution.

Logistics and Package factors	Initial investment	Operational costs	Operational savings
Cost of purchasing reusable containers	x		
Container strength	x		x
Standardized containers	x		x
Cycle time	x		
Expendable package purchase savings			x
Expendable package disposal savings			x
Empty miles, extra handling		x	
Ergonomics	x		x
Handling and other operational efficiencies			x
Container management		x	

*Figure 1.7 Impact Factors on Investment and Operations (*Twede and Clarke, 2004)

The initial investment in the container fleet depends on the length of the logistical cycle, the number of items in a box, and standardization requirements. The number of parts/fruits/items that fit in a standard tote may be different from the number in a corrugated box because the interior dimensions could be different. The shorter the logistics cycle is the lower the capital investment. Will be cutting in half the number of days in the cycle can double the NPV. High cycle variability was the reason for rejecting reusable containers for some projects. Standardized containers minimize the total number needed by using a common safety stock to cover demand variations between users (Teran,1999). A project’s expected savings depend on the alternative expendable packages’ purchase and disposal costs. This is where most projects show the greatest financial benefit, especially in periods of rising landfill costs and corrugated prices. Other operational savings may include the ability to automatically sort inbound product once it is packed in uniform containers, modular stacking, better housekeeping, less damage, and a more uniform way of presenting items to the people who empty the package.

The operational cost flows are more difficult to estimate. Clearly, there will be return transport costs, directly related to the distance. Return transport costs depend on the configuration of the packages and the number returned at one time. Some are designed to nest or collapse when empty, which can minimize transport cost.

A study sponsored by the corrugated fibreboard industry (Turvey,1998). found that the following limited situations financially favour reusable packaging:

- Periods of high corrugated fibreboard prices.
- High disposal costs with no recycling revenue.
- Short return distances, low backhaul costs.
- Little or no washing.
- Long container life.
- Steady demand.
- Comparable inbound/outbound payloads.

1.7 DEVELOPING A “PACKAGING LOGISTICS” APPROACH

An increasing number of companies, especially multinational companies, are making a decisive commitment to implementing sustainability and efficiency-oriented practices in their supply chains, the majority view continues to be that implementing sustainability strategies throughout the chain involves a certain incompatibility with the search for logistic efficiency. The packaging appears among the key elements that can support the implementation of efficiency and sustainability-oriented strategies. This efficiency of packaging in logistics should be considered not only in terms of logistics (in the processes of supplying, packing, handling, storing, and transport), but also in environmental terms (the reduction of packaging and raw materials consumption; for example, re-use, recycle and/or recovery waste from packaging) (García-Art et al, 2016).

A specific legislation was realised (e.g., European Directive 94/62/EC; 1994 and its updated version 2004/12/EC) and it introduced the environmental function of sustainability into packaging design (European Commission, 1994, 2004).

Four key aspects could be identified to promote the development and implementation of 'Packaging Logistics':

- The definition of design requirements, based on identifying commercial, logistics, and environmental needs. The proposal is a combination of different design requirements/functions, including commercial, productive, logistics, purchasing and environmental functions.
- The definition of an organisational structure which integrates and coordinates all related areas along the supply chain, both internally in each company and externally, such as packaging manufacturers, distributors, third party logistics.
- The definition of a system that measures and values the pros and cons of each alternative in packaging. Thus, it would be possible to evaluate different alternatives combining the packaging structure and the main design decisions.
- The adoption of "best practices"' and innovations in packaging design with a view to eliminating waste in the supply chain. The best practices to follow are: the standardization of formats and qualities in packaging; the implementation of efficient unit loads in the handling, storage and transport processes throughout the supply chain; the reduction of the raw materials used in packaging manufacturing, and of packaging waste.

1.8 PACKGING SCORECARD

Olsmats and Chris (Olsmats and Chris, 2003) had developed a performance scorecard for the packaging in order to assessment the packaging performance. The method is based on a scorecard consisting of 20 functional packaging criteria (Figure 1.8). In the scorecard, the importance of each criterion is weighted by various respondents on a scale of 0–100%. The weight is normalised, indicating the relative significance of each criterion. The respondents also evaluate the criteria fulfilment, using scores between 0 (not applicable) and 4 (excellent performance). Multiplying this score with the normalised weight gives an indication of how the package is performing.

For an overseas transport the criteria that are more significant are: machinability, product protection, flow information, volume and weight efficiency, right amount and size, handleability, packaging cost, stackability, traceability.

For an overseas transport the criteria that are not useful are: selling capability, product information, packaging design, unwrapping.

No.	Criterion	Description
1	Machinability	Ability of packaging to be processed effectively in the production line
2	Product protection	Ability to protect the product
3	Flow information	Capability to provide information in the supply chain
4	Volume and weight efficiency	Ability to make use of all the available volume and load capacity
5	Right amount and size	Adapt to right quantity and turnover
6	Handleability	Ability to facilitate handling
7	Other value-adding properties	Other functions than the basic requirements
8	Product information	Ability to display product information
9	Selling capability	Ability to sell and advertise the product
10	Safety	Ability to protect the product from shoplifters
11	Reduced use of resources	Reduced environmental load
12	Minimal amount of waste	Amount of waste from the packaging
13	Minimal use of hazardous substances	Amount of hazardous substances in the packaging
14	Packaging cost	The cost of the packaging
15	Stackability	Ability to stack as many shipment units as possible in warehouse and during shipping
16	Unwrapping	Easy to remove unnecessary packaging material
17	Traceability	Capability to trace packaging/products in the supply chain
18	Recyclability	Amount of packaging that can be recycled
19	Reverse handling	Ability to facilitate reverse handling
20	Packaging design	Attractiveness of the packaging design

*Figure 1.8 Functional packaging criteria (*Olsmats and Chris, 2003*)*

1.9 RFID FOR PACKAGING TRACEABILITY

In overseas transportation, returnable packagings are little used for the complexity of managing a return flow on long distance. “The general rule is: the longer the logistics leg, the less practical it is to return returnable containers”. But the RFID technology could help to manage this flow through continuous monitoring on the packaging.

Originally, RFID presented itself simply as an evolution of the widespread barcode system for object identification. A microchip (called tag or transponder) is fixed on the object to be identified, equipped with an internal memory, in which information relating to the object is stored: its serial number and possibly other detailed information, such as the date of production, the composition of the product. When the tags pass near the electromagnetic field generated by a reader, they send to the latter the data related to the object to which they are fixed, thus allowing their identification. This technology allows tracking the packaging at any moment both during overseas transport and when arriving at the customer plant, this reduces the possibility of loss the packaging [19].

RFID is one of the most promising and widely used technologies that make traceability effective at reasonable costs. Technology based on radio frequency identification (RFID) is a very effective tool in the process of monitoring and digital processing in automotive production. RFID is a system for automated data acquisition based on tagging items. The tags contain transponders that emit messages readable by specialized RFID readers. RFID technology is innovative but still under- utilized technology that offers a wide range of possibilities. It allows real-time identification, during delivery, storage, or any other process-taking place within an enterprise. Using RFID technology, it is possible to track products and equipment, with minimum human intervention. This can potentially cut back operating costs and increase real-time visibility during the complete product life cycle. Monitoring the production process with the help of this technology enables all the collected data being automatically imported into the database without the mediation of communication, avoiding the human factor in these processes (Rudiger,2018).

1.10 PACKAGING RESARCH IN LITERATURE

In this section, the objective is to describe the literature about the packaging process and the packaging functions. The literature stream about the packaging process are:

- Marketing for creating value for the customer with the packaging solution.
- Reusable packaging.
- Efficient packaging logistic.

For the automotive sector, the marketing and the communication purpose it is not very relevant as in other sectors such as food or consumer goods because the first goal of the packaging is the protection and the convenience.

1.10.1 HOW PACKAGING IS INFLUENCING THE MARKETING STRATEGY

The intensive competition requires firms to develop innovative solutions in order to remain competitive and survive in the long term. Packaging and packaging design have therefore come increasingly to be seen by firms as an effective way of differentiating product offerings from those of competitors. Well-designed packages can, in addition, build brand and drive sales. Numerous factors have made packaging an important marketing tool. The main function that companies have traditionally assigned to packaging has been related to the protection of products during distribution from a producer to the end consumer. However, new customer needs have led to a consideration of new requirements for the design of a package and a development process involving the logistic, commercial and environmental functions of packaging. (Rundh, 2013).

The logistic function includes the way a product travels from a producer to the consumer and the physical requirements that packaging must fulfil within the actual supply chain. The commercial function concerns the different requirements for marketing communication, the necessary information to the consumer (example about the content; how to use the product), knowledge of customer demand and its potential impact on the purchase-decision process. (Rod, 1990). Apart from the functions of protection and facilitating distribution, packaging has become a tool for fulfilling several other marketing purposes. Another important function is related to communication purposes such as facilitating brand and product recognition. Customer information about price and ingredients, together with information about how to handle and use the product are other necessary functions of a package. New packaging design can be the marketing tool for achieving marketing objectives and satisfying consumer desires. This can be achieved by using the aesthetic and functional components of a package. Aesthetic considerations relate to a package's shape and size, material, colour, text and graphics. Packaging design is not just crucial for branding purposes but also for the function of the package (Rundh,2013).

From a marketing perspective, packaging needs to fulfil a number of objectives within a marketing strategy:

- Innovative design to create customer awareness.
- Identification of a brand.
- Conveying descriptive and persuasive information.
- Facilitating product transportation and protection of the content.
- Supporting product consumption.
- Clever dispensing and recyclability.

This research of the literature has the objective to show how for many firms the marketing function of the packaging is the most relevant because has the power to drive sales of these products.

1.10.2 IDENTIFYING POTENTIAL SOURCES OF VALUE IN A PACKAGING VALUE CHAIN

The marketing function is not the only one for packaging but there are two other main functions (protection and convenience), that are more important for the automotive sector compared to the marketing purpose.

Value is of special interest in business markets, where customers rely on the products and services they buy from their suppliers to improve their own market offering and overall profitability of their firm. In the business environment of today, delivering customer value is critically important since the power of business customers is growing as technology development; information ubiquity and globalisation of markets effectively increase customer choice. Product packaging has been acknowledged to be one possible source of competitive advantage, especially in a highly competitive environment such as food retailing. For brand owners, packaging is a potential area of innovation and may form the basis for differentiation and brand building. In general, a considerable amount of research concerning various aspects of value creation has emerged in recent years. (Niemelä-Nyrhinen and Uusitalo, 2013).

In figure 1.8 is show a model of customer value of a package develop by Niemelä-Nyrhinen Jenni, Uusitalo Outi.

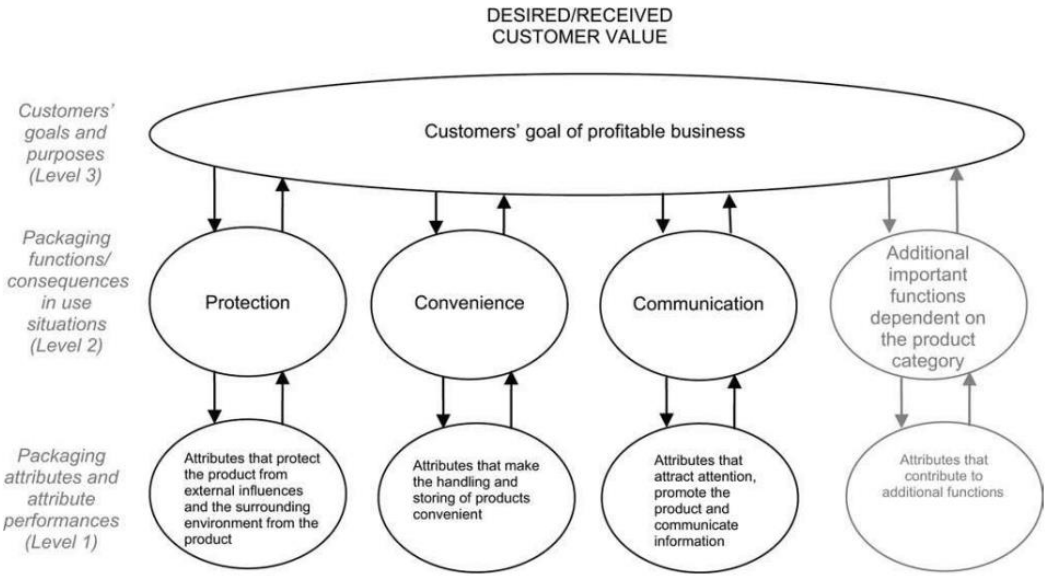

*Figure 1.9 model of customer value of a package (*Niemelä-Nyrhinen and Uusitalo ,2013)

Packaging must have three-core functions protection, communication and convenience these functions may be seen as consequences of specific packaging attributes in use situations. Packaging protects the product from external influences during transportation and warehouse handling. One reason for incurring the added expense of packaging is to reduce the occurrence of damage, spoilage or loss. The communication function of packaging includes attracting attention, promoting the product and communicating information such as content and destination to third parties (also covering such new technologies as RFID), and different information, such as nutritional information and use instructions, to consumers. The third function, convenience, means that packaging should make the handling and storing of products convenient for both the middleman and the consumer. Other relevant functions mentioned in the literature are at least containing, preserving, unitisation and apportioning of products into desirable amounts (Robertson,1990) (Hellstro and Saghir, 2007).

1.10.3 WHAT MAKES REUSABLE PACKAGING SYSTEMS WORK

In recent years, there has been a growing awareness of the environmental benefits of moving from disposable to recyclable packaging and the greater environmental benefits to be gained by making the step to reusable packaging: Disposable → Recyclable → Reusable. The most obvious cost savings are the reduction in purchase and waste disposal costs of one-trip packaging, but the other benefits of standardized reusable packaging are often more important: (Twede and Clarke ,2004).

• reduced product damage;

• improved vehicle utilization – especially for mixed loads;

• standardization of storage facilities;

• ease of handling and stacking at the break-bulk stage;

• ease of handling directly into retail display or point of use in manufacturing.

Reusable transport packaging does not always return for reuse. This is particularly common with packaging going from a small number of manufacturers to a larger number of retail or wholesale outlets. (Kostas et al,2016). Such "diverging" flows are notoriously difficult to control due to the large number of small drop points, where the cost of investigating non-return of packaging units could be more than the value of the units. In "converging" distribution circuits a high reuse rates should be much easier to obtain. In these circuits, such as automotive suppliers delivering to car assembly plants, the problems of high rates of loss at large numbers of small drop points simply do not exist. Hence, in both converging and diverging distribution circuits, the growth in demand for standardized reusable packaging has been accompanied by an increase in the need to obtain high reuse rates. An important theme is the ownership of this returnable package (McKerrow, 1996).

- **Manufacturer owned**. Here the reusable packaging is all owned by the manufacturer who owns or fills it and who is responsible for recovering the empties from his customers.
- **Customer owned**. Here the packaging is owned by the receiver who then reissues the equipment to the suppliers. The best example of this might be some

automotive assemblers. This would apply especially where the unit was very producing specific such as a rack for particular body panels. However, for suppliers producing similar products for different customers is an advantage, instead the use of customer-specific reusable packaging introduces complexity and cost to not only the packing process, but also stockholding and distribution.

- **Jointly owned**. Here a standard specification is agreed on, typically by an industry association or independent body. Users then buy sufficient equipment for their needs and exchange or sell units between themselves. The best example of this is probably the Europallet pool. Such a pool works well provided some discipline is maintained over such things as specification, maintenance, cleanliness and so on.
- **Commonly owned**. A group of companies get together, not only to agree on a common equipment specification, but also to set up a company owned by them which owns all the equipment.
- **Third-party owned.** Here the equipment is owned by an independent third party. Typical examples would be the Chep pallet pool or the IFCO fresh produce crate pool. In such pools, the responsibility for supply and quality is clear.

Reusable packaging systems work best when:

- Quality of equipment purchases, and reconditioning standards are the responsibility of a single entity ensuring individual users' needs are met, but the costs are fairly shared between users.
- The system is managed by someone with authority and responsibility. He/she must care about the reusable packaging.
- The pool management monitors (but not necessarily controls) the use of the equipment in all parts of the distribution process.
- The pool management works with the changing distribution and stockholding circuits and does not expect these to be dictated by the reusable packaging needs.
- Reuse of packaging for onward distribution can be encouraged (with appropriate payment) rather than prevented.

- The pool management can control the collection process to minimize cost, maximize availability and work within the requirements of the drop point. In most circuits, no single solution will achieve this.

1.10.4 EFFICIENT PACKAGING DESIGN IN LOGISTICS

Product design, packaging and logistics are highly interdependent, and together they have a great impact on supply chain activities. It has been recognized that the product design can make excellent logistics possible or impossible, since it strongly affects logistics in terms of modularization, stacking, handling, packaging, manufacturing, transporting. Since nearly all logistics activities are affected by packaging utilities, effective distribution and materials handling require a proper packaging solution. But the packaging is usually not considered until the product design has been decided upon, which makes the packaging design limited by the product design, hence restraining possible logistics solutions throughout the supply chain. There is a recognized need to consider packaging in product development in order to enhance logistics activities and the combined performance of the product and the packaging (Klevås, 2005).

Total packaging cost is a combination of the costs for materials, equipment, operations and labour. The packaging cost can also include the cost of product recalls, failure to repurchase by the customer and the cost of repackaging if the product is not appropriately packed.

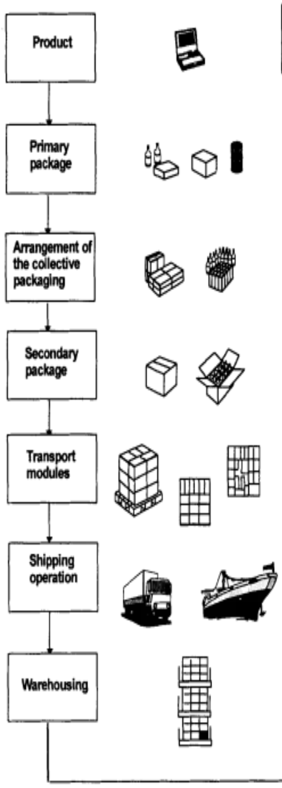

Figure 1.10 Packaging in a typical logistics system (Klevås, 2005)

The three approaches to developing an efficient packaging design in logistics are shown in Figure 1.11. One approach is to concentrate on the primary package, through the use of less material and only for what the package is expected to see. The second approach is to try reducing the amount of secondary packaging, thought the minimize of the board area and with the developing of a new box pattern. The last approach in cost reduction is to optimize the space on the pallet and in the container in the transport module.

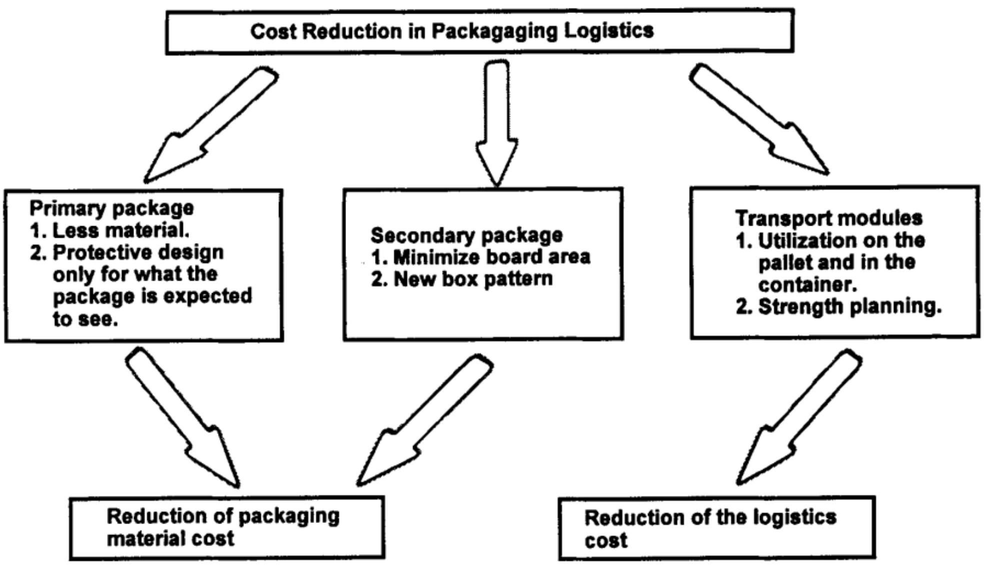

Figure 1.11 Cost reduction in packaging logistics (Klevås, 2005)

The packing of shipping boxes into containers or onto pallets has always been an area of concern for many industries. (Thapatsuwan et al,2007).This is for several reasons. Firstly, inefficient packing leads to usage of more container space to load the same number of shipping boxes that could have otherwise been packed into fewer containers. Secondly, palletizing shipping boxes (by grouping them into stacks) has made the movement of these boxes much easier. Warehousing and storage of the goods and materials along the logistical chain will also impact on costs. The dimensions and stackability of the unit packaging are key factors in the economics of storage. Is possible classify the various costs into two different groups: one is the cost related to the material, the other is the cost related to the logistics and transportation (Changfeng Ge, 1996).

The differences between space utilization and cost optimization are illustrated in Figure 1.12. Space utilization is calculated in terms of total space occupied by the boxes divided by the volume of the container. This could often be satisfied with smaller boxes. The general trend would therefore be that the greater the number of products per boxes, the smaller the percentage of space utilized, as shown in Figure 1.12. For cost optimization, there are two principal objectives to strive for in the minimizing unit total cost.

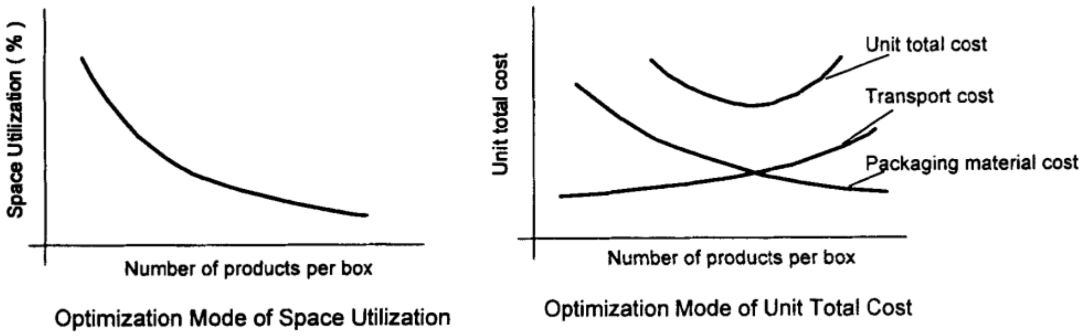

Figure 1.12 Comparison between space utilization and cost optimization (Changfeng Ge, 1996).

Firstly, it is paramount to maximize the space available in order to minimize unit transportation costs. As the number of products per box increases, transport costs increase because the number of products packed in one container (or pallet) decreases due to the limited arrangements for big shipping boxes, which leads to poor space utilization. The packaging material cost, however, decreases with each increase in the number of products per box. The total cost drops initially until the increase in transport cost exceeds that of the packaging material cost. Secondly, the unit total cost curve also shows that there is always an optimization per box which will achieve the lowest cost (Dongmin Kye et al, 2013).

