# Technische Universität Dresden

Faculty of Mechanical Engineering

Institute for Machine Tools and Control Engineering


# Development of a method for the selection of logistics components based on process models.

Bachelor Thesis


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# Abstract

During the modeling process, it must be considered the importance of relevant tasks such as transport and storage. These are relevant tasks to the modeling method of the corresponding elements of logistic information.

The resulting models should allow selecting the type of storage needed and transport on the basis of developed articles (semi-finished, finished products ...). Each object has obtained relevant features that its storage involves, to take the decision, such as physical characteristics or hazard class. Therefore, there will be a classification by types of warehouses and other for goods to store, detailing its features and most suitable packaging to optimize storage.

In this thesis, the properties that are needed to know how to make the selection of a particular type of storage or transport will be specified. This will create a methodology for selecting storage and transport based on an existing process model.

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# 0 Introduction

We can define the store as the physical place in which it is developed a complete management of products that contains. One factor to consider in storage is the preservation of the goods in perfect condition since its entry into the warehouse until they leave it. Therefore it must be applied existing regulations in regard to safety and health. Besides, the goods and packaging can be selected ensuring that corresponds with the conditions provided by the customer. ([Par+04], p.91) To ensure appropriate conditions of the goods stored, the store should be prepared for the different kind of goods that are in it. Many economic activities are dedicated to transform some goods into others, altering its nature. A good is an object (a manufactured good, service or a contract) in one place, at a time and under certain circumstances.

Warehousing is referred to all decision-making facts which have an influence on the stock, which is why we also speak of inventory management. Stocks are a buffer between input and output flows of goods. This buffer is created as soon as the temporal and quantitative structure of the input-output flows from is different. Such buffers due to the different structure of the input and output flows can occur at different places on the sales channel. ([Pfoh96], p.92)

As an introduction to the terms of the study, it will be made a description of the three main areas: goods, warehouses and packaging. There is also a relationship between these three concepts that we will be outlining in the course of this thesis. This is because the packaging may be considered a small storage system of products, the smaller ones in particular. They can be described as it follows:

- Good

One of the main factors to be considered when planning for logistics is the product itself. The product is, in fact, a mixture of its physical nature, its price, its package and the way in which it is supplied. For the logistics planner, the physical characteristics of the product and package are seen to be of great significance. This is because, in distribution and logistics, we are directly concerned with physical flow-movement and storage. We must be borne in mind the type of unit load. ([Rus+06], p.111)

- Warehouse

The design of a warehouse involves making long-term well; it is understood that these decisions condition then the equipment and services that will be required to achieve effective and efficient storage. ([PaDe98], p.358)

- Packaging

Taking into account of the various forms and volumes in which an item can be packed, it is necessary to determine the units of delivery or packaging containing the total amount requested. Some of the most commonly used packages are jugs, bottles, cans, boxes, reels, coils, and bags.

Throughout this thesis, a conclusion reached based on the optimization of the relationship between the packages, stores and merchandise. At some point, it will be considered that the containers are a small warehouse that aggregates and organizes the goods. Also, packages can be considered as individual loads for storing goods.

- Storage Unit

Established delivery units, it is necessary to determine how you want to be grouped these units to meet the needs of storage and maintenance of that good, considering means that the company has. So, it will determine the sizes of storage units and delivery units and purchase contained in a storage unit. Some storage units are boxes, shrink, pallets and containers. ([PaDe98], p.98)

- Transport unit

The frequency and importance of the issue, as well as the various load opportunities offered by the lorry, make it increasingly take into account the possibility to buy goods on the basis of complete units of transport. Some transport units are truck, container, trailer and semitrailer. It can be considered as well used as a transport unit if the filling ratio is above 80%.

In the following table they are found the correlations between the logistics unit of measure that applies to the case for purchase, transport, sale, delivery or storage.

| TYPES OF PHYSICAL LOGISTICS UNITS | | | | | | |
|---|---|---|---|---|---|---|
| **PURCHASE UNITS** | | **TRANSPORT UNITS** | **SALE UNITS** | | **DELIVERY UNITS** | **STORAGE UNITS** |
| LIQUIDS | SOLIDS | Truck | LIQUIDS | SOLIDS | Packages | Boxes |
| Units | Units | Trailer | Units | Units | Boxes | Retractable |
| Liters | Meters | Semitrailer | Liters | Meters | Pallets | Pallets |
| Cubic meters | Square meters | Wagon | Cubic meters | Square meters | Rolls | Containers |
| Kilograms | Kilograms | Tank | Kilograms | Kilograms | Coils | Drums |
| | | Container | | | Cans | |
| | | | | | Bags | |
| | | | | | Bottles | |
| | | | | | Drums | |

Table 1: Types of physical logistics units. Source: ([PaDe98], p.73)

# 1 Background

The purpose of logistics is all business development activities in connection with the procurement of materials and products, its treatment and subsequent incorporation into a manufacturing process to obtain a finished product, storing it and distributing it to customers. The magnitude of the volumes is thus also of the economic system. The country's economic growth and the creation of needs have led to an increase in demand, in quantity and / or diversification of products, causing a large volume of movement, and consequently, large masses materials to store and transport. The development of information technologies and communication in the context of globalization of the economy creates new markets in other countries, expanding business opportunities. ([Ferr07], p.13)

The combination of the characteristics listed forced to endure a number of costs on an ongoing basis to maintain the flow of materials. The companies have in staffing for shopping and storage, computing and communication systems, warehouses with their provision of facilities and equipment maintenance, transportation, etc. These logistics costs are often very important in relation to sales.

With this background of market breadth and level of competition, companies are required to streamline the logistics-related activities:

- Management of shopping for supplies contracted with suitable suppliers and supplies that are made in a timely, quality and quantity required in the packaging and transport conditions of interest and at the lowest possible cost.

- Study of storage needs configuring stores according to the needs of production and distribution, and giving them the means of support necessary to achieve high productivity in the movements of material.

- Handling and location of the material in the store, to avoid damage and inventory differences, speed supplies to production lines and facilitating the preparation of shipments to customers.

- Inventory control of raw materials and finished products in stock, so there is no stock-outs that would impede the process of production or sale, or excess stock that may result in obsolete equipment or inventory numbers more than necessary, using for this inventory management stock techniques and demand forecasting.

- Distribution management through the process of customer orders as opposed to stocks and production planning, as well as the preparation of expeditions using the more efficient transport network to provide a competitive service to customers. ([Ferr07], p.14)

# 2 Warehouse classification

Warehouse is defined as the physical place in which to develop a complete management product that contains. Warehouses are used to store intermediate or final products prior to processing or sale.

The store is one element of a whole, is not a separate entity. It is a link in the supply chain that links production and final client. Therefore, its design, capacity or volume of investment should be geared to achieving the objectives of the company should enshrine with production / procurement and distribution (delegations, distributors, customers). It is necessary to combine several variables, including the amount stored (financial investment in stock), the storage and handling costs (investment in shelving, storage and means), and the quality of customer service (speed and 100% compliance orders). The provision of loading areas must always strive for greater effectiveness and minimizing risks and costs. ([Maul03], p.54)

The different types of storage are classified depending on the nature of goods stored, according to a logistic function, depending on their location, legal status, and handling techniques employed. This classification is more detail below: ([PaDe98], p. 345); ([Fue+08], p.92); ([Maul03], p.4); ([Par+04], p.92)

## 2.1 Depending on the nature of items stored

### 2.1.1 Storage of raw materials

There are considered raw materials, all materials extracted from nature that are transformed into produce consumer goods. They are the basis of industrial processes and the quality as well as costs of the final product depends on them. The individual parts have a lower value than the finished product because the components have not the assigned value-added of the activities.

They will be stored when its use it's not need immediately. Raw materials are deposited waiting to be transferred to the next link in the supply chain. They are classified according to

their origin in plant materials (such as linen, cotton, cellulose or wheat), animal (leather, wool or leather), fossil fuels (natural gas or oil) and minerals (gold, iron, copper or marble).

There are also raw materials associated with a particular activity, such as those used in the construction sector. For example: water, sand, wood, cement, lime, clay or silica sand.

They must be identifiable as outstanding features and measurable in order to determine both the final cost of the product and its composition. Properties require special attention such as temperature, humidity and ventilation for proper storage and preservation. Usually raw materials warehouses can be found close to shops or production centers.

### 2.1.2 Semi-processed materials warehouse

When raw materials have already been manufactured, they are called semi-finished products, semi-processed or under way, but still not a commodity. They are outstanding stock of some kind of transformation. Includes manufactured goods and not for sale until they undergo further processing.