The literature research does not provide a detailed treatment of the overseas packaging and for this reason; the research gap that this work of thesis would cover is about the analysis about industrial packaging for an overseas transport that is not treated in literature in detail. The main topic that this thesis would analyse is connected to the implementation of returnable packaging for the overseas flow from the point of view of the economic aspects and the complexity to manage this flow. The returnable flow for overseas transport is little used and for this type of flow is used mainly the disposable solution. This work of thesis would analysis the implementation of a returnable packaging for overseas flow and not only for drafts that have the short logistic distance where the returnable flow is certainly easier. Another topic that this thesis would analysis is how is possible to obtain an optimization of the packaging costs with a better saturation of the packaging.

CHAPTER 2 FCA

This chapter has the objective of describing the FCA Company and in detail the IRF (Inter Regional Flow) division and the supplier of the logistic service and the items.

2.1 FCA OVERVIEW

In 2014, Fiat Group acquires 100% ownership in Chrysler Group paving the way to complete the union between the two groups in both financial and technical terms. The merger of an Italian company and an American company creates a multi-national organization that operates in more than 140 countries and employs nearly 236,000 people. This marks the beginning of a new phase for the now fully-integrated global automaker.

FCA organization shares in 4 regions in the word:

- NAFTA that includes North America (America, Mexico and Canada).
- LATAM that includes South America (Brazil, Argentina and Venezuela)
- APAC that includes Asia Pacific (China, India, Japan, Australia and South Korea)
- EMEA that includes Europe, the Middle East and Africa.

FCA core business is designs, engineers, manufactures and sells vehicles and related parts and services, components and production systems worldwide through 162 manufacturing facilities, 87 R&D centres, and dealers and distributors in more than 140 countries.

The Group's automotive brands are: Abarth, Alfa Romeo, Chrysler, Dodge, Fiat, Fiat Professional, Jeep, Lancia, Ram, SRT, Maserati and Mopar, the parts and service brand. The Group's businesses also include Comau (production systems), Magneti Marelli (components) and Teksid (iron and castings).

The contributions on the revenue of the 4 regions are as follows:

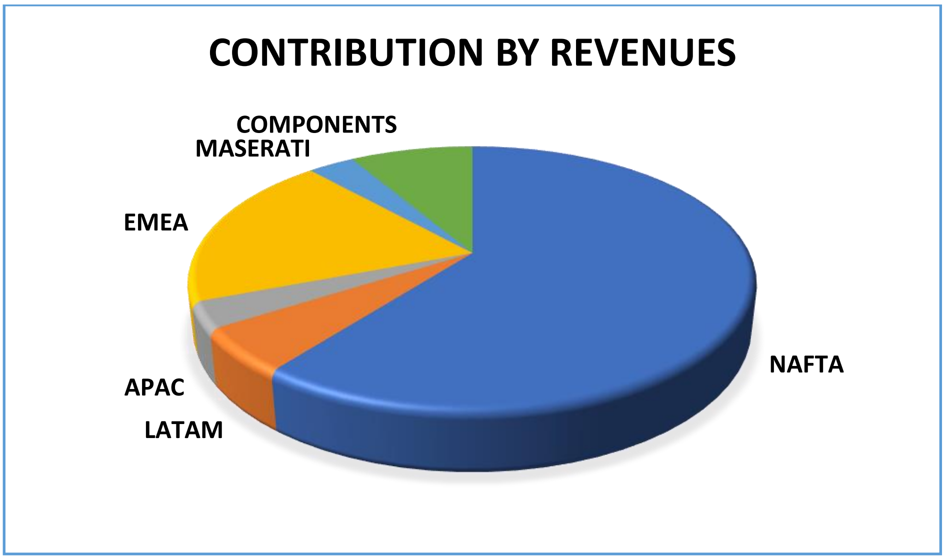

Figure 2.1 Revenue for region [FCA file]

The 80% of the revenue comes from NAFTA and EMEA regions.

2.2 IRF INTER REGIONAL FLOW DIVISION

2.2.1 IRF PACKAGING ORGANIZATION

During the internship and thesis, the division that hosted me is IRF which is responsible for the international supply chain. In EMEA logistic pole managed the logistic flow to the other 3 regions (NAFTA, APAC and LATAM).

IRF (Inter Regional Flow) is a Business Model implemented by the four FCA regions (NAFTA, EMEA, LATAM and APAC) to manage the flow of components between the same regions. IRF coordinates the procurement, packaging, shipping and billing of components from a specific Region / Geographic Area to the Customer Plant located in a different Region / Geographic Area. IRF ensures a standardized management of intercontinental / long distance supplies with a specific level of service, quality and cost targets IRF manages the direct flow of materials at a global level and develops logistics processes for new international initiatives. For packaging operations, IRF support on a third-party logistics operator or in same case implement a direct shipment to customer plant.

IRF division is divided into 4 groups:

- Packaging: it studies and develops the packaging solutions that guarantee the quality of the components shipped from the EMEA region to the other regions in compliance with the logic of Cost Reduction and Sustainability
- Quality: it has the responsibility of the quality of the items that are shipped from EMEA to the other region. IRF quality manages every claim from the customer plant about a qualitative problem of an item that has arrived.
- Operation: it oversees the procurement, consolidation, shipment and invoicing of materials from EMEA suppliers and destined to plants located outside Italy. It manages the flow of material destined to overseas or long-distance shipments following a series of standardized processes to guarantee adequate levels of service and to contain logistics costs. The objective of IRF operation is managing the flow of information and of material.

  In the EMEA region, shipments are made by rail (Serbia and Poland) or by ship (Turkey), for intercontinental shipments to NAFTA, LATAM and APAC, transport by ship is adopted. In an emergency situation, the transport by air could be used.
- Program Management: Coordination of set-up activities for international flows and launches of new import and export projects: validation of production capacity and costs, the definition of contracts, validation of packaging. Support in the definition of processes, roles and flows with cross-functional and inter-Region teams, on new IRF projects. Support and coordinate the improvements / developments of IT systems, in accordance with IRF requests.

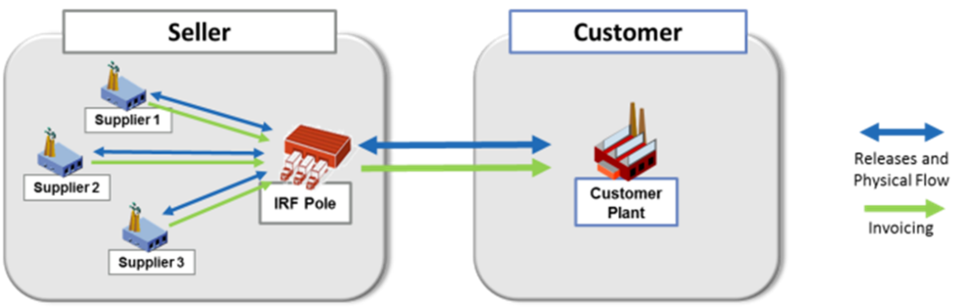

Figure 2.2 IRF logistics flow [FCA file]

In this Figure 2.3, it shows the flow between the different Region pole.

Figure 2.3 Flow between IRF pole [FCA file]

In EMEA region there are three IRF pole Italy, Poland and Turkey. In APAC region there are two IRF pole China and India, while for NAFTA and LATAM there is only one IRF pole.

The EMEA (Italy pole) current volume/ regions are the following:

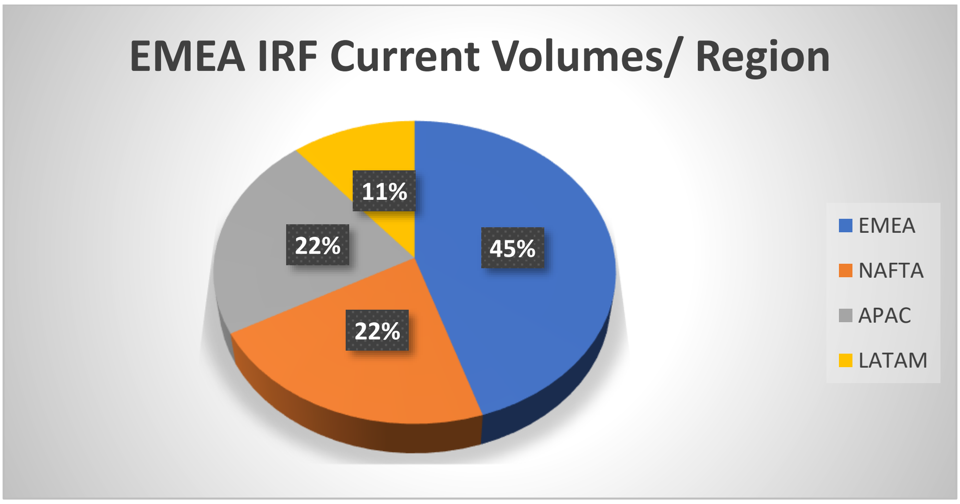

Figure 2.4 Volume for region [FCA file]

Are managed by the Italy polo 1.3 million/ m^3 per year and are managed 12.000 different items.

The IRF packaging division has as mission the study and the development of packaging solutions that guarantee the quality of the components shipped from the EMEA Region to the other regions in compliance with the logic of cost Reduction and sustainability (Figure 2.5).

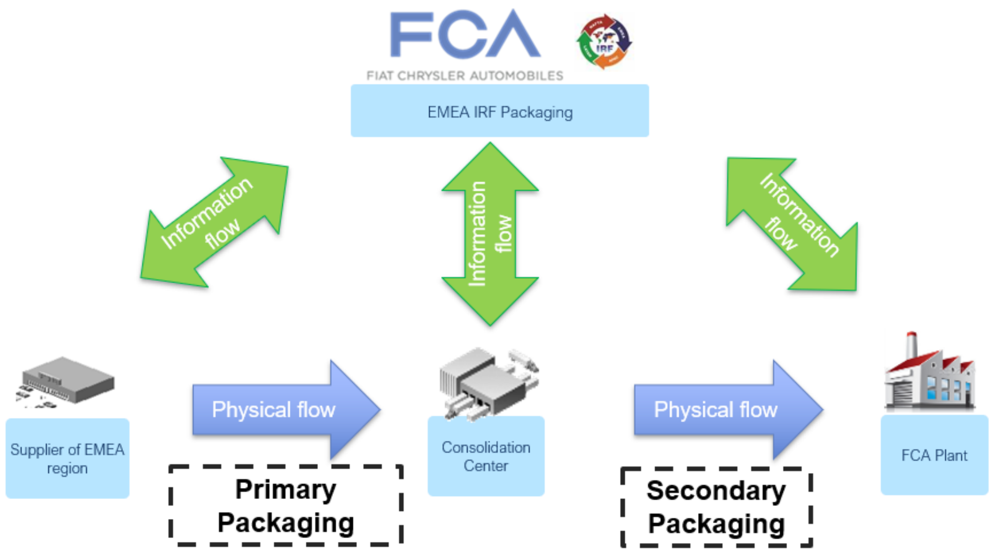

Figure 2.5 IRF packaging flow [FCA file]

2.2.2 IRF PACKAGING KPI

IRF packaging division controls three KPI (key performance index).

- Cost reduction there is a monthly target of savings that must be achieved for the objective of value optimization. Every month there are collect the economical saving on packaging things, for example, changing the type of container, modifying material used or changing the packaging operation.
- Saturation of the first level. It shows how is saturated the rack (Figure 2.6).
- Saturation of the second level. It shows how is saturated the container that is used during the transport by ship, train, plane or truck.

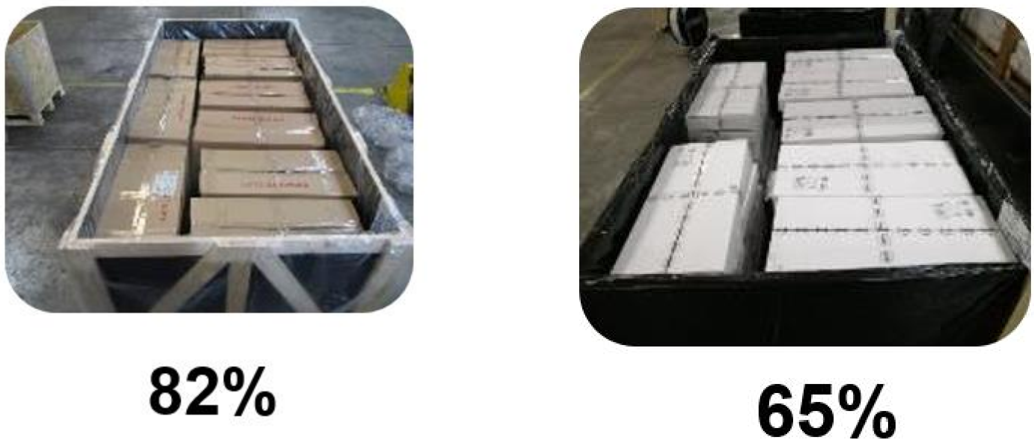

Figure 2.6 Example of saturation of first level [FCA presentation]

2.2.3 IRF CLIENT AND SUPPLER

IRF division clients are the assembly plant in the four regions around the world. Logistic costs are turned over to customers without any margin. The principal clients are the following (Figure 2.7):

- NAFTA (Toledo, Saltillo and Toluca)
- LATAM (Pernambuco, Fiasa and Faasa)
- EMEA (Tychy, Fas and Tofas)
- APAC (Guangzhou , Mazda and Ranjangaon)

Figure 2.7 IRF flow from the Polo Italia - Main Customer Plants and car model [FCA presentation]

The IRF suppliers are of two types: suppliers that supply the items and suppliers who lavish a logistic service.

The suppliers who provide physical objects are more than 5.000 and supply more than 7.500 different items. Among these suppliers the most relevant are:

- BOSCH who supplies oxygen sensor, engine control unit, parking sensor control unit, wiper blade, battery sensor.
- MAGNETI MARELLI who supplies engine control unit, gearbox control unit, electronic throttle body, the velocity sensor, exhaust system.
- VALEO who supplies headlight fog light, clutch control pump, rain sensor module, hydraulic clutch tube.
- MAHLE who supplies aspiration or sewer valve, compressor, cooling module.
- DENSO who supplies alternator, gasket, compressor, electric windscreen wiper motor.
- RAICAM who supplies brake pad.
- ITW LYS FUSION who supplies retention clip, button, rivet
- GKN who supplies drive shaft, differential axes, collar
- AGLA POWER TRANSMISSION who supplies pulley, hub cup.
- ZF FRIEDRICHSHAFEN AG who supplies gearbox control unit, gearshift plate.
- I.B.S. INDUSTRIA BULLONERIA who supplies every kind of screw.

There are internal suppliers of the group like:

- Verrone plant where there is the production of gearbox and transmission.
- Cento plant where there is the production of the diesel engine.
- Termoli plant where there is the production of the petrol engine.
- Pratola Serra plant where there is the production of the modular engine.

The items that are shipped constitute every part of a car from the screw to the engine or door.

The other category of suppliers are the logistics operator that are treated in the next paragraph.

2.2.4 LOGISTICS SERVICE PROVIDER

In Italy, the two Export Consolidation Center are BCUBE at Villanova d'Asti (AT) and Arcese Syncreon at Cerratina (PE). This logistic operator receives the goods from the suppliers and after they manipulate the items and prepare the loading unit to be sent to the final customer.

The items that arrive in the Export Consolidation Center (Bcube or Arcese Syncreon) can undergo different processes.

- **REPACK** the supply condition of the supplier is not suitable for overseas transport or the items need a special protection (VCI or desiccant salts). This is the most expensive operation because the objects must be taken from the supplier's packaging and placed in a new packaging created ad hoc. There are 3 entries of costs: handling (labour), material, volume.
- **RACKING** that is divided into 4 categories: Racking of supplier boxes (logistic operator use supplier boxes and containerize them), Racking into Boxes (logistic operator create new boxes and puts the supplier's boxes inside them), Racking with extra protection (extra protections are added to the packaging) and Racking of supplier pallet (logistic operator use directly supplier pallet and containerize them). These boxes or pallets are inserted inside a large cage to facilitate containerization (Figure 2.8). For this activity, there are 2 entries of costs: material and volume.

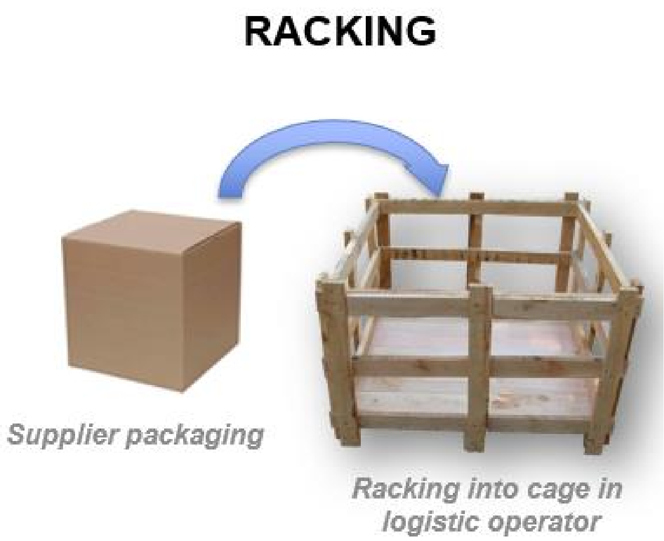

Figure 2.8 Example of racking operation [FCA file]

- **CROSSDOCKING** the supplier packaging is not manipulated, and the logistic operator performs only the containerization activity (Figure 2.9). The supplier realizes a packaging that guarantees the safeguard of the pieces up to destiny. For this activity, there is only one entry of cost: volume. This is the most economic operation, but it is important to be careful to the saturation of the container (saturation of the second level).

Figure 2.9 Example of crossdocking operation [FCA file]

Another possibility of transport is direct shipment. In that case, the items do not transit into the logistic operator, but they are shipped directly from the supplier.

CHAPTER 3 FCA PACKAGING PROCESS

This chapter has the objective to describe in detail the packaging process in FCA for the overseas shipment through the description of the norm, the packaging cycle, the development of new packaging and an overview of packaging type in IRF.

3.1 STANDARDS AND NORMS IN OVERSEAS TRANSPORT

For an overseas transportation the packaging needs some technical specifications:

- The packaging can be developed in wood, cardboard, plastic, metal or Styrofoam;
- The packaging must guarantee the quality and integrity of the parts inside it for a minimum period of shipment/storage of 6 months from the data of delivery to the LSP (logistic service provider) pole;
- All the wooden components within the packaging (pallet, cages, separators, supports) must be certified in accordance with the phytosanitary international standards ISPM-15;
- The packaging must preserve its structural and functional properties until its content has reached the final point of use;
- The packaging must be studied to prevent phenomena of corrosion/oxidation of the parts and considering the significant temperature and humidity variations that might occur throughout the logistic flow.

The overseas transport is subject to particular climatic conditions that must be considered:

- Relative humidity variations: the packaging will be subject to several humidity external and internal variations during transport. Such phenomena are strictly related to weather changes, seasonality and positioning inside the container. These variations can be empirical; below the minimum, maximum and mean values recorded during a standard shipment:
  Min (%): 17%
  Max (%): 100%

Mean (%): 68%

- Temperature variations: the packaging will be subject to several external and internal temperature variations during transport.
  Min (C°): -25 C°
  Max (C°): + 70 C°

For this type of overseas transport there is a norm that establish insertion of protection for metal or electric items like stamped body parts made from uncoated, not galvanised sheet, not painted; engines; gearboxes; mechanical and chassis parts; electric/electronic devices.

The main risk is the corrosion during the shipment. The presence of water in condensed liquid phase or as vapour is the major risk factor for triggering and promoting corrosion processes.

The highest risk for the introduction of water into the packing is encountered during shipping by sea and storage on port docks and in humid tropical environments.

Corrosion also of a considerable entity may occur when packing is exposed to major differences of temperature in high humidity conditions (e.g. day and night), when they are transferred from a hot place to a cooler place or when they are subjected to climate changes during transportation.

The material inserted in the packaging to prevent the phenomenon of corrosion is VCI. VCI indicates a group of substances capable of easily sublimating at ambient temperature and absorbing to metal surfaces thus preserving them from corrosion.

These substances are added by impregnation or mixing to many supports and packing materials (e.g. paper, cardboard, plastic films, foams, dusts, oil or aqueous solutions) which therefore work as vectors for the inhibitor.

The inhibitor sublimates from the media containing it, saturates the volume of air inside the packing and is absorbed, in form of mono-molecular film, by the all metal surfaces contained therein. The VCI can therefore also reach surfaces which are not directly in sight (e.g. cavities, threads, inner piping, concealed areas) providing they are actually accessible to the VCI vapours and these are present in sufficient quantity in the packing.

3.2 PACKING CYCLE

The packaging cycle is developed by the logistic operator (Bcube or Arcese Syncreon) and is approved by the IRF team. A packaging cycle contains all the information's that are necessary for package the items when arriving at the logistics centre.

A packaging cycle is always mono-product, this means that the price for a single item is calculate supposing to put only one product inside a container. In practice, however, it is possible to insert different items inside a rack.

The packaging cycle is the base to determine the price list for each item.

The packaging cycles are different depending on the type of activity that the item undergoes (Repack, Racking or Crossdocking).

3.2.1 REPACK

It is the activity that generates more cost because the supplier packaging is subjected to strong manipulation. With this activity, a new packaging is creates.

This type of cycle is constituted of three different part:

- The information about the packaging, the supplier condition of the packaging (dimension and quantity for a box) and the new package information (Mdr, dimension e quantity of pieces inside of it) (Figure 3.1). Other basic information's are the id number of the item and the client to whom it will be sent.

Cod mdr supplier	Lenght Supp.	Width Supp.	Height Supp.	Qta Supp	Cod mdr	Lenght	Width	Height	Qta
BOX ON PALLET	1460	1160	880	18	46175499	1.46	1.12	1.05	12

Figure 3.1 Information about packaging cycle [FCA cycle sheet]

- Basic cycle that contains the information about the material and the relativity quantity, necessary to build the external package inside which the objects or boxes will be inserted (Figure 3.2).