Some examples of these products are cast iron, aluminum rings, semi-finished plastic products, steel, paper, wooden boards, etc.

This type of storage area is located between the anterior process and posterior process, in order to limit and minimize the distance and manipulations to be performed. They are used as intermediate storage between products produced outside the plant, pending its finish. They are usually located between two workshops and the production process is not entirely complete. ([PaDe98], p.197)

### 2.1.3 Finished goods warehouse

This kind of products is the final result of a production line, including packaged products. Stored products are intended to be sold. Generally, these items are manufactured upon request to make the shops. The inventory is controlled to dispatch products to customers.

The store of its kind, serves the sales department, fixing and controlling stock. It regulates the outflow of the products, acting as a center of production.

### 2.1.4 Spare parts warehouse

Spare parts are those parts intended to be mounted or installed on computers or machines to replace old ones. They can be segregated from finished products, while parts or assemblies are also stored for sale. During the manufacturing, sometimes occur mistakes but the material is undamaged, so it is stored. These stores are widely used in shops or companies related to the automotive environment. Replacement parts may have their own store or be with the finished products, because spare parts are also susceptible to sale.

For example: the spark plugs of an internal combustion engine of a passenger car, wipers and car mats, bits for drill, spare wheel, etc.

### 2.1.5 Storage of auxiliary materials

Auxiliary and also called indirect materials are considered those which supply materials to the production process so that it can be carried out. These goods may be auxiliary to the production, as fuel and oil for certain machinery or tools, or else auxiliary generic goods such as cleaning supplies and hygiene products, detergent, bleach, office supplies, paper, folders, etc. ([Fue+06], p.74) They are no components of a product but needs to pack it.

Tools and equipment are under the custody of a specialized manager. Equipment and supplies are provided to the other departments and production or maintenance workers.

For example: lubricants, fuel, grease, labels, cleaning products, oils or paints are considered auxiliary materials.

### 2.1.6 Information Files

Even though that these stores are not the subject of our study show interesting peculiarities. It should consider the importance of archiving documents to our company or magnetic band file of a data processing center. ([PaDe98], p.345)

## 2.2 According to its role in logistics:

The first tasks in the design of a store are oriented to select the site where they will be located. The situation of a store within a logistics network is one of the key decisions since they affect substantially the ratio cost-service of the global logistics system. If the logistics system can be considered as a network through which goods and information circulates, the stores will be the nodes of the network, where products are temporarily stopped. The problem that arises is the determination of the number of nodes, its size and its position in the logistics network. ([PaDe98], p.355)

### 2.2.1 Storage in plant

The physical planning includes the space needed for movement of materials, storage, indirect workers and all other activities or services, as well as staff and workshop staff. The main objective pursued by the plant layout is to find an arrangement of work areas and equipment, which is the most economical for the job, while the most secure and satisfying for employees.

It is used the principle of minimum distance to the same conditions, it is always better distribution that allows the distance traveled by the material between operations is shorter. The economy is obtained in an effective manner using all available space, both vertically and horizontally. It is required to perform a storage function as the cycles of production and consumption hardly agree. The storage function exceeds the discrepancy in terms of time and the desired quantities.

This kind of warehouse contains finished products waiting to be distributed. Each company must make provisions to keep their products in different places, while they expected to sell.

The products tend to be located within the grounds of the factory, is the first step of the logistics system. The production centers replenish this store, leaving their products to the "field".

### 2.2.2 Field Stores

Within the logistics system are at different levels: central, regional, provincial, local, etc.

#### *2.2.2.1 Local stores*

Every time less used. Also denominated deposits, they were located in close proximity to target markets, thereby reducing the time of transport and delivery to the customer, and increasing customer satisfaction. If demand is excused geographically and difficult to predict, local stores can lead to high inventory costs.

#### *2.2.2.2 Regional warehouses*

They are similar to the locals but are approached to larger markets. They are located near the point of consumption. They are the intermediaries between the central storage and point of sale. These stores have a small stock whose mission is supply a given area or region, in order to provide service as quickly as possible. As known too as approach warehouses, they are supplied from central or regulator warehouses. ([Anay08]; p.26) They are ready to pick up large loads and they use distribution trucks by retail with less capacity. This type of storage reduces transport costs by reducing inventory costs reduce overall costs associated to products, but can also increase the shipping and delivery distances, which can affect customer satisfaction.

#### *2.2.2.3 Central warehouses*

They are in the first step of logistic system. Its aim is to collect all or part of the inflows (production, imports, returns, etc.) for distributing it later into other stores. It is a central store or buffer warehouse, when it aims are to supply a fixed number of peripheral points (regional warehouses, sales channels or customers). They are the warehouse for many regional markets

and deliver products directly to customers. They are located as close as possible to the center of manufacturing and these stores are prepared to handle large loads. They have to be prepared for any unforeseen event that may occur along the supply chain as it constitutes the most distant point of sale. Eventually, they often make direct deliveries to certain areas and / or customers. ([Anay08], p.26)

Incomings to the warehouse are often in full trailer and palletized goods, as well as outputs, although sometimes also outputs are dispatched in boxes as the unit of manipulation.

Their mission is the maintenance of stocks in the logistics system. They are usually classified as follows:

- In normal stock, such as all kind of reserves of something available in a future use. It is contained different assets that the company has and which serve as raw material for the realization of their products.

- The seasonal stock requires temporary storage. Those stocks that are used seasonally, being only at certain times of the year, and disappear at the same time they do the products.

- The outstanding stock (stock speculative). The shares of a corporation's stock that have been issued and are in the hands of the public, also called shares outstanding.

The choice of central or regional warehouses stores depends on the type of cargo and the cost structure of the company. So, in case of low value products or high transport costs, lead to the use of regional warehouses. In contrast, in a situation with high inventory costs for the value of the product, it involves central warehouses. In any case, there are methods for evaluating the best decision.

### 2.2.3 Transit warehouses or platforms

As known as temporary storage, it must carry out national and safety at work legislation. The concept of platform it is used in situation of Cross-docking. They are stores in transit to optimize transportation between the factory warehouses and offices or customers. In cross-docking platform type goods are exchanged between trailers and pallets as a unit of manipulation. This system achieves greater efficiency in the distribution: decrease the mileage of each trailer and, therefore, the consequences are less time and cost reduction.

They must be suitable for storing, loading, examining and sampling of goods. Normally there is an approved place situated within the appointed area of an approved port or airport, but outside the Customs approved area.

Created primarily to take the needs of transport in account, storage outweighs the costs with higher volumes transported. They are used when the journey is long and we must move large quantities of goods, thus prevents the transport cost is very high. ([Fue+06], p.76) They have a wider activity than the field storages and even platforms. They are dedicated to, almost always, the passage of perishable goods.

Because of its special characteristics, we must highlight the importance of involving the services of storage tank. The bonded warehouse storage is an agreement between the owner of the goods and the government, and consists essentially of such goods cannot leave the store until they pay their taxes. This type of tax agreement is mostly applied to products entering the country and is subject to import customs fees. This establishes, generally in ports, warehouses in limited areas, so that a foreign company can enter it your goods, do some manufacturing process and store their products, not paying the appropriate import duties until the goods not enter the country legally, if sent to another country, do not pay these fees.

## 2.3 According to its location:

### 2.3.1 Covered storage

Storage products with complete protection against any of the weather agents, allowing even modify the conditions of temperature and lighting.

To determine the dimensions of the building, it should be planned prior to their purpose and content. However, in all cases must be taken into account the number of plants, geometry, floor, columns, walls, ramps, lighting, building materials, safety, cover and accesses.

The suitability of different areas where a warehouse is divided for a specific use, let's talk about high utility in the operation of storage.

### 2.3.2 Outdoor store

This type of store lacks any type of building and it consist of spaces marked by fences, marked by numbers, painted signs, etc. They are stored products that not need protection from the elements.

If the solid bulk has a low unit price and is impervious to the action of local weather, and it is processed in large quantities, is usually stored in large heaps in the open or in sheds without much protection: for example, include such solid coal, sulfur, pyrites, limestone, sand, common salt, etc.

It can be used cover systems for outdoor storage. The plastic materials provide adequate protection for limited periods of time. Polyethylene products are highly resistant to moisture, are lightweight, easy to use and retain their flexibility at temperatures below freezing. Another widely used material is elastic laminated vinyl, coated with nylon on both sides. This product is quite resistant to corrosion, for example, salt water or different types of acids. ([Fue+08], p.96)

## 2.4 According to its legal status:

The storage activity can take place under three different legal regimes,

### 2.4.1 Itself warehouse

They are those whose facilities belong to the holding company. The company has made an investment in space and equipment for the storage of their goods. These types of stores are profitable because of not having to pay any rent. The advantage of this situation is, first of all, profitability, if its use is intensive. So this kind of storage is recommended when dealing with larger volumes and high turnover. Furthermore it gives more control of storage operations, helping to ensure a higher level of service when the operation and maintenance require special conditions. It allows the company more flexibility in the future use of space and in the design of storage facilities. It can serve as a basis for other complementary activities (sales offices, the center of the vehicle fleet, purchasing department, etc.).