Desc operation	Time tot	Material	Describtion of the material	Total
REPEAT BASIC CYCLE OPERATIONS BOX (46175499)	15.9671	100241	GRAFFE V/840 40 MM/LUNGHE	16
		125108	PUNTI METALLICI N.108 PER	13
		1777	1777 MANIFESTO DI DESTINAZIONE A4	1.042
		400113	400113 SIGILLO	0.042
		46175499	46175499-CASSA PLI-BOX DIM.	1
		46175693	46175693 PROPADRY CONTAINER II	1.667
		46175707	46175707-NASTRO FCA H=75 MM.	0.04
		46175724	46175724-REGGETTA PERSONALIZZATA FCA	9.08
		46176166	46176166-LISTELLO DIM. 2400X80X25	0.208
		46176169	46176169-LISTELLO DIM. 2400X80X50	1.5
		500004	500004-SACCHETTO 250X350X0,10 MM	1.042
		5000805	5000805-ANGOLARI IN PLASTICA	4
		53860909	SPIRALINA	0.042
		600041	600041-POLITENE MONOPIEGA H=1300 MM	0.273
		PIOMBINO	PIOMBINO	0.042

Figure 3.2 Example of basic cycle [FCA cycle sheet]

- Specific cycles give the instruction on how to place the pieces inside the packaging and unlike the base cycle, it is specific to a particular item (Figure 3.3).

Desc operazione	Tempo tot
APRIRE E FARE CONTROLLO VISIVO FORNITURA.	0.5418
TAGLIARE MATERIALE E (DESCRIVERE MATERIALE). MULTICEL DIM. MM 2600X1200 - 7 FOGLI	7.7268
APPROVVIGIONARSI DEL MATERIALE NECESSARIO ALL IMBALLO. I FOGLI DI MULTICEL ED IL MATERIALE A FIANCO	5.5191
TOGLIERE/POSIZIONARE COPERCHIO SCATOLA FORNITORE. RIMUOVERE IL COPERCHIO DI DUE 4202 DA 5 PEZZI	1.5769
PRELEVARE E INSERIRE PIANETTO DI. CARTONE IN VERTICALE ALL INTERNO DELL IMBALLO	0.2838
PRELEVARE E INSERIRE UN FOGLIO DI. MULTICEL SUL BANCO DI LAVORO	0.3154
ESTRARRE PARTICOLARE E POSIZIONARLO SU BANCO DI LAVORO . PESO 2,88 KG - SUL FOGLIO DI MULTICEL	0.3978
RISVOLTARE O SOVRAPPORRE FOGLIO E UNIRE UTILIZZANDO PINZATRICE DA SCRIVANIA EUROPLIER. IL FOGLIO DI MULTICEL ATTORNO AL PARTICOLARE	0.3942
PRELEVARE E POSIZIONARE PARTICOLARE ALL INTERNO DELL IMBALLO . IN VERITCALE	0.3978
RIPETERE OPERAZIONE . RIP. CICLO 91327(60,70,80,90,100)-TOT. IMBALLO 7 PEZZI	10.7347
RIPETERE OPERAZIONE . RIP. CICLO 91327(60)-SUBITO DOPO L ULTIMO PARTICOLARE	0.2838
PULIZIA MDR E MOVIMENTAZIONE IN ZONA "MDR VUOTI". ABBATTERE I CONTENITORI DI FORNITURA	2.7089
PULIZIA E RIORDINO POSTO DI LAVORO 2% T.E..	0.995

Figure 3.3 Example of specific cycle [FCA cycle sheet]

The total cost of this activity is the sum of three parts, this cost is always calculated for single item.

$$€/Piece\_tot = €/Volume\_piece + €/Mdo\_piece + €/Mat\_piece$$

The volume cost is calculated multiplying the volume unitary and a specific price specified in the contract with the logistics operator. The volume unitary is found dividing the external volume of the package and the number of items present within it.

The handling cost is calculated multiplying the total time used for doing the package and a specific price specified in the contract with the logistics operator.

The material cost is calculated multiplying the total number of materials that are used for doing the package and the cost of this material specified in the price list of the logistic operator.

3.2.2 RACKING

The items managed with this activity the cycle it is slightly different because the specific cycle is missing. There are only the basic cycle and the packaging information as described in the previously chapter for repack activity (Figure 3.4).

The total cost of this activity is the sum of two part, this cost is always calculated for single item. Unlike the repack activity for racking there is not a handling cost.

Activity	Lenght Supp.	Width Supp.	Height Supp.	Qta Supp	Cod mdr	Lenght	Width	Height	Qta	Material	Total
RACKING	350	260	250	400	46176283	2.25	1.47	0.86	36000	1777	1.05
										100160	110
										125108	128
										400113	0.05
										500004	1.05
										600041	0.376
										5000805	4
										46175693	0.5
										46175707	0.06
										46175724	17.32
										46176166	0.5
										46176169	0.2
										46176283	1
										46177230	2
										46177231	2
										46177238	1
										53860909	0.05
										PIOMBINO	0.05

Figure 3.4 Racking activity cycle [FCA cycle sheet]

The items managed with this activity the cycle it different because there are only the packaging information's because for the shipping is used the supplier package.

The total cost of this activity is the sum of one part, the volume cost, this cost is always calculated for single item.

$$€/Piece\_tot = €/Volume\_piece$$

3.3 DEVELOPMENT PROCESS OF NEW PACKAGING

For the design of new packaging solution there are 5 phases that must be followed:

- **DESIGN** Packaging is designed using physical parts as well as math data. Part design considerations include: part protection, ergonomics and line side display, customer and end-user requirements, cube utilization inside the packaging, cube utilization in transportation.
- **PROTOTYPE AND PART FIT** during this operation the physical prototype is built and the item that must be packed is inserted for evaluate the fit.
- **TESTING** static tests are carried out at the supplier using a transportation simulator for export and import packaging concept. Prototype packs are tested using various machinery designed to simulate the transportation environment. Other tests include the impact of compression tests to determine stacking and load capability and shock tests to assess drop and impact during handling.
- **CUSTOMER SIGN-OFF** Prior to the actual test shipment there is this phase that allows customers to provide feedback on concerns prior to production launch. The provider gives the customer a copy of the unit load data sheet which contains information about the packaging specs as well as instructions for loading and unloading the pack.
- **VALIDATION** The final phase is validation. The prototype packaging is loaded at the supplier and shipped to the final destination plant. Parts and packaging are checked to ensure part quality, ease of unloading and address any additional concerns from the receiving plant.
  For the test, shipments should use full container quantities of parts and a label that identifies the test.

The FCA norm imposes three different shipping's with three different containers and for validation, all three must be exceeded. Figure 3.5 shows the checklist that the customer plant must complete for validation.

#1 Check-list (Customer Plant)

Case nr.:

Question	YES	NO	Remarks	Validated by
Rusted material		X		
Collapsed material		X		
Material with dent, deformation, damage		X		
Package collapsed without affected material		X		
Package in wet condition		X		
Others (issue description)		X		

Figure 3.5 Check-list for Customer Plant validation [FCA file]

3.4 PACKAGING OVERVIEW FOR IRF

In this moment for the shipment of the items from EMEA to the other regions LATAM, APAC, NAFTA and EMEA (Poland, Serbia e Turkey) are used returnable and disposable packaging.

The 44% of the shipment volume is into returnable packaging like GAFER, Wooden racks or IFAST containers. For MIX is intended many different types of normalized racks and specific rack.

The GAFER is a collapsible metal rack where the items are inserted into it (Figure 3.6).

The IFAST container are returnable container manage by a company owned by FCA called indeed IFAST Logistic.

Figure 3.6 Example of gafer [FCA photo]

The other volume 56% are shipment into disposable packaging like carton boxes or wooden racks (Figure 3.7).

Returnable (44%):

- **7%** → GA.FE.R.
- **10%** → Wooden Racks (only Returnable Wooden Cages)
- **4%** → IFAST (KLTs, KPTs, Odette Pallets)
- **23%** → MIX (Different Types of Normalized Racks and Specific Racks)

Disposable (56 %)

- **38%** → Carton Boxes
- **2%** → Polystirene Racks
- **17%** → Wooden Racks (Boxes, Cages, OSB)

Figure 3.7 Current packaging situation [FCA analysis]

It needs particular attention the fact that of this 44% of the volumes that are shipped into returnable most of it is toward the EMEA region. Expect the gafers and the wooden racks that are used in two cases for overseas client the other returnable packaging are used only for EMEA clients (Poland, Turkey, Serbia). This is due to the reason that managing a returnable flow for clients who do not have a long distance between the logistic operator/supplier is easier.

RETURNABLE	%
EMEA	71%
NAFTA	27%
LATAM	1%
APAC	1%

Figure 3.8 Percentage of returnable packaging in the 4 regions on volume [FCA analysis]

The 71% of the volumes of items that are shipped into returnable packaging is for EMEA client. Another region with a high percentage is NAFTA with 27% of the total volume but this flow is concentrated for only one client (Figure 3.8).

Instead of managing a returnable flow for the client into the LATAM, NAFTA and APAC regions is more complex because the distances are much greater than client into EMEA region.

This means that for the overseas transport at that moment FCA shipped the items into the disposable packaging. There are few cases that are used returnable gafers for overseas transport.

DISPOSABLE	%
EMEA	7%
NAFTA	66%
LATAM	20%
APAC	7%

Figure 3.9 Percentage of disposable packaging in the 4 regions on volume [FCA analysis]

Of the disposable packaging the height volume is for NAFTA region with 66%. Also, LATAM has an important percentage with 20% (Figure 3.9).

One possible improvement that is possible to implement a returnable flow not only for the EMEA clients but also for the clients into the other regions.

3.5 SUPPLIER PACKAGING CONDITION

Each item is associated with an IPDP (International packaging data plan) that contains all information on the conditions of supply (Attached 1).

In this document, there are the following information's:

- **Photos** of the supply conditions (Part, Internal Container and Complete Unit Load/Pallet).
- **The information about the part number** (Size, Weight, Classification, Material type and type of Protection).

- **Primary container information** (Container Element; Container Type; Container Dimensions; Density (parts/carton); Tare Weight (empty carton); Gross Weigh (loaded carton); Interior Dunnage Material Type.
- **Unit Load Information** (Pallet Type; Pallet Element; Pallet Dimension; Cartons per Layer; Layers per Pallet; Unit Load Density (total parts/pallet); Unit Load Dimensions; Unit Load Stack Height (maximum); Banding Type.
- **Logistic Information (for Direct shipment)**

3.6 LABEL AND SHIPPING INFORMATION

Logistic suppliers must assure that all material shipping containers are correctly labelled with the proper AIAG (Automotive Industry Action Group) (B-10) identification labels and when required, the appropriate federal and local government labelling. This type of label is attached to the single packaging (Figure 3.10).

Packing and Shipping Identification Label must contain the following data fields:

- Part Number
- Part Description
- Quantity
- Supplier Identification Code
- Date Manufactured
- Safety Item
- Serial Number (traceability)
- Change Letter Information
- Dock Location
- Drop Zone Information

Figure 3.10 Shipping label information [FCA file]

A 'Master' label must be used to identify a unit load of multiple, single packaged cartons of parts of the same part number. One label is required per part number. The label shall be placed on the unit load in such a manner that when the pack is broken apart the label is discarded (Figure 3.10).

A 'Mixed Load' label must be used to identify a load of multiple, single packaged cartons of parts of different part numbers. Mix loads are required to have a Master Label of each individual part applied to the shipments (Figure 3.11).

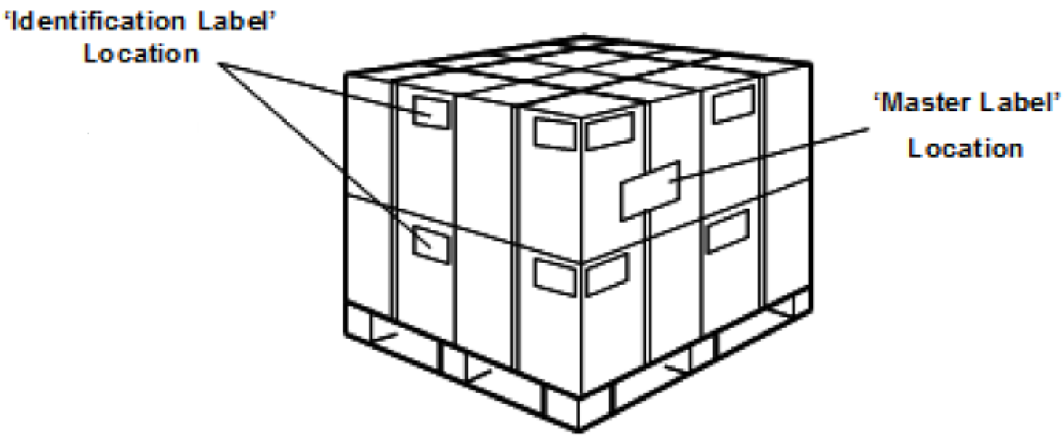

Figure 3.11Label for a unit load [FCA file]

3.7 PACKAGING INNOVATION IRF

There are many types of possible activity that could be implemented to improve and innovate a current packaging solution.

- It is possible to work on the dimension of the packaging trying to find a standardized solution that could be used for multiple items and trying to get a packaging that has an optimal primary and secondary volume saturation that implies lower costs and greater efficiency. The dimension of a packaging must be such as to maximize the number of items that it is possible to insert inside of it, respecting the weight constraint.
- It is possible to change a logistic flow; the principal innovation is the passage to a direct shipment directly from the supplier. The fundamental condition is to have a demand that it is enough high to allow a direct shipment. The main advantage of this solution is that the items don't transit anymore into the export centre of the logistics service provider, which implies significant savings.
- It is possible to change packaging material, for example, switching from cardboard to wood or from wood to plastic or metal solution. That could bring optimization in the weight, the saturation and the protection of the items inside the packaging.
- It is possible to work on the saturation of first and second level through the optimization of the packaging dimension to have an optimal saturation of the items inside the package and of the package inside the container.
- It is possible to change the packaging activity that is performed at logistics service provider. For example, it is possible to switch from a racking to a crossdocking that involves fewer costs and less organizational difficulty.
- It is possible to change supplier packaging condition to facilitate the work of the logistic operators. If the supplier packaging has the right characteristic for an overseas transport this package will not to be manipulated from the logistic operator with a consequent saving of money.
- It is possible to implement returnable packaging solution that involves investment but generates saving of money in the long run.

The issue that has not been already explored in IRF is the use of returnable packaging for the overseas shipment like is made for the EMEA flow. This thesis is strictly connected to the study of this possible solution to help the company to evaluate this new way of overseas shipment that is completely different compared to the actual disposable solution.

CHAPTER 4 NEW RACK 285

The objective of this chapter is to describe the economical convenience which results from the reduction of 173 mm of the width of the wooden rack 285 that involves a noticeable better second-level saturation. In this analysis, it is also considered the switch from the 283 to the new 285 racks with less dimension. This analysis is requested to validate the possibility of changing the dimensions of a current package.

4.1 CURRENT SITUATION

Nowadays is used a rack 285 with this dimension is used (Table 4.1).

285 RACK OLD	EXTERNAL	INTERNAL
LENGTH [mm]	2250	2150
WIDTH [mm]	1470	1370
HEIGHT [mm]	1290	1160

Table 4.1 285 old dimension

This project there considers the items that are shipped into this type of rack and that are submitted to activities of Racking of supplier pallet, Racking of supplier boxes and Racking with extra protection, that are described in section 2.2.4. The 285 rack is the external packaging and inside its cardboard boxes or wooden pallets are inserted to allow and make the overseas transport easier Figure 4.1. Without the external rack, it is impossible to ship a cardboard box with a small dimension into a container and the 285 cages have also the utility to saturate better the container (saturation of the second level).

There are also the items shipped into 283 racks for the switch to the new 285 solutions with 170 mm in less of width. The dimensions of 283 racks are the following (Table 4.2):

283 RACK	EXTERNAL	INTERNAL
LENGTH [mm]	2250	2150
WIDTH [mm]	1470	1370
HEIGHT [mm]	860	750

Table 4.2 283 dimension

The project is developing a new 285 rack (Figure 4.1) with the new dimension that can improve the saturation of the items inside the rack with a consequent economical saving as the saturation of the first level is a KPI it is important to monitor it carefully. A bad result for the KPI of first level saturation means that this type of rack is shipped empty and you are paying space in containers to send air.

The change is reduced by 170 mm the width of the rack from 1470 to 1320 mm. The length and the height are the same compared to the old version because there are standard dimensions that saturate the container very well. Into a 40 high cube container, it is possible to load eighteen of this type of rack with a saturation of the second level of the 99%. The dimensions of 285 new racks are the following:

285 NEW RACK	EXTERNAL	INTERNAL
LENGTH [mm]	2250	2150
WIDTH [mm]	1320	1200
HEIGHT [mm]	1290	1160

Table 4.3 285 new dimension

Figure 4.1 New 285 rack [FCA file]

Figure 4.2 New 285 rack [FCA file]

This improvement has been proposed by the logistic operator Bcube.

The objective of this analysis is to understand if this new solution determines a saving through the improvement of the saturation of the first level.

4.2 ANALYSIS

To evaluating the economical saving of this proposal 4 separate analyses were performed

- Items managed with racking of supplier pallet from 283 to 285 new
- Items managed with racking of supplier pallet from 285 old to 285 new.
- Items managed with racking of supplier box or extra protection from 283 to 285 new
- Items managed with racking of supplier box or extra protection from 285 old to 285 new

All these analyses are made on the price list that IRF pay to the logistics operator for the packaging.

In the case of racking activity, the total unitary cost of items is determined by the sum of volume cost and the material cost.

The volume cost is calculated in this manner: the volume is calculated with the external dimension of the rack (for example 285 old is 2,250 x 1,,470 x 1,290 = 4,27 m^3) and them this value is divided by the number of the items into the rack (Volume / number of items). In this way get the value of the unitary volume in m^3 that must be multiplied with two fix prices specified in the contract with the logistics operator, that for reasons of secrecy it is not possible to describe in detail into the thesis.

When comparing the two solutions the cost of the material is supposed to be constant.

The analysis is made with a planning for the next 6 months, that provides an assessment of shipping volumes for the coming months. The total unitary cost is multiplied with the planned quantity to determine the total cost of the packaging for these items.

4.2.1 RACKING OF SUPPLIER PALLET FROM 283 TO 285 NEW

Racking of supplier pallet means that the pallet arriving at the logistic operator from the supplier is put inside the rack 283 with a determined number of items inside of it. In that case, passing from a 283 rack with a height of 860 mm to a new 285 with a height of 1290 by executing the passage of the items determines a worsening of volume occupation that generates more costs because the volume unitary that generates the unitary cost of packaging is greater. The items considered in this analysis are 40 for example rod bushing, sensors, differential tree, headlight, cooling module, fixed tensioner, sleeve, diesel filter or disk brake.

In the first step, the new unitary volume for the 285 racks is calculated maintaining the same number of items inside the package. Unavoidably there is an increase in the unitary cost of items because the unitary volume with 285 racks is more than 283 (same number of pieces but more volume caused by a higher height).

With this configuration of only transfer from 283 to new 285, there is an increase in the cost of 15% in comparison with the as is cost (worst case).

For not having an economic inconvenience, it is evaluated how to exploit the empty space generated with the new rack 285. Between the 283 and the 285 new, there is 410 mm of difference in height.

The supplier pallet with a maximum height of 580 mm was considered because this package has the height to be stacked and doing so the second floor with a consequent doubling of the pieces inserted inside the rack. Increasing the number of items inside the rack is possible to have a better saturation of the first level that determinate fewer volume costs.

Ten items have been identified with this characteristic of a maximum height of 580 mm, obviously, the possibility of stackability needs to be verified with the supplier.

For these ten-cases doubling the number of items inside the rack and calculating the new unitary volume generate a global saving of 3% (best case). The saving that is produced by 10 items is more than the extra cost that the other 30 items cause. The total number of items in this category is 40.

Of these 10 items, there is one that determinates more than 55% of the saving because the next 6 months plan is very high and with the stackability it gets an optimal saturation. The item is a diesel filter shipped to Toluca Mexico that has this dimension (1200 x 800 x 560) of the unit load. The supplier confirms the possibility to stack the pallet (Figure 4.3).

Figure 4.3 Supplier packaging condition internal and external for diesel filter [FCA file]

4.2.2 RACKING OF SUPPLIER PALLET FROM 285 OLD TO 285 NEW

In that case, switching from old 285 to new 285 makes the analysis simpler because the checking consists only in considering if all pallets have the dimension such to be inserted into the new 285 with 170 mm less of width. The items managed in supplier pallet into 285 racks are 73, for example, electric windscreen wiper motor, starter motor, drive shaft, door lock, headlight, bearing shelter, exhaust pipe, pump or engine oil sump. All supplier pallet fit in the new 285 racks, this means that the reduction of 170 mm in width does not reduce the number of pallets entered for any part number. The same number of items that were inserted in the old 285 are put in the new 285 racks. The convenience lies in the fact that the volume of the rack is diminished, passing from 4,27 m^3 to 3,83 m^3 but the number of items remains the same. That involves a reduction in the unit volume and a consequent reduction of the volume cost.

Thought the computation of the new unitary volume of an item in the new 285 racks is possible to estimate the new unitary total cost and multiplicate this value with the planned of the next six months get it the total cost of packaging of these 73 items.

Comparing this new cost with the old cost is possible noticed that improving the saturation of the first level through the decrease of the width has generated a saving of 4%.

4.2.3 RACKING OF SUPPLIER BOXES AND EXTRA PROTECTION FROM 283 OLD TO 285 NEW

Racking of supplier boxes means that the supplier boxes when arriving at the logistic service operator are put inside the rack, the difference with the supplier pallet is that the boxes have a small size and many boxes are inserted to saturate the cage.

Racking with extra protection are items that need an addiction of extra protection material like VCI or desiccant bag for an overseas transportation.

The items managed in supplier boxes and extra protection into 283 racks are 598 for example headlight, sensors, gaskets, valves, cap, antenna, screw, tensioner, belt cover, nuts, control unit, external operator or oil introduction tube.

For each item are taken the supplier conditions of the box (length, width, height and the number of pieces inside a box). In the price list is specified the total number of items present in the current cycle. Dividing this number with the number of pieces inside a box is possible to calculate the number of boxes that are inserted into the 283 racks.

Switch from 283 to 285 rack with more 430 mm in height but 170 mm less in width must calculate the new number of boxes that is possible to insert into the new 285 racks.

This formula has been used for calculating how many pieces could be inserted into the new 285 racks. It was considered to arrange the boxes in two dimensions long side and short side. All divisions are approximated for a defect. For the rack 285 has been used the internal dimension (2150 x 1200 x 1160).

$$MAX([((\frac{2150}{box\ lenght})*(\frac{1200}{box\ width})*(\frac{1160}{box\ height}))*\text{Num of pieces into a box})] ;$$
$$[((\frac{2150}{box\ width})*(\frac{1200}{box\ lenght})*(\frac{1160}{box\ height}))*\text{Num of pieces into a box})])$$

Among the two values have must be taken the maximum.

The same formula, obviously changing the internal dimensions (2150 x 1370 x 750) is used for calculating the theoretical number of pieces that must be present in the old 283 racks. For 129 out of 598 items there is a discrepancy between the number that is specified in the price list and the theoretical number calculated with the formula. The discrepancy is both greater than lower (24 items with at price list quantity minority that the theoretical quantity and 105 items with at price list quantity greater than the theoretical quantity).