The only notable difficulty of this type of store is the high volume of investments to be made in land, buildings and even plants above all at the beginning of the industrial activity. The costs incurred belong to the organization of the company. In some cases the nature of the product or particular logistics system makes this the only valid. ([PaDe98], p.346)

### 2.4.2 Warehouse for rent

A common scenario is the leasing of industrial buildings already built, but generally not equipped and is intended for use in warehouses, practicing as if it were their own. In addition to rental costs, there are the investments in equipment and facilities they need to function properly. They are of public ownership or private property, publics are the property of the council, the administration in general and privates are from companies or individuals. Public warehouses allow a group of companies' converged services and solutions optimizing and minimizing costs. In both cases, public or private, the owner rent it to companies that need seasonally. ([Fue+08], p.76)

For example, a store of this type can be used during a season to store oranges, another to store grapes, other rice, etc., depending on the activity of the employer who hires him.

At present there are companies whose business is to provide storage services. The configuration of these public stores usually oriented multiple use and widespread. It is recommended when storage space required is variable in many different places.

It is possible to distinguish two main types of rental service stores: those who simply are hired on the basis of the volumes occupied and those that offer a variety of complementary services. The services usually offer the latter, also known by ADIF (physical distribution warehouse), in addition to basic reception, storage, transmission, consolidation or shipping division, are: Storage in transit, storage tank for customs office, storage temperature and controlled humidity, inventory, consolidation of loads, preparation of orders, packaging, labelling, issuance of delivery notes... etc.

### 2.4.3 Leasing warehouse

This option is presented as an alternative to the two previous terms. Since the user is obliged to hire the rental store for a predetermined period of time, you lose flexibility as to the possibility of changing the location of the store, but allowing you to control both storage space and the operations performed. In an effort to reduce costs and to meet the increasingly stringent demands of the customers, companies are getting rid of their private stores for the benefit of outside options. Although is not a universal solution, outsourcing is a cheap alternative, based on a comparison of internal costs against external. ([Sanc08], p.111)

Leasing companies prefer an external store to manage inventory continuously, and they can also rent other warehouses to resolve emergencies and situations of temporary storage.

Not only store but also the industrial and office equipment, transportation, real estate, machinery and control equipment can be obtained with the leasing system. Increases flexibility in changing markets very quickly and allows them to cope with technological obsolescence.

## 2.5 According handling techniques:

Selecting the right storage system for an application involves reconcile the movement and storage needs with the characteristics of equipment. This fact involves balancing two conflicting objectives that are: To maximize the use of volume, and allow easy and fast access to stored products.

Handling unit in the stores is measured in terms of type of pallet to be used and their composition to the number of packages that can accommodate, taking into account the limitations of way and high of the level of product family. ([Anay08], p.41) The design of the pallet handling system represents the most widely used in industry.

The choice between the use of own or public warehouse is not an easy task, requiring a detailed comparative study of the costs involved. The leasing will cost money in the short term; it is considered a cost to doing business. It is universally manufacture of wood, although developed metal or plastic models for very specific applications, since in general the cost is higher to achieve the same performance. In Europe, standard measures are 800 x 1200cm europallet and 1000 x 1200 cm. They have access on all four sides to facilitate their movements.

It is the basic starting point of the entire logistics system for storage, handling and physical distribution, because from here will define the required storage systems, characteristics of the shelves, areas, etc. Important is to mention that in any case we get a significant reduction in handling time of the product, and therefore costs. The following are just these types of stores:

### 2.5.1 Conventional

Classic storage system with manual access shelves served by trucks, which have the advantage of access to materials can be done manually, thereby is possible to gain a more rapid removal and placement of tools. The assembly of these shelves is easy and convenient, and offers great versatility in terms of regulating the height of the shelves.