These 129 items with discrepancy represent approximately 40% of the total cost of this analysis. To have a more reliable assessment of the saving these items are put into a Pareto analysis in order to take those part numbers that generate higher costs. Of these 129 items, 30 compose 80% of the total cost. This 30 parts number they were assessed together with the logistics operator to identify any errors.

In most cases, the discrepancy is due to the fact that the logistic operator inserts more boxes to occupy the empty spaces but not in a traditional position that could not be calculated with a simple formula. In another case, there were errors that were promptly resolved.

In this analysis were considered 460 parts number out of 598 that represent the 84% of the total cost of the packaging of these items.

Calculating, as done previously, with the new quantity of pieces the unitary volume is possible estimated the new total cost of a single part number. Multiplicating this value with the planned of the next six month gets it the total cost of packaging of these 460 items.

In this case, there are items in which there is a saturation improvement and in other items, there is a worsening of saturation. Comparing the new total cost with the old cost, it is possible to notice that a saving of 3% will be generated.

The next steps of this analysis will be the evaluation of the other 138 parts number with discrepancy to consider the 100% of the items in the analysis.

4.2.4 RACKING OF SUPPLIER BOXES AND EXTRA PROTECTION FROM 285 OLD TO 285 NEW

For this category of items, the process is the same that will be followed in the last chapter 5.2.3.

The items managed in supplier boxes and extra protection into 285 racks are 83 for example switches, handle, sleeve, starter motor, control unit, tab, oil tank, tubes or car radio. In that case is the size of the rack similar, the only difference between 285 old and 285 new is 170 mm less in width. Calculating with the formula that was used in the chapter 4.2.3 it was found the total pieces that can be inserted into the new 285 racks.

For 78 out of 83 items, the total number of pieces is the same between the old and the new rack. This means that for these items there is a saturation improvement with less volume cost.

For 5 items the number of pieces calculated with the formula is less when compared to the old quantity. For these 5 items by reducing the number of inserted boxes, the saturation has worsened with an increase in the total costs.

Considering all 83-parts number a saving of 3% is obtained.

4.3 SUMMARY OF RESULTS

Through the analysis that has been done with the switch from the 283 and the 285 old to the new 285 racks, there is a considerable economic advantage.

The case "RACKING OF SUPPLIER PALLET FROM 283 TO 285 NEW" considering only the transfer, appears to be economically inconvenient (worst case) but if the stacking solution of the load units is applicable for all ten parts numbers, also this case results to have an economic saving and not an extra cost (best case).

The potential saving for each category is expressed in percentage because it is not possible to show the punctual value expressed in euros for reasons of secrecy into this thesis.

The percentage that is shown in Figure 4.4 is calculated in the following manner.

$$\% \ OF \ DELTA \ COST = \frac{TOTAL \ COST \ WITH \ THE \ NEW \ SOLUTION}{CURRENT \ TOTAL \ COST}$$

The overall economic results are shown in the figure 4.4.

$$\% \ OF \ DELTA \ COST = \frac{TOTAL \ COST \ WITH \ THE \ NEW \ SOLUTION}{CURRENT \ TOTAL \ COST}$$

		NUMERO DI PART NUMBER	WORST CASE	BEST CASE
283 - 285 NEW	RACKING PALLET	40	15%	-3%

		NUMERO DI PART NUMBER	BEST CASE
283 - 285 NEW	SUPPLIER BOXES AND EXTRA PROTECTION	460	-3%

		NUMERO DI PART NUMBER	BEST CASE
285 OLD - 285 NEW	RACKING PALLET	73	-4%

		NUMERO DI PART NUMBER	BEST CASE
285 OLD - 285 NEW	SUPPLIER BOXES AND EXTRA PROTECTION	93	-3%

Figure 4.4 Overall economic result of the analysis of the new 285 rack

The worst case is presented only for the parts numbers in the category of racking of supplier pallets from the 283 to the 285 rack, but the impact on the total costs of these 40 parts numbers is not very relevant and even if this eventuality occurred, the overall project would have a saving on the total costs of 2%.

The implementation of this project could bring in the best-case a saving of 4% of the total costs of the analysed parts numbers. The total cost is on the order of millions of euros per year and therefore the saving is very significant.

The timing of implementation of this project, in agreement with the logistic operator Bcube that will have to modify all packing cycles of the 700 parts number, will be approximately for the end of September 2018. Therefore, from the month of October, after the change of the price list of this part number, it will be possible to evaluate with more reliable data the economic convenience of this project.

CHAPTER 5 BENCHMARKING AND RETURNABLE PACKAGING FOR OVERSEAS TRANSPORT

The objective of this chapter is to show in the first place a benchmarking with the packaging solution that the other automotive company are using at that moment, focusing on the solutions of returnable packaging because the will of FCA is to want to study the possibility of implementing a flow of returnable packaging for the overseas clients. In the second part of this chapter is presented an analysis that describes the possibility to use returnable packaging in place of the disposable standard wooden rack and a comparison between the metal and plastic solution for the returnable packaging. In the third part is shown an analysis of the possible utilization of returnable asset that FCA has at this moment and are not used. (Gafer and plastic pallet).

5.1 PACKAGING OVERVIEW FOR OVERSEAS TRANSPORT

In this moment for the overseas flow, almost the whole packaging is expendable because once the desired destination is reached, the packaging is thrown away and it is not re-used.

“The general rule is: the longer the logistics leg, the less practical it is to return returnable containers,” notes packaging expert Felix Meyer-Horn *[20].*

Although the expendable packaging is the primary type used for ocean containers, there is a trend to move away from material like cardboard and wood. The biggest advantage of reusable packaging is the higher cube utilization of the ocean container. Consolidation centres for expendable packaging can have very bad cube utilization – as low as 40% – whereas reusable containers can have 90-97%. For reusable packaging, the first challenge is to find a standardized container solution [20].

Below it is shows the definition of returnable and expendable packaging.

Returnable packaging: is a reusable container that will be used over multiple journeys. Reusable packaging can take the form of bulk containers, handheld totes, shipping racks, dunnage and even pallets Figure 5.1.

Figure 5.1 Example of returnable packaging [21][22][23]

Expendable packaging: is designed to only make one journey before being disposed of / recycled, commonly produced using corrugated cardboard materials Figure 5.2.

Figure 5.2 Example of expendable packaging [24][25]

Lately, it was observed a rise in the use of returnable packaging, driven by an increased standardization of load carriers and more modular packaging concepts. In most cases, manufacturers use returnable equipment within regions, relying on disposable cardboard and dunnage for long-distance shipments to avoid empty return shipping. However, in some cases, including Ford and Mercedes-Benz, companies are exploring the use of returnable bins as part of shared, rented pools, or some hybrid types of returnable and one-way packaging.

Alexander Koesling vice president of supply chain in Mercedes-Benz said "The *method that we use to ship to China or North America is a hybrid solution, which includes an outer box that is collapsible and returnable, while the inner dunnage is one-way" [26].*

While most western carmakers use a reasonably high proportion of returnable equipment and packaging pools for regional supply chains, some are moving towards long-distance or even intercontinental solutions. For example, Ford recently switched from disposable packaging to ISO bins for a number of intercontinental parts shipments, including Spain and South Africa. Ford rents the equipment as part of a wider pool, and so avoids empty returns, while gaining had better pack density and stacking.

Though packaging pooling is far from new in western markets, Dirk Willmann at Ford also sees potential to go further, from sharing KLTs to extending pooling and renting to ISO bins, FLCs or Odette containers, with specialist third parties managing the equipment across different companies and industries *[26].*

One way of using returnable material is through pooling networks, whereby manufacturers only rent the equipment for one part of the journey. Rodney Salmon, from the supply chain consultant for global automotive at Macro Plastics, says that pooling companies such as DHL and Chep offer one-way rentals of plastic folding pallet boxes for which they also find return routes [27].

Also, Jaguar Land Rover has announced a new pooling management contract with Gefco that will provide reusable packaging solutions to support the company's parts production.

One prominent example of a tier one supplier using reusable containers for its overseas shipments is Linde + Wiemann, a supplier of body frame parts, seats, and instrument panels based in Dillenburg, Germany. Linde + Wiemann was searching for an alternative to cardboard boxes for its overseas shipments of single components for body-in-white parts, such as front ends, rocker panels and doors. The aim was to reduce packaging costs, maximize the capacity of 40ft ocean containers, avoid damage and improve handling at overseas plants. Linde + Wiemann found a solution in the MB5 container from Goodpack, which has replaced the supplier's one-way packaging for body parts *[28].*

The MB5 is a metal container with a standard footprint that fits across industries. It is 1.465 meters long, 1.15 meters wide and 1.09 meters high, including an extension for use in high-cube sea containers. The MB5 has a removable door on one side and the other side folds halfway across for easier access (Figure 5.3).

Figure 5.3 MB5 container from Goodpack [29]

MB5 has helped Linde + Wiemann reduce its shipping costs thanks to higher load factors for sea containers; the packaging equipment has also minimized cardboard scrap and improved warehouse usage. Linde + Wiemann demonstrates the advantage of shipping reusable containers overseas to improve its packaging efficiency. Its partnership with Goodpack is a prime example of how a reusable packaging provider can add significant value in overseas logistics by removing cardboard and coordinating flows with other industries *[28].*

There are other cases that competitors of FCA like PSA Peugeot Citroën Automobile prefer to adopt for overseas transport a solution that uses one-way packaging instead of returnable packaging.

Frank Neurath, manager of outbound sea freight for Volkswagen Group, says the carmaker uses wooden crates, cardboard boxes and wooden pallets for shipping service parts overseas, all mostly one-way packaging. Parts arrive from suppliers at Volkswagen Group's centralized service parts hub in Kassel, central Germany, in metal boxes and are repacked into containers for global shipments.

Volkswagen Group, Mercedes-Benz and other brands that ship parts and semi- or complete-knockdown (SKD or CKD) kits overseas maintain that they primarily use disposable equipment, though there are opportunities to use returnable packaging as described above.

5.2 POSSIBLE FUTURE STRATEGIES FOR FCA

Even though during times of uncertainty expandable packaging may be attractive, the long-term impact of this packaging is not seen the best business solution.

Implementing a pure returnable solution for overseas flow is difficult to apply for the complexity and the cost that the return flow cause. However, from the comparison with the other automotive company, as shown in the section 5.1, for the overseas packaging solutions there are possible implements, one of this returnable solution that could improve the efficiency of the packaging process.

- **HYBRID-SOLUTION** like Mercedes-Benz, it is possible to implement this solution for overseas transport. A returnable rank (plastic or metal) and inside of it one-way packaging. With this solution, it is not necessary to invest in a specific packaging for a particular item, but this packaging is modular and could be used for different types of items. The proposal is to have three or four external racks with a standard dimension that saturates very well the container. In FCA case this solution can be implemented for the wooden racks that have standard dimension and are used mainly for the Racking activity. To manage the return flow, that is the priority problem for overseas returnable packaging, it is possible not to force a flow of empty containers, but a solution is to use this rack for the inverse transport flow. For example, a returnable rack ship from EMEA to NAFTA region when it arrives in America could be to use by IRF NAFTA pole for the shipment of the item to EMEA. This solution is possible if there is a flow of bi-directional goods between the different regions.

  A problem of this solution is to manage how many containers are needed in the 4 regions because it is possible that the quantities shipped between two regions are not balanced. This generates the need to ship empty collapsed to the region that is in stock-out.

  The tag RFID is a solution to maintain traceability of the returnable packaging.

  One possible solution of plastic returnable packaging is shown in Figure 5.4.

Figure 5.4 Returnable plastic rack [30]

- **POOLING MANAGEMENT** like Ford, it is possible to implement this solution for overseas transport. With this solution, the returnable packaging is rent by a third-part logistics service that could manage the flow of this returnable package exploiting economies of scale in renting these packages to multiple providers. Entrusting the management of the flow of these racks to third parties eliminates the problem of managing empty containers during the return flow. Pooling strategy is not only the possibility of capital freed and available to be used for core business investment, but the hassle and administration of tracking, tracing, cleaning and maintaining an own pool of containers is also eliminated. Some people may argue that complete outsourced pooling is more expensive than owning and managing a pool in-house or using one-way packaging. This may be true if only looking at the purchase costs compared with hire fees. Studies have proven that outsourcing container management delivers overall supply chain savings of 15-25% [27]. Outsourcing also enables companies to use only what they need when they need it. So, the challenge of uncertainty, seasonality, or fluctuating production is now removed. One problem with this solution is the need of standardization of the dimension of containers between different actors.

Comparing the two proposed solutions the hybrid project is certainly the easiest to be implemented because it requires the development of a returnable solution in place of the disposable solution currently used. The problem is to manage the worldwide flow of this container.

The pooling strategy is certainly a possibility that could be implemented in the future to concentrate company resources on more value-added activities. This solution requires a substantial revolution in the way to manage the flow of overseas packaging. More standardization of the dimension is one of the consequences. An international partner must be found to be able to manage the flow of these returnable containers and that is not simple.

5.3 RETURNABLE PACKAGING FOR OVERSEAS TRANSPORT

After the comparison with the other companies, FCA wants to study the possibility of implementing a returnable flow of packaging also for the overseas clients. At this moment a returnable flow, as mentioned previously, is made only for EMEA clients.

There are two cases of a returnable flow implemented on overseas clients. Gafer to Latam and returnable wood rack to Nafta.

The first problem of returnable packaging is managed the flow of these items on long distance because the time to go and come is high and there are many uncertainty and variability during an overseas transport. This high lead time results in having to have a lot of packaging and an important investment to be supported.

From the benchmarking analysis, two strategies emerged for the returnable packaging.

- POOLING STRATEGY
- HYBRID STRATEGY

Through various comparisons with the IRF team the pooling strategy has been excluded at the moment because it is not considered economically advantageous because the fee that is necessary to pay at the third part operator is more than the actual cost of the disposable packaging and another problem is the lead time that the packaging is immobilized into the client warehouse.

Then it was decided to study the implementation of the hybrid strategy that consists to use a metal or plastic external rack and inside of it a disposable packaging. This rack needs to be designed with a standard dimension that saturates optimally the containers and is possible to use it for various items and different packaging activities (Racking and Repack).

The first step of the analysis is to identify the disposable packaging that wanted to be replaced by a returnable packaging.

The second step of the analysis is to identify the material built the new returnable packaging is made of: metal or plastic considering the tradeoff of these two materials both from the point of view of the advantages and disadvantages.

The disposable packagings that are evaluated to be replaced are 282,283 and 285 wooden rack (Figure 5.5). This type of packaging is used for Racking and Repack activity. Carton boxes or pallets are inserted into this rack. This type of racks is in wood and are disposable at this moment. The future solution is to have a returnable packaging that replaces this type of racks in order to have the optimization of costs by the elimination of the disposable packaging.

Figure 5.5 Disposable external rack in wood. [FCA file]

The actual dimension of the disposable rack in wood are shown on figure 5.6:

RACK 283	EXTERNAL	INTERNAL
LENGHT [mm]	2250	2150
WIDTH [mm]	1470	1370
HEIGHT [mm]	860	750

RACK 285	EXTERNAL	INTERNAL
LENGHT [mm]	2250	2150
WIDTH [mm]	1320	1200
HEIGHT [mm]	1290	1160

RACK 282	EXTERNAL	INTERNAL
LENGHT [mm]	2250	2150
WIDTH [mm]	1160	1040
HEIGHT [mm]	860	750

Figure 5.6 Dimension of the disposable rack 283,285,282

The returnable packaging will be designed with the same dimensions that are used in this moment. The length of the packaging is the same for all three racks 2250 mm while the width and the height are different. Of these three racks, the optimal solution is to standardiz the dimensions to have only two types of packaging.

5.4 METAL VS PLASTIC RACK

In this part of the analysis a comparison between the metal and the plastic solution for the external rack is made to identifying the best solution in terms of costs and quality of the packaging.

Different aspects of the two solutions sum as quality, costs, handling, logistic, adaptability are analyzed Figure 5.7.

	GAFER *ISO 4661*	**PLASTIC**
DAMAGE RATE [%]	≈ 2,2%	≈ 1,7%
LOADING CAPACITY [KG]	1500 Kg	1200 Kg
TARE [KG]	255 Kg	120 Kg
PRICE [€]	≈ 380	≈ 400
COMPONENTS [Pieces]	3 Pz	5 Pz
USEFUL LIFE [years]	20 (estimated)	10
AUXILIARY MATERIAL	YES (12€/Gafer)	NO
MODULARITY	✗	✓
LOSS RATE [%]	4,6%	4,6%
HANDLING [cost]	=	=
FOLDED PACKAGING INTO THE CONTAINER (DINAMIC)	1:4	1:4
FOLDED PACKAGING INTO THE WAREHOUSE (STATIC)	1:8	1:8
STACKABILITY (DINAMIC)	1+1	1+1
STACKABILITY (STATIC)	1+2	1+2
SUPPLIER UTILIZATION	✓	✓
FLEXIBILITY	=	=
ITEMS PROTECTION	=	=

Figure 5.7 Comparison between the metal and plastic solution

In the first part of Figure 5.7 are shown the different characteristic of the new solutions.

• Damage rate is the percentage of the rack that needs to be replaced or to be repaired, for the Gaffer that are already used for some flows. This value is calculated with historical data. For the plastic solution that is completely new, the value of 1,7% is taken from a benchmarking with the damage rate of plastic packaging of I-FAST. For this characteristic, the plastic rack is better than the metal solution.

• The loading capacity is how much weight is possible to insert into the rack. The Gafer could bring 1500 Kg against the 1200 kg of a plastic rack.

• The tare is the weight of the rack without items. The plastic solution in comparison with the metal obviously has a less tare because the plastic material is less heavy. The difference between the two solutions is of 135 kg.

• The price is how much a single item costs. The prices of the two solutions are very similar with a little preference for the Gafer solution.

• The number of pieces is how much components need to assemble the returnable packaging. The plastic needs 5 pieces instead the Gafer needs only 3 pieces.

• The useful life is how much time the items could be used before to be scrapped. The Gafer has a double durability compared to the plastic solution. It is important to underline that the 10 years of the plastic is the durability that the supplier guarantees and with an adequate maintenance, the items could persist more than only ten years.

• An important point are the auxiliary materials. The plastic rack does not need this type of material instead the Gafer for the completion of the packaging needs auxiliary material. This cost for single Gafer is estimated of 12€.

• The modularity is the possibility to bring in future a changing of the packaging dimension. This characteristic is only for the plastic rack because is combinable instead the Gafer has a fixed structure that is not possible to carry future changing.

In the second part of Figure 5.7 shown the characteristic that are comparable to the new solutions. The most important for a returnable packaging are as follows:

• Folded packaging into the container is how many collapsed racks is possible to insert into a container during the return flow. The acronym 1:4 means that for one normal rack there are four folded packaging. This characteristic is equal for the two solutions.

• Stackability is how many packaging is possible to put one on top of the other. The dynamic Stackability is 1+1 and the static is 1+2 packaging.

• The handling is how much are easy the movement, the assembly and loading and unloading operation. The handling of the metal and plastic rack is very similar and there is not a solution that outclasses the other.

From this analysis it does not emerge a net preference for one future solution. The metal and plastic rack have advantages and disadvantages. The choice of one material with whom to build the future returnable rack will be subject of future discussion also considering the technological advancement of plastic solution that is much more recent compared with the metal solution.

5.5 HYPOTHESIS OF IMPLEMENTATION OF RETURNABLE RACK

In this analysis is made the hypothesis to implement a returnable flow with the three clients that more use this type of wooden rack (46176282, 46176283 and 46176285). The three clients are Pernambuco (Brazil), Saltillo (Mexico) and Toluca (Mexico).

The first step is to find the number of returnable racks that needs to implement a returnable flow with this client. From the shipment sheet the total number of racks shipped in 8 months from January 2018 to August 2018 was taken. This value needs to be adjusted because the first analysis (Cap 4) that describes the reduction of the 46176285 racks and the passage of the Racking of supplier boxes and Racking of supplier pallet from the 46176283 to 46176285 will be implemented in the month of October 2018.

Obviously, the TO-BE number of 46176283 racks will be lower than the previous one and consequentially the TO-BE number of 46176285 racks will be greater. This exchange of rack will not be linear because the 46176285 has a bigger dimension.

For Racking of supplier pallet activity, the number of future racks of 46176285 is the same compared with the 46176283 racks. The difference is in the Racking of supplier boxes or Racking with extra protection activity because with the new rack it is possible to insert more boxes.

With an analysis on the volume two percentages were estimated for calculating the TO-BE number of 46176283 and 46176285 rack.

- 38% of the total number of 46176283 racks remains into this type of packaging. For example, all PN managed with a Repack activity or Racking into Box.
- Of the 62% of 46176283 racks that passed to 46176285 racks, the 27% is managed with the Racking of supplier pallet activity and for this reason, the future number of 46176285 remains the same, for the remaining part of 46176283 racks only the 75% pass to the 46176285.

Two hypotheses of the round have been made, that is how many times the packaging made a travel of round trip. The round is the division between the annual days 365 and the number of days that the packaging remains outside, or rather how many times it takes to come back. Two hypotheses are made based, on the experience of 120 days (3 round) or 146 days round (2,5 round).

In Figure 5.8 below is shown the estimated number of returnable packaging that is necessary to implement a returnable flow on all parts number shipped into these three types of racks.

CLIENT	DISPOSABLE		RETURNABLE (ROUND 2,5)	RETURNABLE (ROUND 3)
Pernambuco	Nm Mdr AS-IS	Nm Mdr TO-BE	Nm returnable Mdr	Nm returnable Mdr
46176282	3.639	3.639	1.456	1.213
46176283	12.627	7.235	2.894	2.412
46176285	6.215	10.623	4.250	3.541
TOTALE	22.481	21.497	8.600	7.166

CLIENT	DISPOSABLE		RETURNABLE (ROUND 2,5)	RETURNABLE (ROUND 3)
Toluca	Nm Mdr AS-IS	Nm Mdr TO-BE	Nm returnable Mdr	Nm returnable Mdr
46176282	1.514	1.514	606	505
46176283	5.450	2.071	829	691
46176285	3.474	6.245	2.498	2.082
TOTALE	10.438	9.830	3.933	3.278

Figure 5.8 a Analysis for the three clients

CLIENT	DISPOSABLE		RETURNABLE (ROUND 2,5)	RETURNABLE (ROUND 3)
Saltillo	Nm Mdr AS-IS	Nm Mdr TO-BE	Nm returnable Mdr	Nm returnable Mdr
46176282	2.882	1.921	769	641
46176283	2.909	2.143	858	715
46176285	720	1.350	540	450
TOTALE	6.511	5.414	2.167	1.806

Figure 5.8 b Analysis for the three clients

The client that more utilized this type of racks is Pernambuco (Brazil), to implement a full returnable flow are necessary approximately 8.000 returnable racks considering all three categories of packaging.

The second step of the analysis is evaluating the economic advantages of this returnable solution.

5.6 BUSINESS CASE FOR RETURNABLE RACK

The analysis proceeds with the evaluation of the business case to buy and manage the returnable rack for the three clients considered previously Pernambuco, Toluca and Saltillo. The business case for metal or plastic solution it is very similar and is not a determinant factor of decision between the two solutions.

CLIENT 191,834,862										
	Mdr/year	Mdr necessary		NEW Plastic rack cost		INVESTIMENT		ACTUAL COST		RETURN COST
46176282	12.053	4.018		400		1.607.200,00 €		867.816,00 €		286.258,75 €
46176283	31.479	10.493		400		4.197.200,00 €		2.077.614,00 €		747.626,25 €
46176285	15.614	5.205		400		2.082.000,00 €		1.374.032,00 €		370.832,50 €

Figure 5.9 Mdr AS-IS and TO-BE and the relative costs

ASSUMPTION	NOTE
MAINTENANCE COST	2,2%
LOOSE RACK COST	3,0%
MDR IN HEIGHT	8
DISCOUNT RATE	10%

Figure 5.10 Business case assumptions

CASH FLOW	YEAR 0	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5
REVENUE (actual cost of the packaging)		4.319.462,00 €	4.319.462,00 €	4.319.462,00 €	4.319.462,00 €	4.319.462,00 €
COST OF RETURN		- 1.404.717,50 €	- 1.404.717,50 €	- 1.404.717,50 €	- 1.404.717,50 €	- 1.404.717,50 €
MAINTENANCE COST		- 173.500,80 €	- 173.500,80 €	- 173.500,80 €	- 173.500,80 €	- 173.500,80 €
LOOSE RACK COST		- 236.592,00 €	- 236.592,00 €	- 236.592,00 €	- 236.592,00 €	- 236.592,00 €
INVESTIMENT	- 7.886.400,00 €					

CASH FLOW	- 7.886.400,00 €	2.504.651,70 €	2.504.651,70 €	2.504.651,70 €	2.504.651,70 €	2.504.651,70 €
CASH FLOW DISCOUNT	- 7.886.400,00 €	2.276.956,09 €	2.069.960,08 €	1.881.781,89 €	1.710.710,81 €	1.555.191,65 €

NPV (10 years)	€ 7.503.600,45
PAYBACK [year]	3,97
INVESTMENT REVENUE	95%

Figure 5.11Cash Flow

In Figure 5.9 shown how many racks are necessary for the implementation of the returnable flow for the three clients. The calculation of this value is described in the previous paragraph. It is also shown the unitary cost for one rack in wood or in the returnable material (metal or plastic), obviously the returnable rack has a major cost compared to the disposable but has the greater advantages to be reusable.

The return cost is a new voice of cost that emerged with a returnable flow because with the disposable solution when the rack arrives at the client is thrown away instead with the returnable flow the rack after the utilization needs to go back to be used again. Assume that an overseas transport cost 1900 € and in a container 40 High cube there are on average 70 collapsed rack (the accurate value for the three racks is shown in Figure 5.12). The division between these two values is the cost of return for a single rack and the multiplication with the Mdr/Year voice gives the annual cost of return for the three categories of racks.

RACK	Number of collapsed rack into a 40 High cube container
46176282	80
46176283	72
46176285	64

Figure 5.12 Collapsed rack into a container

In Figure 5.10 is shown the assumption that was made in this business case, the maintenance and the loose percentage are taken from a benchmarking with I-FAST (FCA company) that have more experience with the returnable packaging. Mdr in height is how many collapsed racks is possible to insert into a 40 High Cube container in height.

In Figure 5.11 is shown the cash flow for this project, in the figure for reason of space is displayed only the first 5 years of the cash flow, but for the calculation of the NPV (net present value) was considered a period of 10 years. The cash flow is a discount with a rate of 10%.

For an investment of 7,9 million, the net present value is 7.5 million with a payback of 4 years. The investment revenue is 95% that is calculated with this formula.

$$INVESTIMENT\ REVENUE = \frac{NPV}{INVESTIMENT}$$

From the discussion with the FCA packaging team about this business case emerged that the payback of 4 years is the major problem of the implementation of a returnable flow for an overseas client because this time of payback is an unacceptable amount of time for the return of an investment for FCA standard.

5.7 HYPOTHESIS OF UTILIZATION OF THE UN-USED GAFER

At this moment there are un-used Gafer at the logistic operator warehouse. The hypothesis is to find parts numbers for a new client in order to replace the disposable rack with a returnable solution.

The research of the PN is to concentrate on the logistic operator Arcese Syncreon because there is more disponibility of free Gafer.

We need to identify the parts numbers that nowadays are shipped into a 46176283 wooden rack to replace with a 4660 Gafer with the same dimension.

The difference of costs between a wooden rack and a metal solution is shown in Figure 5.13 below:

	MDR	DELTA COST
AS IS	WOODEN	-41 €
TO BE	GAFER	

Figure 5.13 Delta costs between wooden rack 46176283 and Gafer 4660

The handling cost is lower for the Gafer solution because less minutes to build the rack in compared to the 46176283 racks are necessary. The Gafer needs 15 minutes less than the wooden rack and in economic value there are 5 € of difference between the two solutions.

The major difference between the two solutions is the cost of the material, obviously, for the wooden rack, the cost is high because it includes the cost of the disposable wooden rack and the auxiliary materials whereas for the Gafer there is only the cost for the auxiliary material.

There are two voices of costs are only for the Gafer solution that is returnable, the cost of return and the maintenance cost.

The total saving for a single wooden rack that is replaced with a returnable Gafer solution is approximately 42€.

This delta cost is calculated for the Repack activity that includes the cost of handling, the delta cost for the activity of Racking, which does not provide the handling costs, is 37€ (it is not considered the delta of 5€ for the handling).

Two hypotheses of clients have been made, where implement a returnable Gafer flow, the India clients and Pernambuco (Brazil).

The analysis follows this step:

1. It was identified the part number to managed into a 46176283 wooden rack.
2. From the shipped sheet is taken the number of the disposable rack that are used.
3. From the planned sheet is taken the number of the disposable rack that will be used.
4. Between the sums of these two values it is possible to estimate how many wooden racks are used in a year.
5. The round of the returnable Gafer is considered equal to 140 days.
6. To define the number of Gafer that are necessary for the implementation of the returnable flow the following operation has been made:

$$Nm\ of\ Gafer = \frac{Nm\ of\ Rack\ calculated\ at\ the\ point\ 4}{365/140}$$

7. The potential saving from this operation is calculated multiplicating the value calculated at the point 4 and the unitary delta cost shown in the Figure 7.10

5.7.1 INDIA FLOW

The analysis of the volume for these clients showed that the annual number of a disposable wooden rack is very low approximately 435, and the equivalent number of Gafer necessary for the implementation of the returnable flow is 174. This number is not enough to managing a returnable flow. The first problem is that a full container with a collapsed 4660 Gafer contains 96 racks, more than half of the Gafer necessary for the flow. The problem is that to fill the container more than 3 months are needed and adding the time of overseas transport (2 mouths) is an unachievable timing.

The potential saving with this operation on this flow is very low, approximately € 10.000.

5.7.2 PERNAMBUCO (BRAZIL) FLOW

For this client 16 PN have been identified, 6-part number is managed in Repack with more saving as described before and 10 items in Racking with less saving but always relevant.

Through the analysis of the volume for Pernambuco client emerged that the annual number of the disposable wooden rack is very high in comparison with the India clients and it is approximately 1660.

The number of Gafer that are necessary for the implementation of the returnable flow is 637.

In average 35 racks per the week are shipped of this part number. Considering that a full container of 4660 Gafer contains 24 racks, approximately 1.5 container is shipped weekly.

The potential saving with this operation is approximately 64.000€ that is relevant compared with the India flow.

The future step is to implement the returnable flow of Gafer for Pernambuco client both to use the Gafer that stopped in the logistic service warehouse and have an economical saving.

5.8 RETURNABLE PLASTIC PALLET

There is a very high quantity of I-FAST plastic that is not used at this moment. The project is to find a way to use this pallet in substitution of the disposable wooden plastic. The reasoning is the same that is was made with the Gafer in substitution with the wooden 46176283 racks.

The available plastic pallet has this dimension.

	INFORMATIONS
LENGHT	1200
WIDTH	1000
HEIGHT	160
LOADING CAPACITY	1500 Kg

Table 5.1 Pallet dimesnion

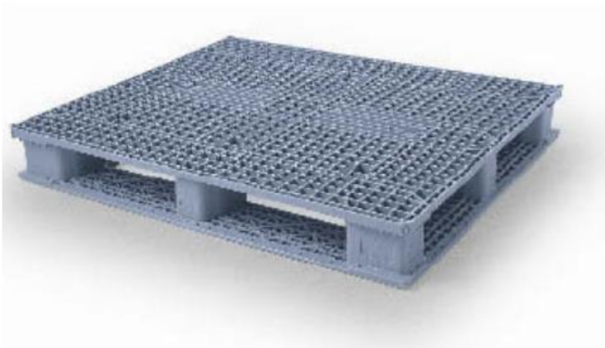

Figure 5.14 Plastic pallet 1200x1000 [FCA file]

The objective of this analysis is to identify a group of suppliers that at this moment use disposable wooden rack and substitute it with a returnable plastic pallet. To allow this operation to be beneficial is essentials that the supplier is geographically near the logistic operator center otherwise the cost of return become more than the saving that is generated by the elimination of the wooden pallet.

5.8.1 PLASTIC PALLET ANALYSIS

The cost that will be eliminated with the use of plastic pallet is the cost of a single wooden pallet that is approximately € 6 for unit, on the other hand there is a new source of cost: the cost of the return of the plastic pallet from the logistic center and the supplier plant and for this reason the distance between this two-actor needs to be minimal for minimize this new cost.

The first step of the analysis is setting the supplier in ABC for volume and was considered only the parts numbers that are managed in repack or in racking, in such a way as to analyze only the most relevant suppliers.

The second step is to calculate the number of pallets that was used by the supplier, this value is estimated. The starting point is the planned quantity for a single item for each supplier. This value is divided with the number of pieces that the supplier put into a single box to obtain the number of boxes managed into 6 months (1*). Now for estimating the numbers of pallets that are used by the supplier some assumptions are necessarily made.

For each part number was taken the dimension of the box that the supplier declares (L=length; l= width; h=height). With this formula the number of boxes for the layer was calculated, considering placing the boxes along the two dimensions.

$$\boldsymbol{BOXES\ FOR\ LAYER} = (MAX[ROUNDDOWN\left(\frac{1200}{L}\right) * ROUNDDOWN\left(\frac{1000}{l}\right); ROUNDDOWN\left(\frac{1200}{l}\right) * ROUNDDOWN\left(\frac{1000}{L}\right)]$$

The number of layers for the pallet is estimated because the real value it is necessary for all IPDP (International packaging data plan) for each part number. By the information's that is possible analysis by the IPDP that are available, was been estimated the number of the layer for pallet equal to four.

The multiplication between the value calculated with the formula above described and the number of the layer has been estimated the number of boxes that stay into a

1200x1000 pallet. The number of pallets managed by a supplier is simply the division by the number of boxes calculated above (1*) and the number of boxes that are introduced into a pallet.

The number of plastic pallets that are necessary to manage a returnable flow is calculated with this formula.

$$\boldsymbol{\#\ OF\ RETURNABLE\ PALLET} = [\frac{\#\ OF\ DISPOSABLE\ PALLET}{\frac{365}{DAYS\ ROUND}}]$$

5.9 SUMMURY OF THE ANALYSIS

How is described in this chapter the implementation of a returnable packaging with standard dimension is not easy because the cost of the investment is very high and the payback of the investment (3.9 years) is not acceptable. The solution to optimizing the packaging cost is trying to maximize the utilization of the actual returnable packagings that are used in prevalence for the EMEA flows and for two overseas clients. The solution is to employ these returnable packagings that are not used at this moment, for other overseas clients in order to have an economical saving. Currently, there are high disponibility of Ga.fe.r and plastic pallet and this chapter show how is possible to use them.

CHAPTER 6 NEW RETURNABLE PACKAGING FOR DUCATO DOORS AND FRAMES

This chapter describes the study about the design of a returnable rack for the Ducato doors and frames. These metal racks are in substitution of a cardboard disposable solution. In the first part of the chapter is shown the economic advantages of this solution, in the second part are described the phases of the executive planning of the new metal rack with an FCA software.

6.1 CURRENT SITUATION

Through an ABC analysis of packaging costs, two cases have been identified in which the cost of an expendable packaging is very high. The part number into account are the doors and the frames of the Ducato that it is produced at the Toluca plant in Mexico (Nafta region).

At this moment the packaging is made by cardboard with the insertion of VCI (Volatile corrosion inhibitor) for an anticorrosive protection (Figure 6.1).

Figure 6.1.a Door packaging in cardboard [FCA

Figure 6.1.b Frame packaging in cardboard [FCA

The cost of this packaging solution is very high, for both part number it is approximately 2€ Million for year.

The project will develop a returnable metal rack for these two items to eliminate the expendable packaging that generates a high cost of packaging.

6.1.1 DOOR PACKAGING

The door has this dimension:

	DIMENSION
LENGTH [mm]	1080
WIDTH [mm]	124
HEIGHT [mm]	1720

Table 6.1 Ducato door dimension [FCA file]

Figure 6.2 Ducato door [FCA file]

The actual characteristics of the door packaging are the following:

	INFORMATIONS
LENGTH [mm]	2260
WIDTH [mm]	1981
HEIGHT [mm]	1275
PIECES FOR PACKAGING	16

Table 6.2 Ducato door packaging informations [FCA file]

The doors, as can be seen from the Figure 6.3 are not disposed in vertical but in horizontal, with a rotation of 90 degrees. This allows to insert into the packaging with the dimensions specified before 16 pieces (Figure 6.4).

Figure 6.3 How the door is inserted inside the packaging [FCA file]

Figure 6.4 The 16 doors inside the cardboard packaging [FCA file]

6.1.2 FRAME PACKAGING

The frame has this dimension:

	DIMENSION
LENGTH **[mm]**	1352
WIDTH [mm]	157
HEIGHT [mm]	1800

Table 6.3 Ducato frame dimension [FCA file]

Figure 6.5 Ducato frame [FCA file]

The actual characteristics of the frame packaging are the following:

	INFORMATIONS
LENGTH [mm]	2260
WIDTH [mm]	1486
HEIGHT [mm]	2050
PIECES FOR PACKAGING	25

Table 6.4 Ducato frame packaging informations [FCA file]

The frame as can be seen from the Figure 6.6 is disposed vertically. It is impossible to replicate the horizontal disposition of the door for the frame because the width of the item (1350 mm) does not allow developing a packaging solution that has a height such that it is less than 1275 mm to make it possible to stack the packaging inside the container. For this reason, the items are disposed of in vertical.

Figure 6.6 How the frame is inserted inside the packaging [FCA file]

Figure 6.7 The 25 frames inside the cardboard packaging [FCA file]

6.2 ANALYSIS

6.2.1 BUSINESS CASE

The first step of this analysis is evaluating the economic advantages of the new returnable solution compared to the old disposable packaging because before proceeding to the design of the packaging it is necessary first of all an economic advantage of the project with an acceptable payback.

To determine the demand of this two-part number, the volumes of the shipped (from June 2017 to August 2018) and programmed (from September 2018 to January 2019) have been taken, to have an annual basis in this way.

For determinate, the number of returnable racks that will be necessary to buy can be calculated in the following manner.

$$\# \; OF \; RETURNABLE \; RACK = \frac{\# \; OF \; DISPOSABLE \; RACK}{\frac{365}{DAYS \; ROUND}}$$

The assumption is that the day's round of the metal rack are 140.

The quantity for a month is calculated with a weighted average between the shipped and the planned. The planned is weighted for the 80% while the shipped is weighted for the 20% because it is more important the future compared to the past.

	MONTH											
DOOR	1	2	3	4	5	6	7	8	9	10	11	12
2017 SHIPPED [units]						9888	10189	7168	9324	7268	9712	6016
2018 SHIPPED [units]	8528	5216	11568	9936	14672	12480	11552	7872				
2018 PLANNED [units]									4864	19728	12528	9936
2019 PLANNED [units]	9600											
WEIGHTED AVERAGE	9386	5216	11568	9936	14672	11962	11279	7731	5756	17236	11965	9152

TOTAL QTA [units]	TOTAL DISPOSABLE RACK	TOTAL RETURNABLE RACK
125859	7867	3018

Figure 6.8 The calculation of the number of racks to buy for the door

	MONTH											
FRAME	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
2017 SHIPPED [units]						8062	9552	7000	11827	5550	3600	7925
2018 SHIPPED [units]	8075	8000	13100	7650	12024	11000	14975	7000				
2018 PLANNED [units]									5050	19670	12572	9908
2019 PLANNED [units]	9614											
WEIGHTED AVERAGE	9306	8000	13100	7650	12024	10412	13890	7000	6405	16846	10778	9511

TOTAL QTA [units]	TOTAL DISPOSABLE RACK	TOTAL RETURNABLE RACK
124923	4997	1917

Figure 6.9 The calculation of the number of racks to buy for the frame

For the doors at this moment are shipped 7867 packaging in one year, with a returnable solution will be necessary 3018 racks that must be purchased.

For the frame at this moment are shipped 4997 packaging in one year, with the returnable solution will be necessary 1917 rack that must be purchased. For the frame, despite having a similar demand, the numbers of packaging that are shipped in one year is less because in one packaging are inserted 25 items versus 16 that are put into the door packaging.

6.2.2 DOOR BUSINESS CASE

In the following Figure 6.10 is shown the business case for the Ducato doors.

CASH FLOW	YEAR 0	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5
REVENUE (actual cost of the packaging)		-€ 1.169.441	-€ 1.169.441	-€ 1.169.441	-€ 1.169.441	-€ 1.169.441
COST OF RETURN		€ 311.402	€ 311.402	€ 311.402	€ 311.402	€ 311.402
MAINTENANCE COST		€ 26.554	€ 26.554	€ 26.554	€ 26.554	€ 26.554
LOOSE RACK COST		€ 36.210	€ 36.210	€ 36.210	€ 36.210	€ 36.210
INVESTIMENT	€ 1.206.992					

CASH FLOW	€ 1.206.992	-€ 795.276	-€ 795.276	-€ 795.276	-€ 795.276	-€ 795.276
CASH FLOW DISCOUNT	€ 1.206.992	-€ 722.978	-€ 657.253	-€ 597.502	-€ 543.184	-€ 493.804

NPV	-€ 1.807.729
PAYBACK	1,736
INVESTMENT REVENUE	150%

Nm mdr to purchase	€/mdr	Investment
3.017	€ 400	€ 1.206.992

ASSUMPTION	%
MAINTENANCE COST	2,20%
LOOSE RACK COST	3,00%
DAYS ROUND	140
COST OF RETURN	€ 1.900
DISCOUNT RATE	10%
FOLDED PACKAGING	1:4

Figure 6.10 Balance sheet, cash flow and assumption for the door

- **REVENUE COST** is the actual cost of the expendable packaging, which is considered revenue as this cost will no longer be sustained. It is calculated multiplicating the unit cost of packaging and the total demand for a year.
- **COST OF RETURN** is a new voice of cost with the returnable solution, it is the cost to send back the returnable rack to be used again. This cost is calculated in this manner:

$$\text{RETURN COST} = \frac{Return\ cost}{\text{Rack in lenght} * \text{Rack in height}} * \text{Necessary rack}$$

Return cost is assumed: 1900€

Rack in height is assumed: 8

Rack in length is calculate: 6 (12000 (the length of the container)/ 1981 (the width of the packaging)

Necessary rack: 7349 as specified in Figure 6.8.

- **MAINTENANCE COST** is the cost to carry out the maintenance of the racks. This cost is assumed the 2.2% of the investment for the year.
- **LOOSE RACK COST** is the cost to replace the possible racks that were lost. This cost is assumed the 3% of the investment for year. That means that of the 3017 racks 91 are lost every year.
- **INVESTMENT** is the cost that must be born for the purchase of the 3017 rack. The single cost of a racks is assumed to equal to 400€.
- **CASH FLOW** is the difference between the revenue and the other voice of costs.
- **CASH FLOW DISCOUNT** is the cash flow discounted with a rate of 10%
- **NPV** is the sum of the 6 cash flow. The net present value of the investment is approximately 1,8 million.
- **PAYBACK** tells the time that the investment needed to cover. In this project, there is a payback of 1.7 years. The payback is calculated with the following formula:

$$\boldsymbol{PAYBACK = (t) + cash\,flow\ (t+1)/investiment}$$

t: is the last period that the sum of the cash flow is negative.

6.2.3 FRAME BUSINESS CASE

Following the same reasoning used in the door business case, the business case for the frames is presented in Figure 6.11

CASH FLOW	YEAR 0	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5
REVENUE (actual cost of the packaging)		-€ 935.197	-€ 935.197	-€ 935.197	-€ 935.197	-€ 935.197
COST OF RETURN		€ 148.378	€ 148.378	€ 148.378	€ 148.378	€ 148.378
MAINTENANCE COST		€ 18.979	€ 18.979	€ 18.979	€ 18.979	€ 18.979
LOOSE RACK COST		€ 25.880	€ 25.880	€ 25.880	€ 25.880	€ 25.880
INVESTIMENT	€ 862.668					

CASH FLOW	€ 862.668	-€ 741.960	-€ 741.960	-€ 741.960	-€ 741.960	-€ 741.960
CASH FLOW DISCOUNT	€ 862.668	-€ 674.509	-€ 613.190	-€ 557.445	-€ 506.769	-€ 460.699

NPV	-€ 1.949.943
PAYBACK	1,307
INVESTMENT REVENUE	226%

Nm mdr to purchase	€/mdr	Investment
1.917	€ 450	€ 862.668

ASSUMPTION	%
MAINTENANCE COST	2,2%
LOOSE RACK COST	3,0%
DAYS ROUND	140
COST OF RETURN	€ 1.900
DISCOUNT RATE	10%
FOLDED PACKAGING	1:4

Figure 6.11 Balance sheet, cash flow and assumption for the frame

The business case for the frames has a positive NPV (Net Present Value) equal to 1.9 million in 5 years and a payback of 1,3 years. The investment for the frames is less than the doors because fewer number of racks are necessary (1.917 for the frames and 3.017 for the doors). This because in one rack of the frame there are 25 items while in a doors rack there are only 16 pieces.

6.2.4 BUSINESS CASE OVERVIEW

TOTAL MDR TO BUY	INVESTMENT
4935	€ 2.069.660

CASH FLOW					
YEAR 0	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5
€ 2.069.660	-€ 1.397.487	-€ 1.270.443	-€ 1.154.948	-€ 1.049.953	-€ 954.502

Figure 6.12 a Business case overview

NPV	INVESTMENT REVENUE	PAYBACK
-€ 3.757.672	182%	1,48

Figure 6.12 b Business case overview

The NPV of the two business cases is 3.7 million, a payback of 1,48 year and an investment revenue of 182%.