Figure 1 - Conventional shelving boxes (manual picking). Source: ([Maul06], p.127)

If the stored pieces are large or heavy, the most suitable stores are these for pallet racks, because they can withstand high weights and contain very large pieces. These shelves are made of scales (columns) and the beams, which are assembled without the need for any tools that may be done at different heights, adaptable to the size and shape of the parts. The pieces are placed on the shelf, directly on pallets or in a container or covered with something that prevents gather dust. Efforts will be made up no shelf high towers, which would be difficult to access for workers, endangering their safety. The height of the shelves should allow the operator to see the parts to be removed. This operation should be done with trolley lifts, when the parts are stored on the upper floors, or trolley for pallets, to withdraw when there are parts of high weight and they are placed on the lower floors.

### 2.5.2 In Block

This system, also known as compact store, is possible to use both palletized products as for non-palletized ones. It involves a stack of products (or pallets), one above the other or on shelves for this, forming solid blocks in the store , which represents a minimum cost, as it requires no special infrastructure, possibly manipulated by hand (courier) or with simple equipment such as forklifts conventional, when the products are palletized. Pallet height depends on the resistance of materials to the stack.

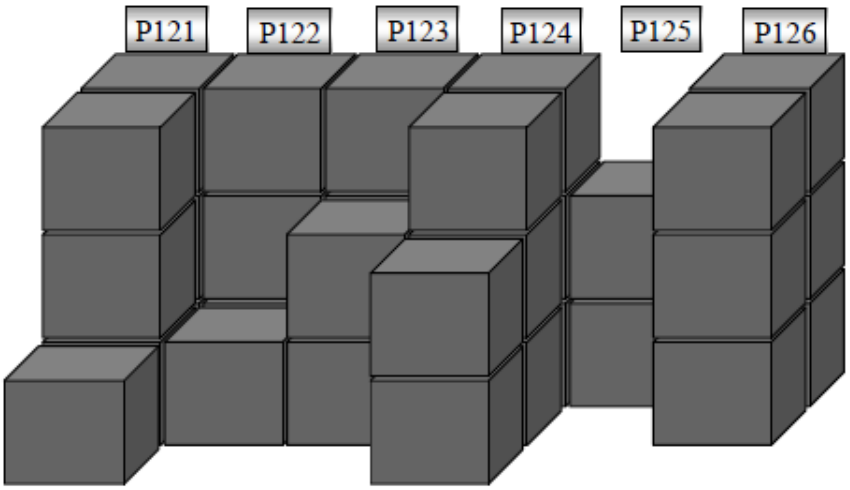


Figure 2 – Example of block warehouse viewed from the front. Source: [Geor08]

This type of storage requires no investment on shelves and has high density storage. This type of installation is sometimes used for storage of produce in bulk packaging (such as fertilizers), which are stored in bags, tote bags with handles to be handled by forklift, empty containers of soft drinks in plastic boxes, etc. The bags are stacked directly on the ground or on the pallet, which facilitates handling. Only one operator can pick up and leave the pallets from the truck. ([Maul03], p.9) This system is widely used in temporary storage, such as products still sorting or quality control. As disruptions, it is possible to mention: the possibility of spoilage if the packaging is not good, the difficulties in counting and rotation of products, and a low efficiency in the stack if the height is not large enough.

### 2.5.3 Compact drive-in

Corridors may represent an area equal to that occupied by furniture storage. That is true also in terms of volume. However, when stocks move little, these corridors are neither frequented. A solution for improving the organization of the store would be that the furniture to keep things can moves and save a single corridor between 5 and 8 furniture.

The mobile storage (also called compact), consists of pallet racks or lockers that can move sideways. When you want to access a box, it will move some furniture for the hall opens to the storage address of interest. The displacement of these units can be powered in case of heavy loads or when necessary automation is demonstrated, if it is not the case, the workers carried the movements out manually by turning a steering wheel or a crank. ([Roux03], p.99)

Figure 3.a – compact shelving palletization. Source: ([Maul03] p.16)

Figure 3.b – compact shelving palletization. Source: ([Maul03] p.16)

When it is desirable high density storage of pallets on racks, with a very high volume to total volume used, the system recommended is compact palletizing, where the shelves are corridors through which they move the trucks, leaving the pallets a side by side within each load level. There are two variants of this system, usually called drive-through and drive-in.