6.3 DEVELOPING AND DESIGNING THE NEW RETURNABLE PACKAGING

6.3.1 DIMENSION OF THE NEW PACKAGING

It was decided to keep the same number of pieces inside the new packaging (16 for the doors and 25 for the frames).

For the frame is made a simulation with the FCA software (NX 11 Siemens PLM software) to dispose the items in horizontally position like the doors to obtain a packaging lower in height to allow stacking into the container that is height 2680 mm and thus eliminating the empty space that the old packaging leaves in the container (2680 – 2050 = 630 mm).

How is possible see in Figure 6.12 the width of the frame is 1350 mm that does not allow developing a packaging with the height lower than 1350 mm which allows two-way stacking.

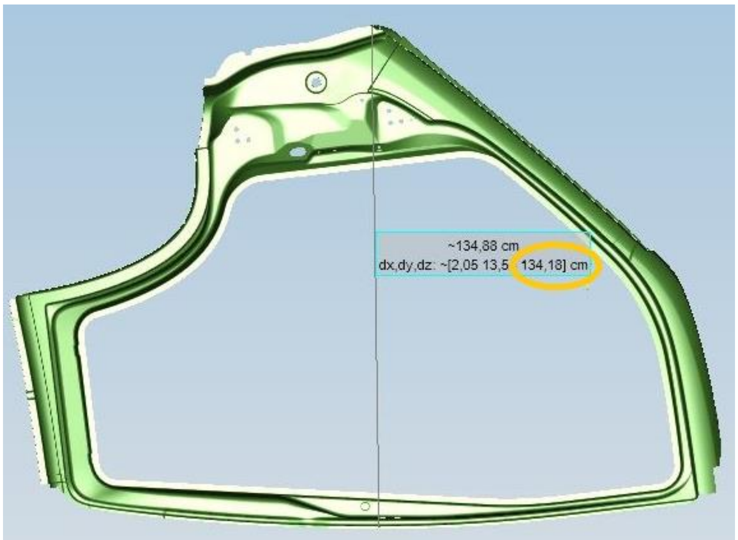

Figure 6.13 Frame dispose in horizontally and relative height [NX 11 Siemens PLM software]

For this reason, it was decided to keep the same dimensions of the old packaging for both the doors and the frames.

DOOR	
LENGTH [mm]	2300
WIDTH [mm]	1981
HEIGHT [mm]	1275
PIECES FOR PACKAGING	16

FRAME	
LENGTH [mm]	2300
WIDTH [mm]	1486
HEIGHT [mm]	2100
PIECES FOR PACKAGING	25

Table 6.4 New returnable packaging informations

6.3.2 DISTANCE BEETWEEN TWO ITEMS INSIDE THE PACKAGING

It is necessary to determine the distance to which dispose of the items inside the new packaging. For doing this activity the 16 doors and the 25 frames have been inserted into the software in the beginning overlapping and after they are separate for find the minimum distance such that the pieces are not cut off between them. The optimal distance that separates with a security franc of about 2 cm the items was found after several attempts made per step (Figure 6.14 and Figure 6.15).

For the doors, the distance between two items is 138 mm.

For the frames, the distance between two items is 83 mm.

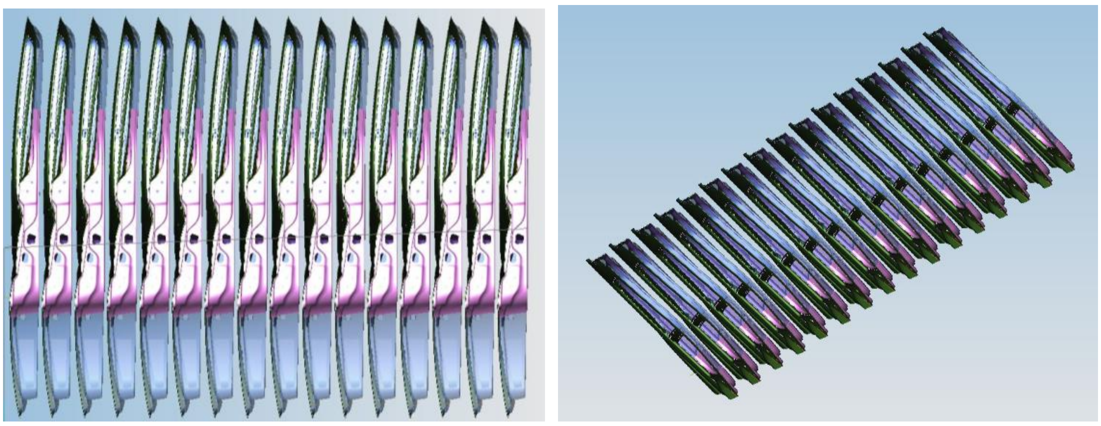

Figure 6.14 The disposition of the 16 doors inside the packaging [NX 11 Siemens PLM software]

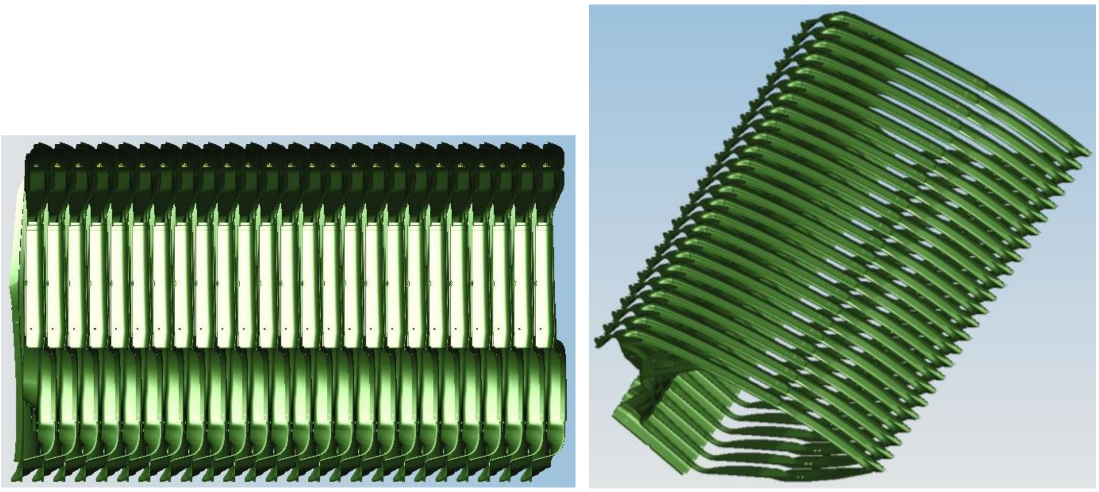

Figure 6.15 The disposition of the 25 frames inside the packaging [NX 11 Siemens PLM software]

6.3.3 DESIGN OF THE RETURNABLE METAL RACK

The objective is developed and designed the new metal rack. For doing this activity was using an FCA software (NX 11 Siemens PLM software) that allows drawing and simulating the new packaging. To start was taken a structure of the metal rack for the engine and was adapted to the door and frame dimension, the length is the same for the two racks 2300 mm instead the width change 1981 mm for the door (Figure 6.16 and 6.17) and 1486 mm for the frame (Figure 6.17 and 6.18).

The base of the metal rack is developed in this manner: the long side (2300 mm) has been divided into 4 parts, 600 mm the two external parts and 550 mm the two internal parts. The short side (1981 mm for the door and 1481 mm for the frame) has been divided into 5 parts. On both sides was left the appropriate space to allow the forkability of the metal rack (1060 mm).

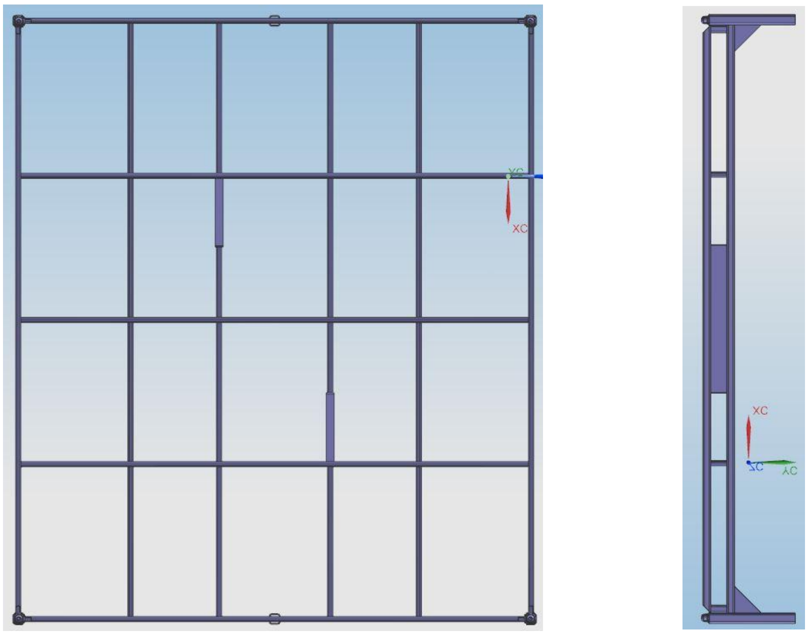

Figure 6.16 Door metal rack base view from the top and from the short side [NX 11 Siemens PLM software]

On each axis of the internal structure was inserted a metal bar support to sustain the weight of the items that will be inserted into the package. The empty space is necessary to allow the handling of the metal rack with the forklift (Figure 6.16 and Figure 6.18).

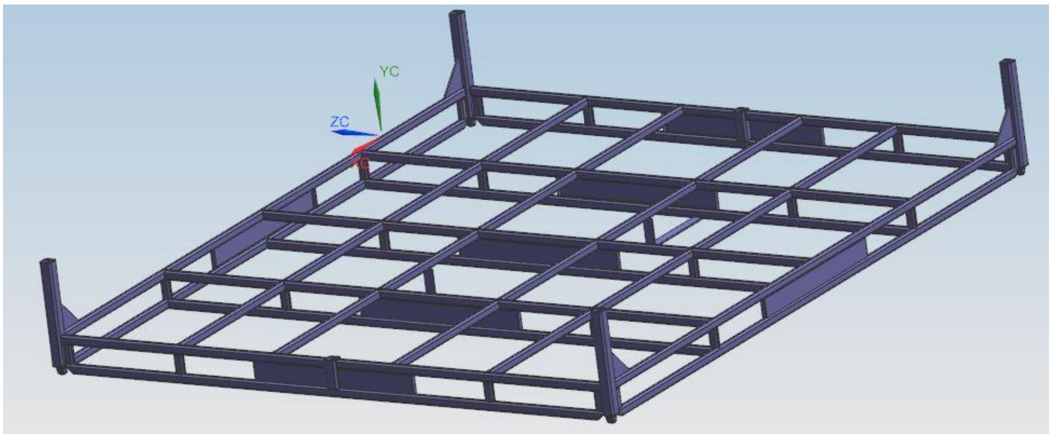

Figure 6.17 Door metal rack base global view [NX 11 Siemens PLM software]

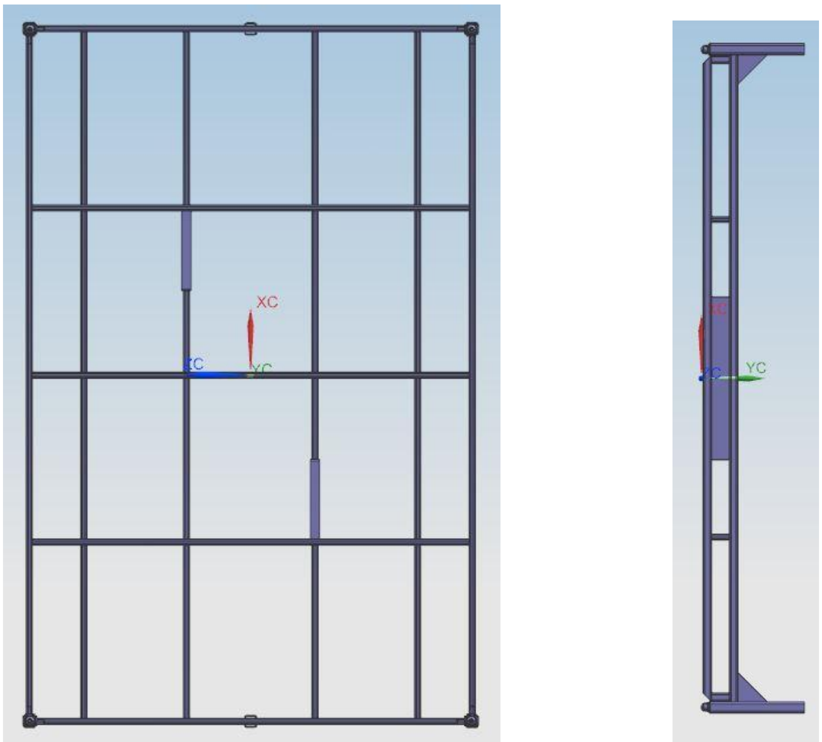

Figure 6.18 Frame metal rack base view from the top and from the short side [NX 11 Siemens PLM software]

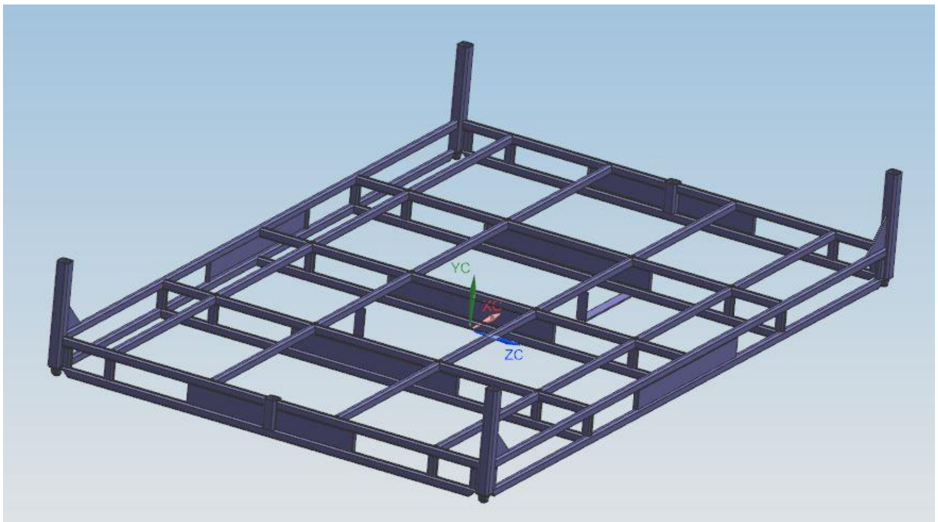

Figure 6.19 Frame metal rack base global view [NX 11 Siemens PLM software]

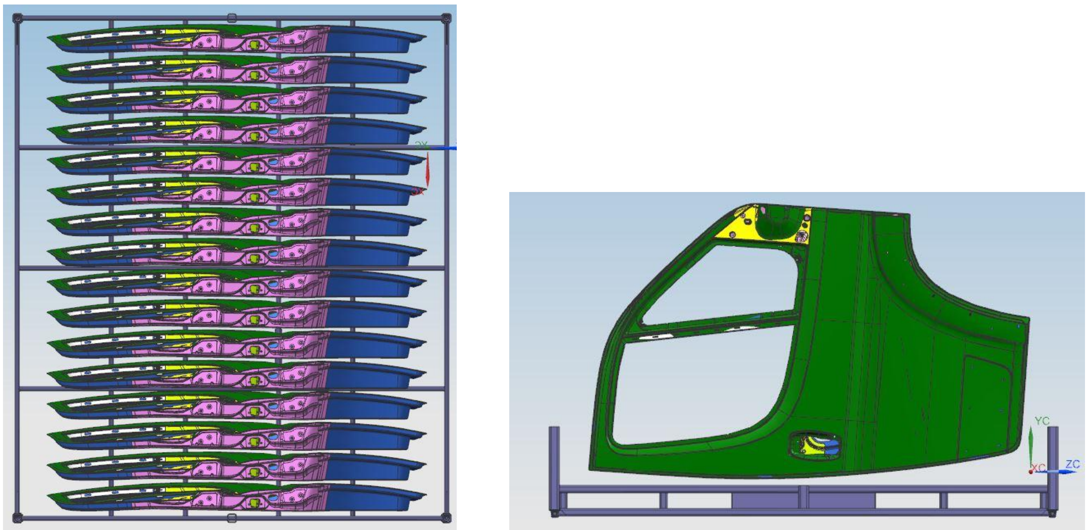

Figure 6.20 Door metal rack with the doors inserted [NX 11 Siemens PLM software]

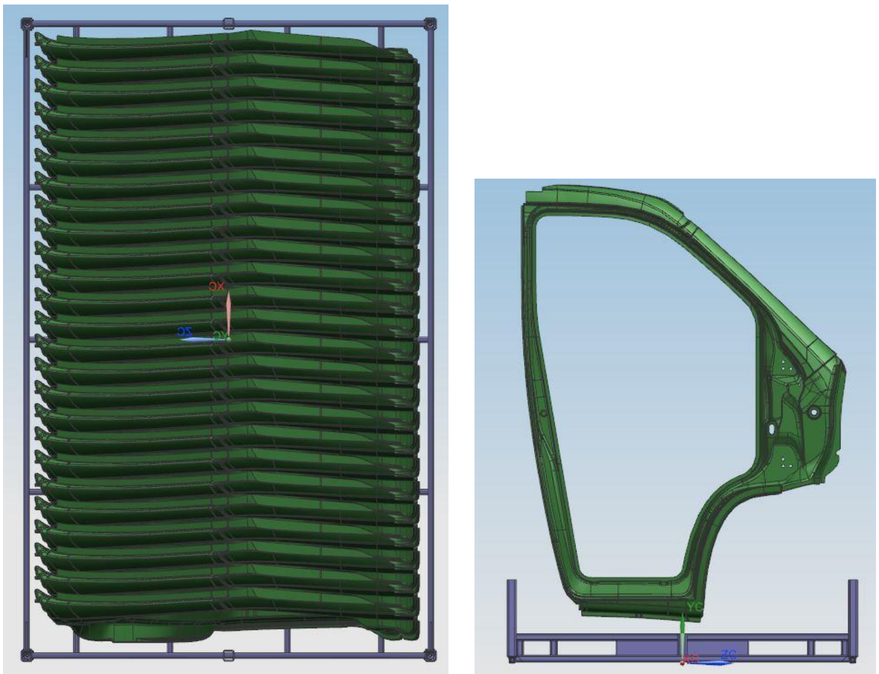

Figure 6.21 Frame metal rack with frames inserted [NX 11 Siemens PLM software]

For the fixing of the items, four supports have been designed for the door rack (yellow parts in Figure 6.21), two from the bottom of the metal rack that has the function to block the parts number from the side on which they support the metal rack. The other two supports have the objective of lock on the two external sides of the doors. Figure 6.21. For the frames are designed only three supports (yellow parts in Figure 6.22), two like the doors rack for the lock on the two external sides of the frames and only one support from the button of the frame because being vertically arranged the surface of rest is less than the door structure; as is possible to see in Figure 6.23.

All this support needs to be closable because the rack needs to be folded during the travel of return, in order to make a container with the largest number of racks inside of it to reduce the return costs that is the most relevant new source of cost that is present in the returnable solution compared with the disposable solution. To make this there is a rotating system at the base of the supports to make them rotatable.

Each support needs to be, add a toothed shape for inserted and fit together the doors and the frames into the metal rack. The doors base have 16 incisions with a distance of 138 mm each; the frames base have 25 incisions with a distance of 83 mm each.

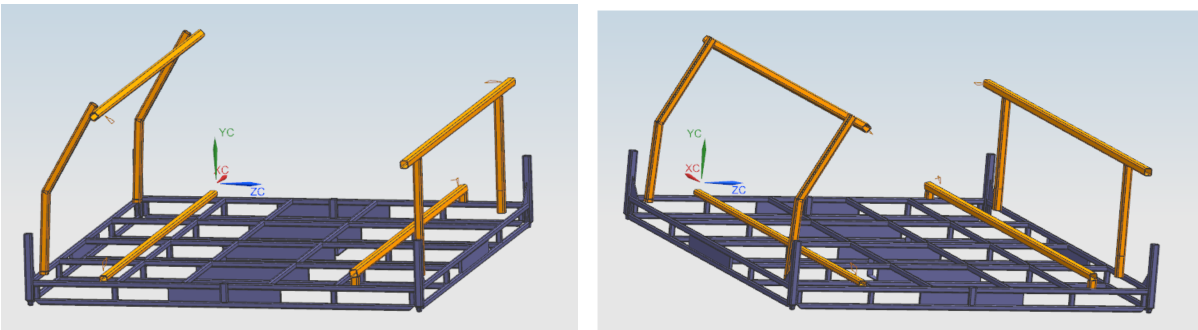

Figure 6.22 Door metal rack with 4 supports [NX 11 Siemens PLM software]

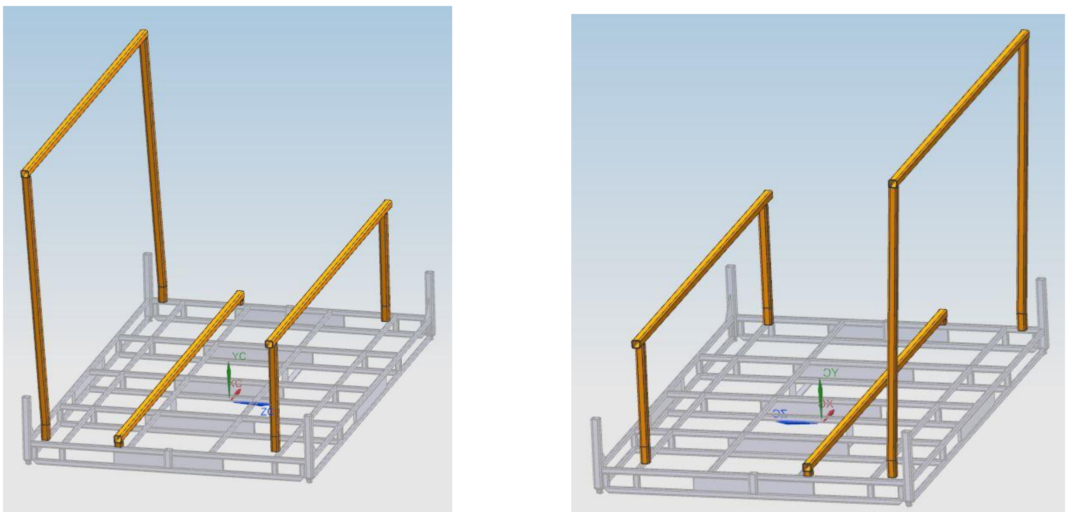

Figure 6.23 Frame metal rack with 3 supports [NX 11 Siemens PLM software]

For each metal rack is designed a structure to allow the stackability of the packaging into the container and into the warehouse for the door and only for the warehouse for the frame because with the height of 2100 mm it is impossible to insert two packaging into the containers (height 2550 mm).

These walls need to be inserted into the three-support positioned along the short side of the metal rack (1981 mm for the frame and 1481 mm for the door). Figure 6.24 and Figure 6.25. The upper metal bar has the function to attack the transport seal.

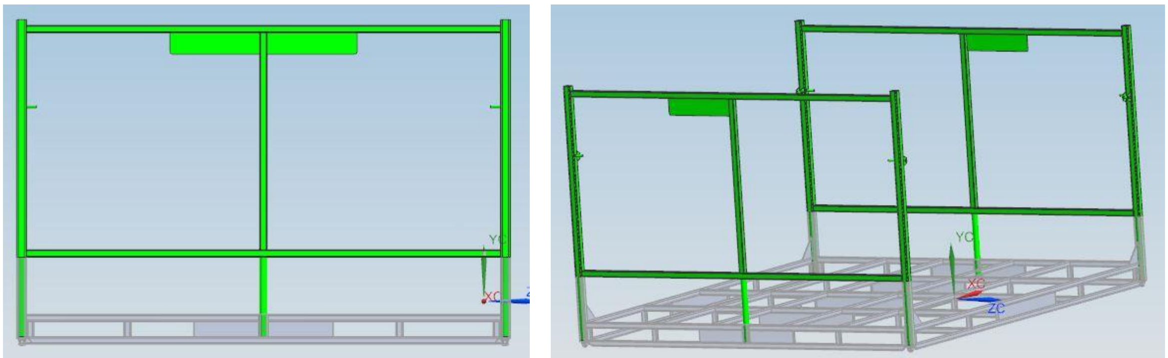

Figure 6.24 Door metal rack with the walls that allow the stackability [NX 11 Siemens PLM software]

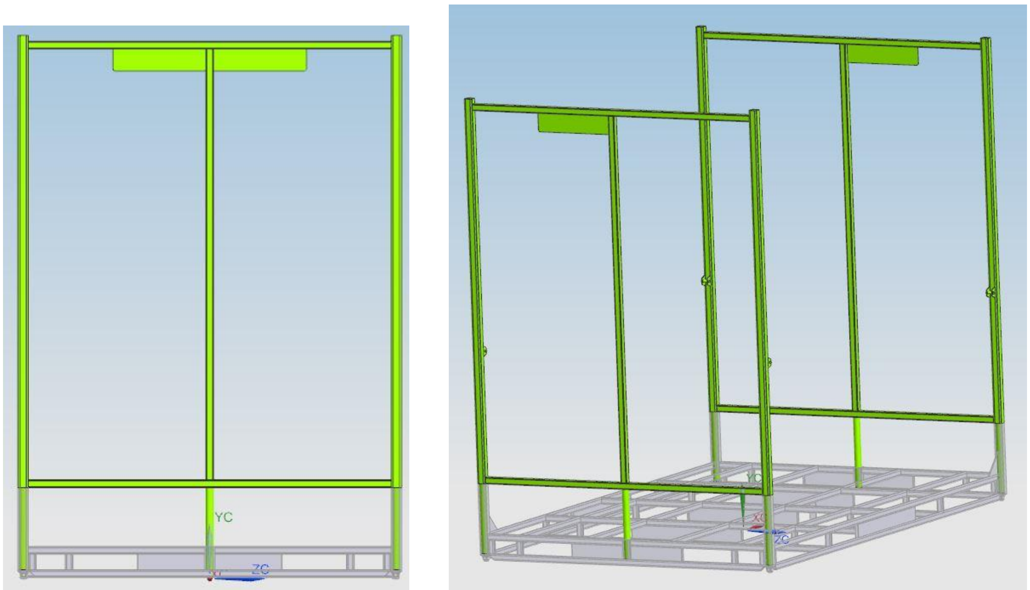

Figure 6.25 Frame metal rack with the walls that allow the stackability [NX 11 Siemens PLM software]

In Figure 6.25 and 6.26 are show the metal rack staked at two.

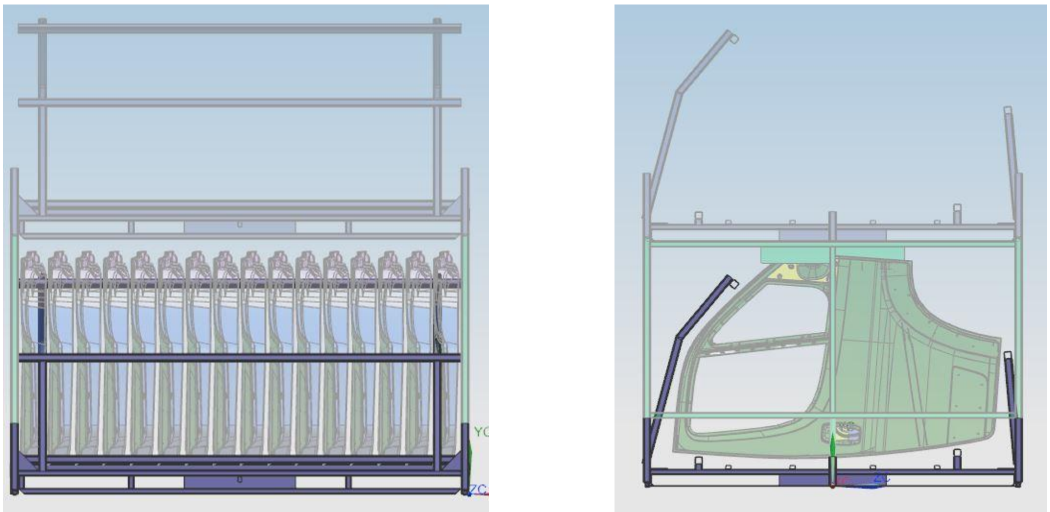

Figure 6.26 Door metal rack staked at two [NX 11 Siemens PLM software]

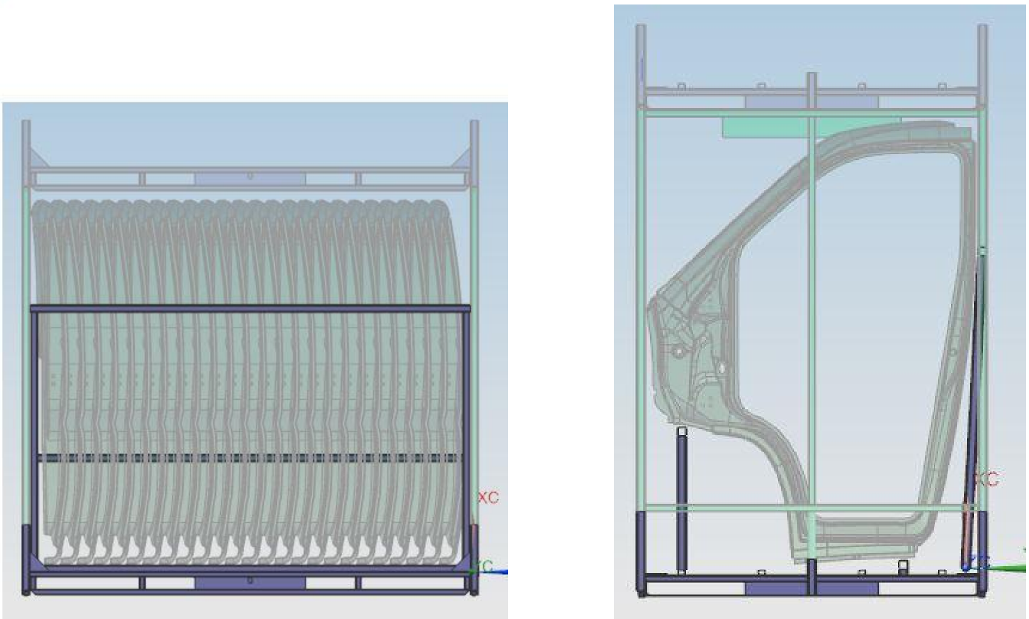

Figure 6.27 Frame metal rack staked at two [NX 11 Siemens PLM software]

To let the stackability of the metal racks without a failure of the packaging (Figure 6.26 and 6.27) a structure long the 2300 side needs to be developed this allows to support the weight of the packaging positioned above. It is designed a rectangular bar of 20 x 30 mm fix on a pin, in order to allow the movement and another cylinder positioned at 920 mm on the green structure that is shown in Figure 6.29 (the structure that allows the stackability). In this way, when the bar is in a standing position will be hocked to this support and resistance to the weight of the package will be provided, thus avoiding the possibility of deformations and sagging of the metal rack (Figure 6.27 and Figure 6.28).

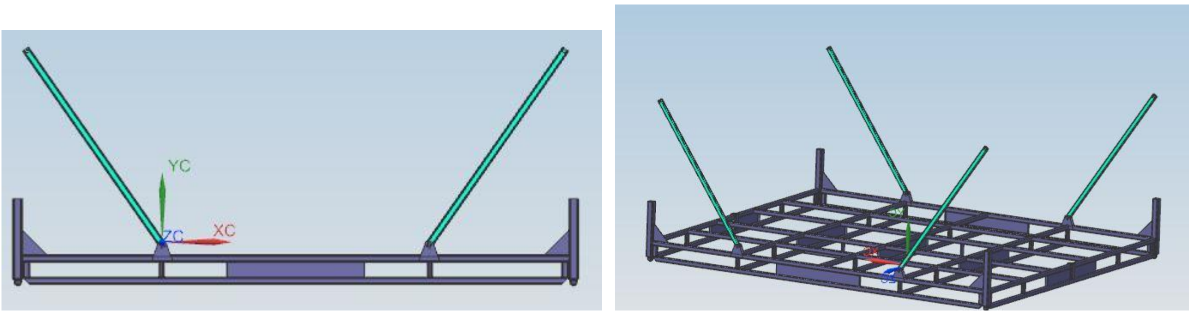

Figure 6.28 Door and frame metal rack with bar of support [NX 11 Siemens PLM software]

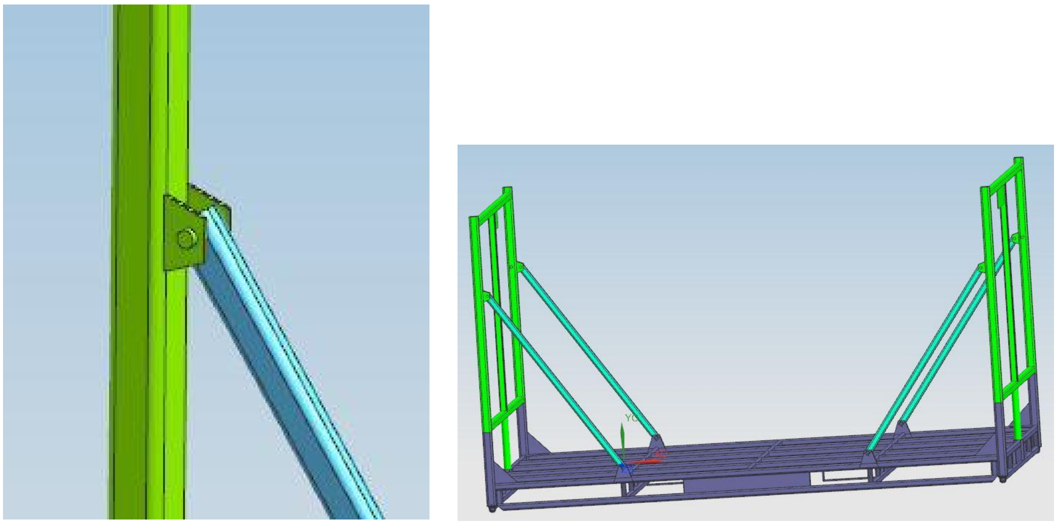

Figure 6.29 Point of contact between the support and the stackability structure [NX 11 Siemens PLM software]

To allows the stackability of 8 metal rack into the container during the transport of return (the packaging is empty), the rack needs to be collapsible at a maximum height of 322 mm (2580/8). In this space is necessary to be insert all parts that constitute the metal rack:

- The 3 for the frame or 4 for the door supports (yellow in Figure 6.30 and 6.32);
- The walls (green in Figure 6.30 and 6.32);
- The bar that allows that the metal rack will not a failure (blue in Figure 6.30 and 6.32).

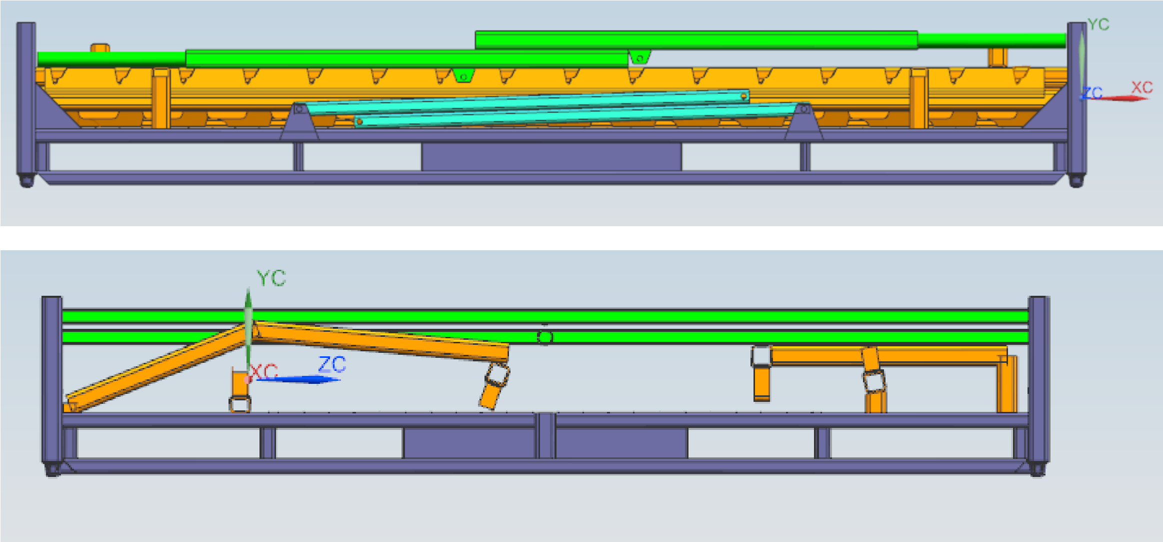

Figure 6.30 Door metal rack collapsed [NX 11 Siemens PLM software]

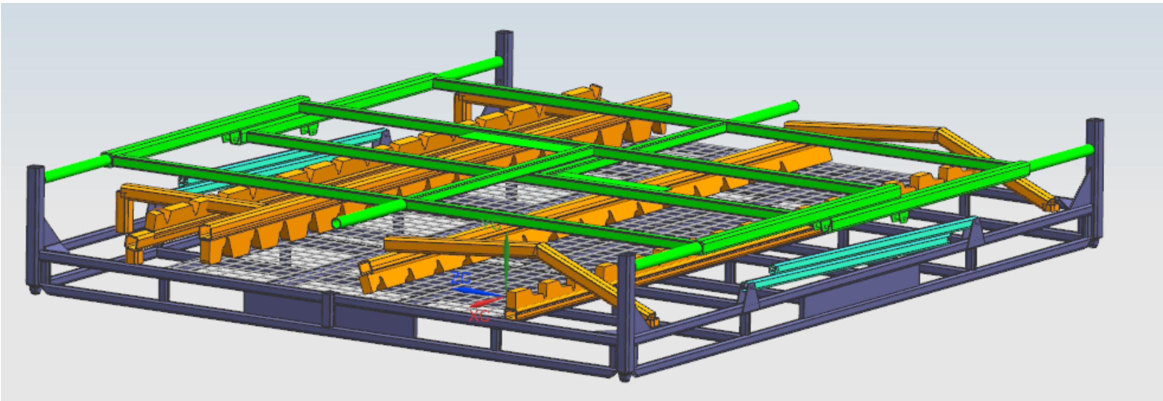

Figure 6.31 Door metal rack collapsed [NX 11 Siemens PLM software]

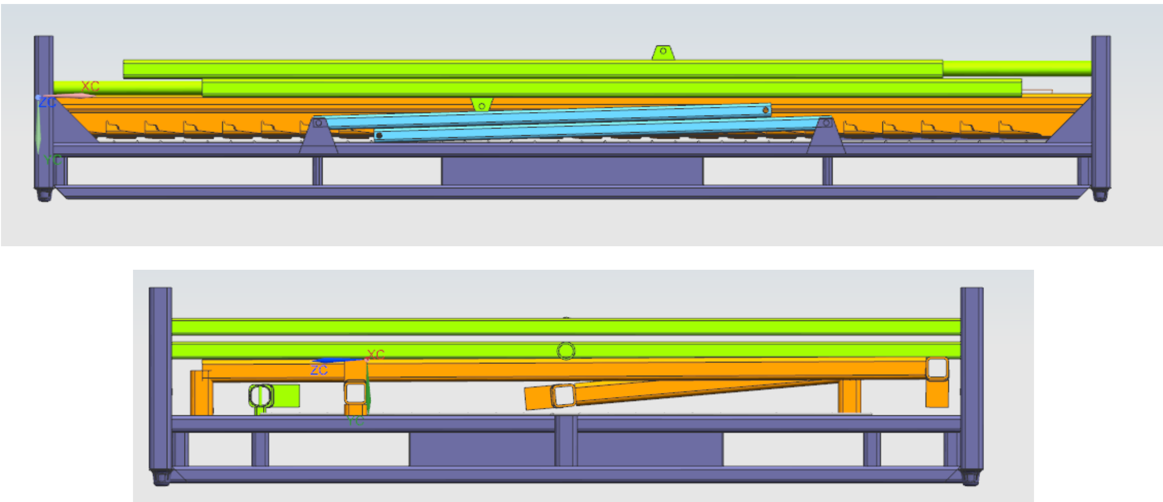

Figure 6.32 Frame metal rack collapsed [NX 11 Siemens PLM software]

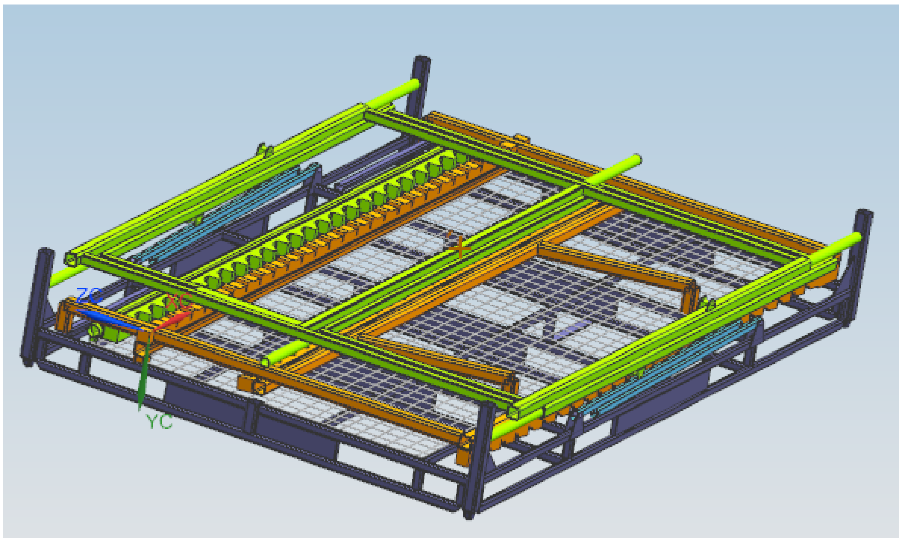

Figure 6.33 Frame metal rack collapsed [NX 11 Siemens PLM software]

At the base of the metal rack has been added a heat-sealed rack to allowing, to the operators who will load the items inside the package, the walkability inside the metal rack. Cylinders with a diameter of 5 mm, spaced apart 50 mm each, form this metal structure. In vertically there are 46 cylinders and in horizontally there are 24 cylinders. This base is identical for the doors and frames metal rack Figure 6.34.

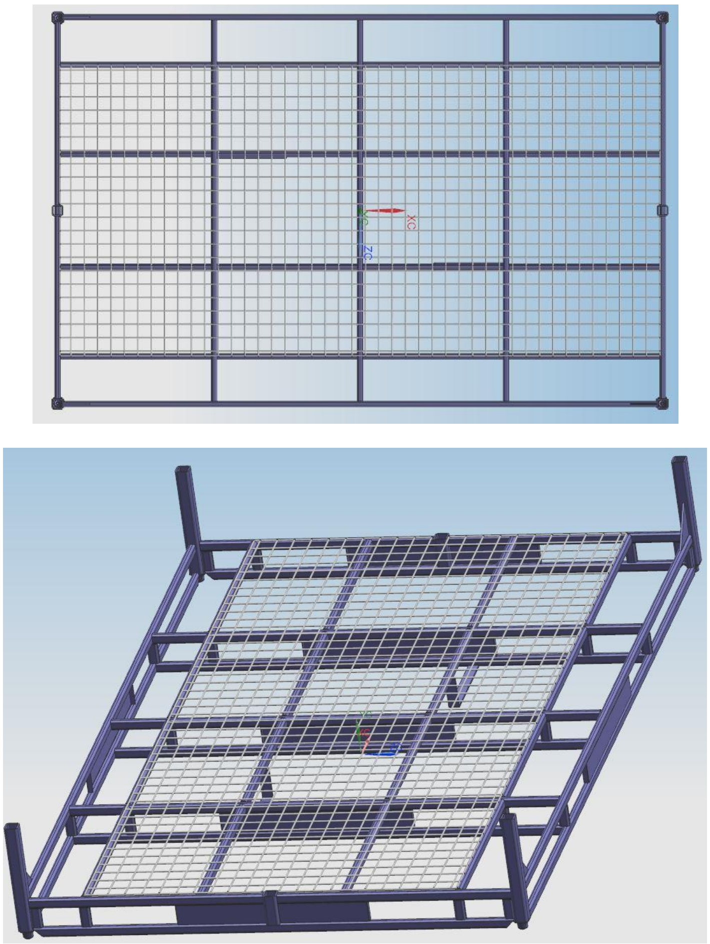

Figure 6.34 Metal rack for allow the walkability inside the metal rack [NX 11 Siemens PLM software]

The final step is designing the racks for the supports to allow the interlocking of the pieces inside the metal rack. Each rack is designed ad hoc for the door geometric shape and for this reason the four toothed shapes are different between them. These parts are not in metal like the other part but in a particular gum that is flexible up to a certain tolerance (Figure 6.35, Figure 6.36, Figure 6.37).