This storage system whose main characteristic is to not have spaces in between aisles, trolleys can be introduced into the shelves. These shelving systems are specially designed to meet strict monitoring in the rotation of the product, following the principles LIFO (last thing that comes located is the first selected) or mandatory following-up of the FIFO (what first in its first out). The selection of pallets can be made either from the very head of the linear (drive-in), thus ensuring the LIFO system, or through the tail (drive-through), in which case the system is guaranteed FIFO. The selectivity is small and provides a relatively slow operation, so it applies to situations with a high number of identical pallets with a small movement. It is allowed a good use of volume; it can be stacked up to 9 meters high with simple equipment. ([PaDe98], p.370)

This equipment is especially suitable for file storage or for libraries in areas reserved for books that move little. A recent example of library project has shown that the use of movable shelves rather than static allowed a saving of around 45% of global investments, equipment and buildings. The savings is given by the reduction of necessary building surfaces. The extra cost due to the mobility of the shelves is not significant.

This storage class requires no operator complex. Only the furniture must be moved one by one and put safety devices that prevent the case that a passageway is closed when an operator is in it.

The rationale for choosing this type of equipment will be comparing the number of references to be stored with the corresponding access number, as the times to access a reference increase due to the time needed to open the hall. The time to access a reference in a compact rack can exceed 50% access time of a static shelf.

### 2.5.4 Dynamic

The dynamic storage reflects the same motivation as compact storage, but the context and the solution are different. In this type of installation, the furniture not moves yet but the charges that are within the furniture moves.

If you have to have in stock several articles of the same reference, is it really necessary to simultaneously access all of these items? In most cases the answer is no. Hence the idea of deep alveoli and through that the article may be introduced at one end and drawn at the other. ([Roux03], p.100)

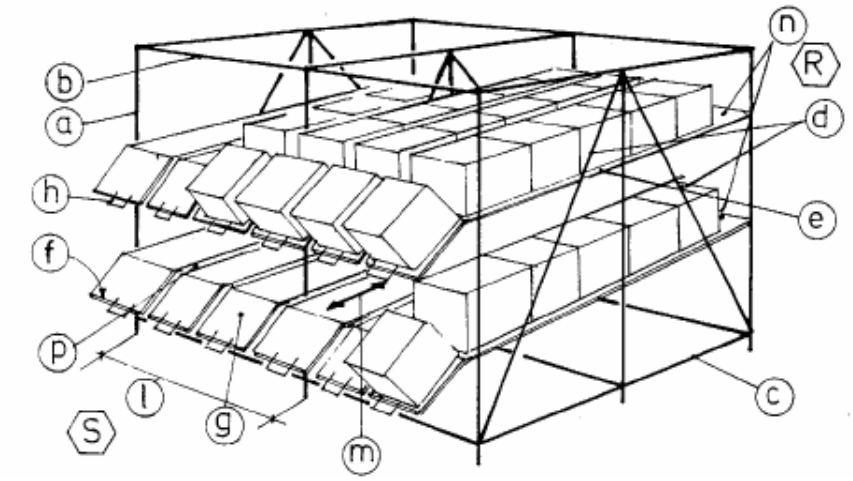


Figure 4 – Structure of dynamic storage with slides. [Source: UNE legislation]

This is a system for mobile storage space, formed by solid blocks, without hallways. Its main feature is the sliding of the pallets from the entry point of the shelf, to the output. Dynamic shelves are an alternative to drive-through system, the pallets are automatically placed in the tail of the line by gravity (coasting through rollers) to allow easy removal of them, they are equipped with special security systems to prevent the fall of pallets. This will reduce difficult movements and speeds up the picking process.

To see if this type of storage is justified, compare the number of references to be stored and the number of relevant articles. This solution is adopted in the stores where items are of the

same reference number and turnover rates are high. It should be noted that helps avoid cross-flows easily, and that entries are held in stock in a particular aisle and exits in another. It should also point out that this installation requires, ipso facto, observing a strict FIFO and storing a single reference by aisle.

The system requires close monitoring of the FIFO, with good use of the volume, being excellent for goods of small size and rapid movement. This type of equipment exists in the catalog, for pallets and for much smaller loads in cardboard boxes or buckets.

FIFO comes from the phrase "First in-First out", meaning that the first thing that comes should be the first to leave, or in other words, that the products are giving out in store in the same order they entered , which obviously favors the products will not wear out or expire within the shelves.

### 2.5.5 Automatic warehouses

They are automated warehouses that require less, or almost any human intervention. A common feature of all is that the operator does not move to the goods, on the contrary, the merchandise is moving toward the operator.