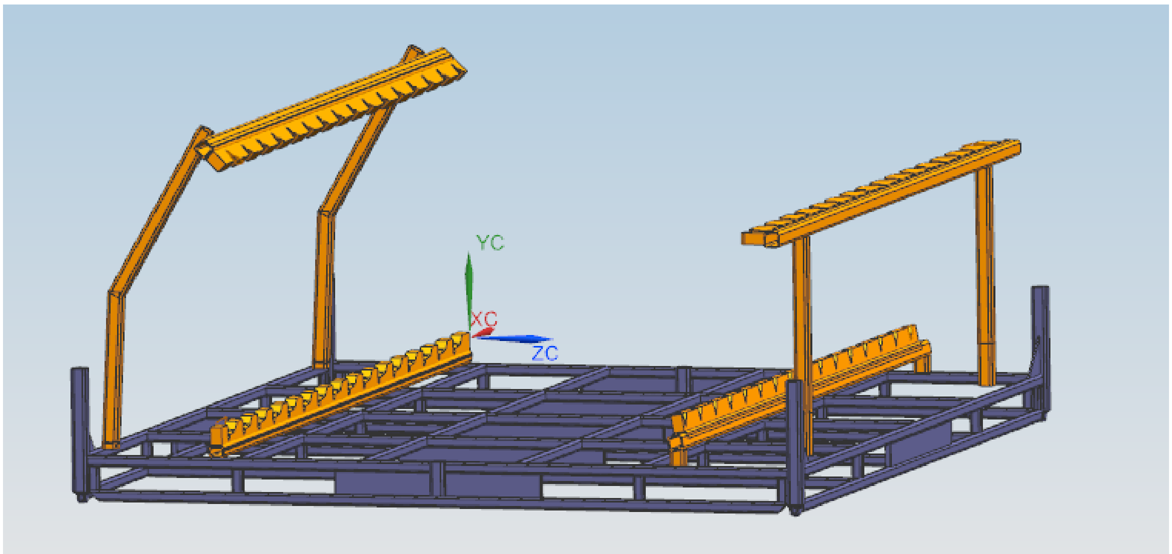

Figure 6.35 The four racks for the structure of the doors [NX 11 Siemens PLM software]

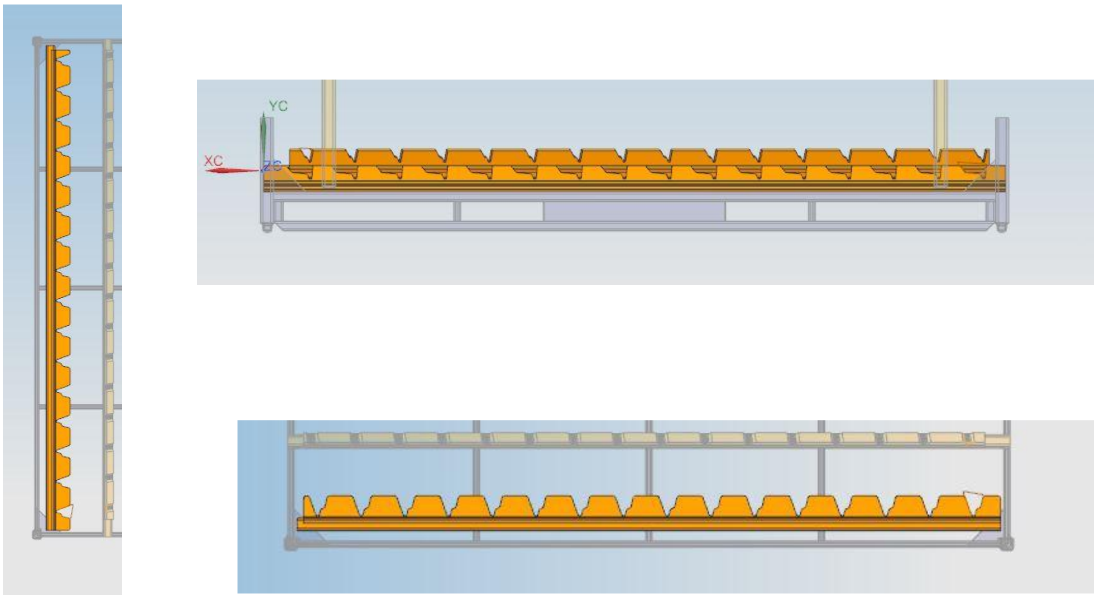

Figure 6.36 The four racks for the structure of the doors [NX 11 Siemens PLM software]

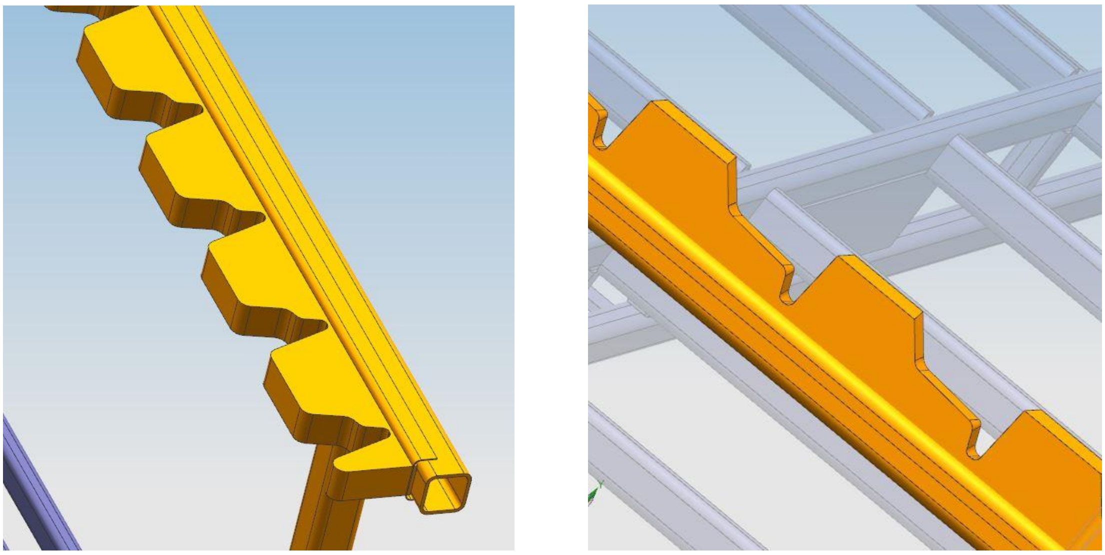

Figure 6.37 The four racks for the structure of the doors [NX 11 Siemens PLM software]

The racks for the frame are shown in Figure 6.38, for the frame how is described before there are 3 supports on the base of the metal rack and another support is added on top for have a better fixing of the items (Figure 6.38).

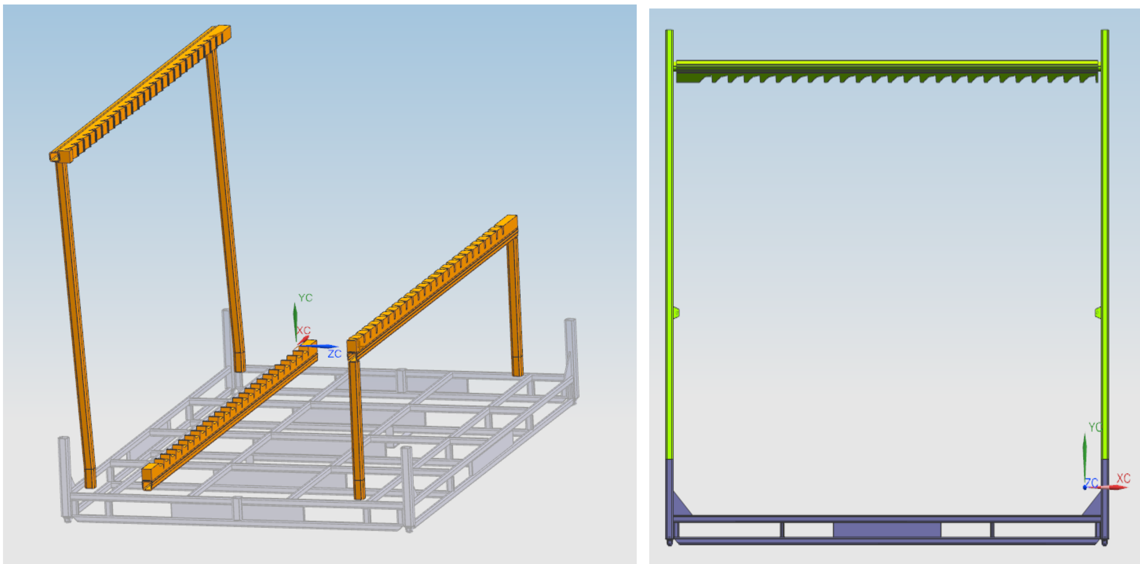

Figure 6.38 the racks for the structure of the frames [NX 11 Siemens PLM software]

The packaging with the doors inside is show in Figure 6.39.

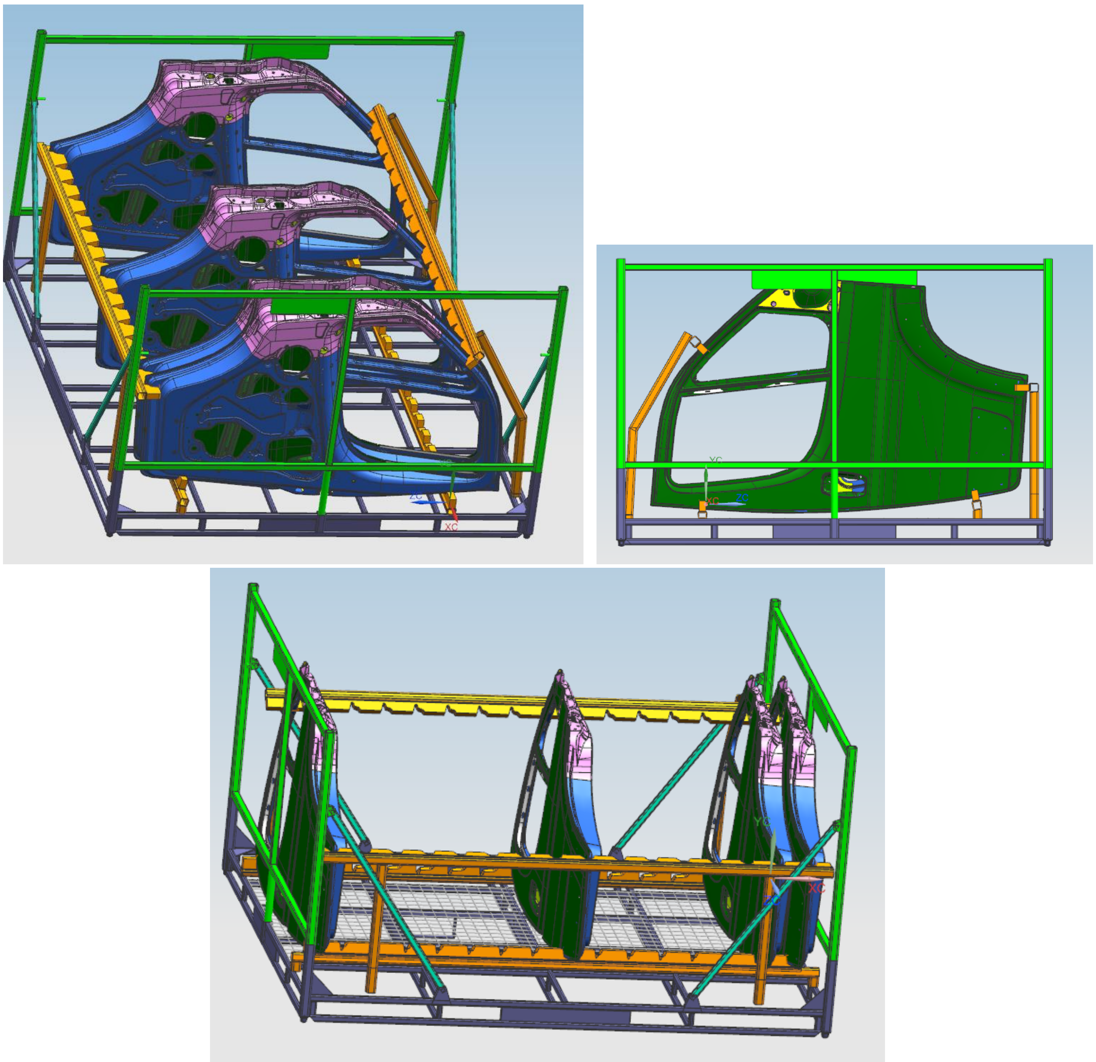

Figure 6.39 Returnable packaging with doors inside [NX 11 Siemens PLM software]

The packaging with the frames inside is show in Figure 6.40.

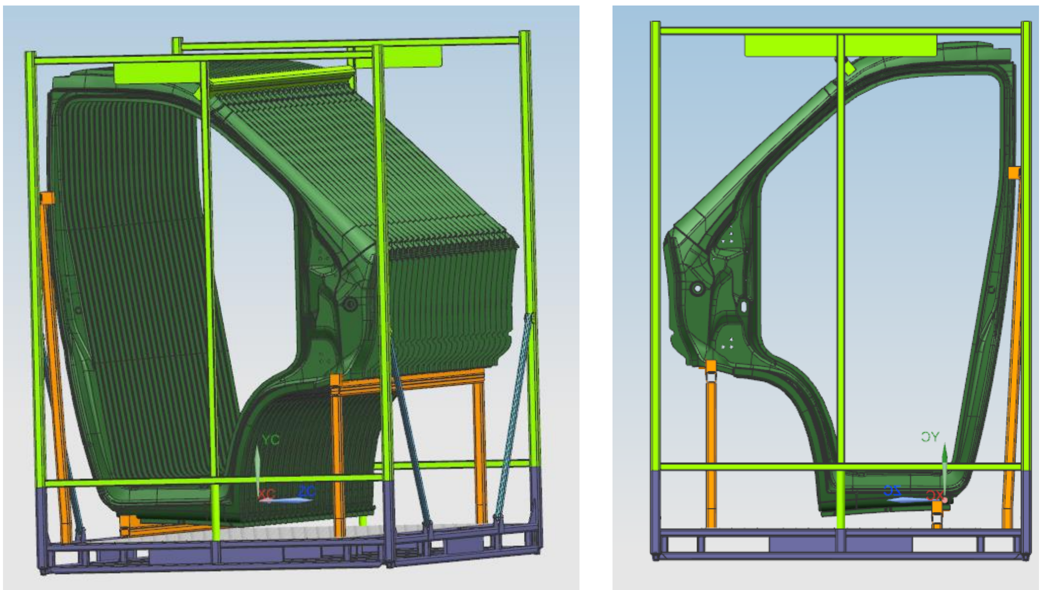

Figure 6.40 Returnable packaging with frames inside [NX 11 Siemens PLM software]

6.4 RESULTS OVERVIEW

How it is described in the chapter this project is certainly convenient economically because a payback of 1.5 years is very low also compared to the 4 years of the other project that is analysed in Chapter 5. This project has the objective to replace the actual disposable solution in cardboard with a returnable metal rack.

This metal rack was developed with the support of a drawing software (NX 11 Siemens PLM software) in all their parts. The metal rack needs to be foldable to guarantee a minimum cost of return. The value added that the candidate gives to this project was been develop the packaging in all parts because this project is completely borns from zero. The most important things to pay attention has been the arrangement and the shape of the different supports to allow the foldability of the packaging because when closed, the various parts of the packaging must be combined to minimize the space occupied.

The only problem that this project has is that being a specific packaging for items it is usable for it and only for it and if in future these parts number will not be shipped any more these metal racks would be disused or will be necessary a work of adaptability of the packaging to new items.

CHAPTER 7 CONCLUSIONS

This chapter has the objective to shown the benefits and the limitations of this work of thesis and the future steps that FCA could follow for implement the project that is described in the thesis.

7.1 BENEFITS OF THESIS WORK

This work of thesis has the objective to analyze the use of returnable packaging for the overseas flows that is not implemented at this moment. The study of a returnable packaging both for a standard dimension of a container and also for specific items like doors and frames has the purpose to show the economic advantages of the returnable solutions.

It is tried also to provide an overview of which material is appropriate to investing for the design of the new returnable packaging, with the comparison of the metal and plastic solutions not emerged nowadays a solution that predominates the other that justifies its use in all cases, but every proposal for a returnable packaging must be evaluated in detail.

How is described into the thesis the use of returnable packaging leads the birth of new voice of costs like the returnable cost, the maintenance cost and the cost of loose of the returnable packaging. With the returnable solution is also incremented the complexity to manage the flow of this packaging because with the increase of the distance the possibility to control and manage the returnable packaging is difficult.

Compared the two returnable solutions that are described Chapter 5 (standard dimension returnable packaging) and Chapter 6 (specific metal rack for the doors and frames) are both convenient from the point of view of the economic aspect. The specific metal rack is certainly a more profitable project for two main reasons: the investment that is necessary to implement this project is much smaller than the case of standard dimension packaging; the second reason is the payback of the investment 1,5 years compared to the 3,9 years of the other project. This difference between these two projects is generated by the ceasing cost of the disposable solution. The wooden racks with standard dimension have a unitary cost very low (see section 5.5 for the business case) compared to the cost of a single cardboard packaging for the doors and frames.

The unitary saving for the doors and frames packaging (sees section 6.2.1 for the business case) is 500% more than the wooden racks packaging and for this reason, this project is more suitable.

From another point of view, the investment in the specific metal rack is riskier than the standard dimension packaging because it is a package that fits only one type of item and for this reason has been exposed that in the future, changing the models produced, this packaging may no longer be used. Instead, the packaging with standard dimensions, being adaptable to different types of items (almost all items managed into racking activity at the logistics center) and for this reason, there will always be demand for these packages.

Both projects have advantages and disadvantages that must be carefully evaluated before being implemented. The advantages for both projects are the economical saving which results from the use of returnable packaging, thought the projects of doors and frames have a payback very minor compared to the other project of standard dimension packaging. The main disadvantages for a specific returnable packaging are the risk that in future these items will not be used anymore. On the other hand, for the project of standard-sized, returnable packaging, the disadvantage is that the return on investment is very long and not in line with company indications, although it is economically advantageous in the long term.

7.2 LIMITATIONS OF THE THESIS

The main limitations of the thesis work are the several assumptions that are made in all business cases that are described, for example, the cost of single returnable packaging is estimated, or the percentage of maintenance or loss is taken on the basis of the company experience.

Another factor that it affects a lot all the business cases and that has been estimated is the days round of a returnable packaging. In this thesis, it was estimated 140 days round but, in the reality, could be much more or even a lot less.

Another limitation of the thesis is that the design of the returnable metal rack is a feasibility study performed on a software and the step to physically verify the feasibility of this project is missing and need to be made in future.

7.3 FUTURE STEPS THAT THE COMPANY CAN MAKE

The future steps that the company can make based on the results of the thesis are to implement a returnable flow for the overseas client that is not explored at that moment. The implementations of these projects need a high investment that at this moment is difficult to sustain for FCA, but if in future, there will be the availability of money to invest these two projects of investments have a high return. Another possibility of analysis is to evaluate the possibility to make the investment to the logistics operator and sharing the economical saving.

About the returnable packaging, the next step will analyze the better way to have a good traceability of this packaging inside the flow from a logistic operator to the production plant.

One-step of research that is important that the company will make studies in deep the plastic solution for the returnable packaging because this technology for packaging with considerable dimensions (like 2250x1470x1290 mm) is very recent. Because until now the plastic solution is, develop only for small packaging.

Another step that the company will have to do is the study of new packaging that improves the saturation of first and second level, like the project described in Chapter 4 because a low level of saturation means that is shipped air inside the container that has a considerable cost.

The next step that FCA could make for the returnable metal rack for the doors and frames, that is developed with the software (Chapter 6), shares the project with some supplier of a metal rack for evaluating the physical feasibility of this project and a more precise economic exploitation of how much it can cost.

ATTACHMENTS

INTERNATIONAL PACKAGING DATA PLAN (IPDP)

FCA
FIAT CHRYSLER AUTOMOBILES

Supplier Code :	66833	Part Number(s) :	77648220 (our item S.ST284)
Supplier Name :	SALGOMMA S.R.L		
Contact Person :		Part Description :	PLUG PF
Phone No :			
E-mail :		Program Name :	

Date : 19 - 10 -2017
Pilot : ☐ PVP, VP, PS
Production : ☒ V1 Launch

(May 2016)

Photograph/Sketch

(Part)	(Internal & External Container w/ Dunnage)	(Complete Unit Load w/Pallet)
		

Part Information

Part Size:	Length : 18	Width: 18	Height: 7,4	☐ (in)	☐ (mm)		
Part Weight:	Wgt 0,00112	☐ (lb)	☒ (kg)				
Part Classification:	☐ Hazardous Material	☐ Date Sensitive	☐ Electronic	☐ Powertrain	☐ BIW	☐ PIA	☐ Trim ☐ Hardware
Material Type:	☐ Plastic	☐ Steel	☒ Aluminum	☐ Fabric	☒ Other, (describe) RUBBER		
Protection:	☐ Anti-Static	☐ Oil	☐ VCI	☐ Desiccant	☐ Other, (describe)		

Primary Container Information

Container Element:	☒ Corrugated	☐ Plastic	☐ Other, (describe) CARTON BOX		
Container Type:	☐ Manual Hand Tote	☐ Bulk Pallet Box	☐ Custom		
Container Dimensions:	Length 400	x Width : 300	x Height : 300	☐ (in)	☒ (mm)
Density: (parts/carton)	Pieces : 10000				
Tare Weight: (empty carton)	Wgt : 0,65	☐ (lb)	☒ (kg)		
Gross Weight: (loaded carton)	Wgt : 11,85	☐ (lb)	☒ (kg)		
Interior Dunnage Material Type:	☐ Corrugated	☐ Foam	☒ Plastic	☐ Wood (certified)	☐ Other, (describe)

Unit Load Information

Pallet Type:	☐ (4-way)	☐ (2-way)	Pallet Tare Weight:	☐ (lb)	☐ (kg)
Pallet Element:	☒ Wood *	☐ Corrugated	☐ Plastic	☐ Other, (describe)	* Wood Pallets MUST be ISPM-15 Certified
Pallet Dimensions:	Length : 1200	x Width : 800	x Height : 180	☐ (in)	☒ (mm)
Cartons per Layer:	Cartons : 8				
Layers per Pallet:	Layers : 3				
Unit Load Density: (total parts/pallet)	Pieces : 240000				
Unit Load Dimensions:	Length : 1200	x Width : 800	x Height : 1100	☐ (in) ☒ (mm)	(one part number / pallet)
Gross Unit Load Weight:	Wgt : 309	☐ (lb)	☒ (kg)		
Unit Load Stack Height: (maximum)	In-transit Sea Container : NO		Warehouse - Storage:		
Banding Type:	☐ Polyester	☐ Metal	☐ Stretch-Film		

Logistic Information (for Direct shipment)

Export Location:	City:	Country:	Code:
Import Location:	City:	Country:	Code:
Shipping Model:	☐ 20'	☐ 40'	☐ 40HC
Direct Shipment: (FCA facility)	☐ Yes	☐ No	Consolidation Point

Supplier Acknowledgement

OEM Supplier : Date :

Title :

*NOTE: Supplier is responsible for component quality through to the point of use.

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