They can be classified as follows: from light loads through horizontal rotary systems (carousels) and vertical (Paternoster, megalift, shuttle) or small cranes parts (mini-load) and a pallet stacker.

#### *2.5.5.1 Carousel*

The carousel is a horizontal rotary warehouse consisting of an electric motor, rail and a pull string that lets you move the merchandise that is hung in a series of vertical shafts in which are placed 3-8 baskets / crates according to the size of the product stored. They are leaded from a computer located at the extraction point in which the reference to remove is indicated. ([Maul06], p.128)

Figure 5 – Horizontal carousel. Source: ([Maul06], p.128)

It reaches a length of 15-30 meters and may contain 5000-10000 references. To avoid waiting times needed for bringing a reference that is 20 meters away, 3-5 carousels are installed connected to a computer that simultaneously prepares 5 orders with 10-20 LP each, so that the operator can get a referral every 15-30 seconds.

Its advantages are clear: many references in little space, minimum personal travels. It is used for small goods and products with little stock. Therefore, it is used in high production orders. They require less investment in proportion to the standard paternoster systems. They are used in distribution. Not suitable for manufacturing because they take up considerable ground on the surface. The movement of the shelves is made through a rugged profile arranged horizontally. The supports for trays and mobile shelves can move loads up to 25 tons.

#### *2.5.5.2 Paternoster*

It is a storage system in vertical carousel. Any mechanism is inside a closet (5 / 10 m high, 3-5 m wide and 1.5-3 m deep). The goods are housed in more or less equidistant trays (30 to 40 cm). These trays can be compartmentalized so that the total width can be stored several references in an orderly manner. In the front and controlled by a computer equipped with a slot and external tray attached. At the request of the operator (introduced by reference and

quantity), the mechanism rotates like a wheel in one direction or another, to minimize the distance of rotation (position where the merchandise is a tray operator), placing the requested tray on a height of the adjacent slot / bar so as to the operator removes the goods requested.

The idea is similar to the carousel, but to be oriented at height, it is more collected, it occupies less space and therefore is used not only in distribution but also in production (at the machine they are spare parts, for example, a regular commodity type drill with CNC machines). In distribution, it is used in various circumstances, for example, if products are not bulky and expensive (electronically material, etc.) and you want to lock it or coated from powder.

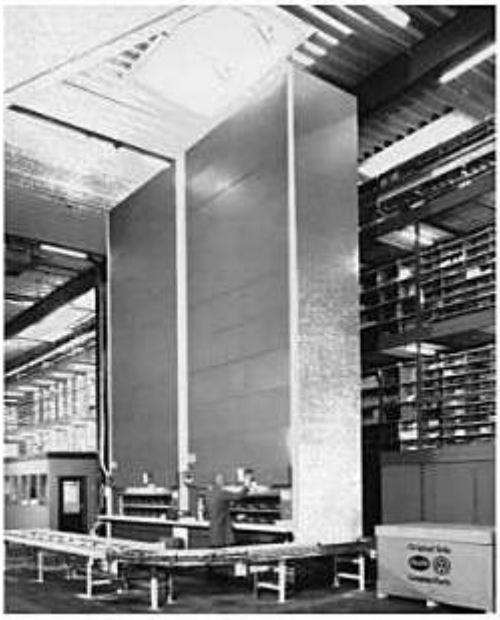

Figura 6 – Paternoster. Source: ([Maul06], p.129)

### *2.5.5.3 Shuttle*

Shuttle is also known as megalift, and is similar to paternoster but with some variations. It consists of one or two towers of trays and a hole between them. Not all trays are equidistant. The trays do not rotate, they move horizontally to a position in the free tower of ascent / descent and move vertically through the central hole down or up.

When ordering the goods on the computer that command, the appropriate tray slides into the inner tower of displacement and tray scroll down to the height position of the slot / tray where the operator is. It is said, there are two movements: the first is moved horizontally and then vertically downward (or upward movement of return). Not all trays rotate, as only the tray in which the merchandise is moves. That allows for greater capacity (height), heavier and irregular loads. ([Maul03], p.28)

#### *2.5.5.4 Transelevator*

They are mechanical devices capable of handling (loading and unloading) merchandise through narrow corridors at high speed. There are palletized load handling (with or without driver) and also for operating a box and / or baskets of small parts. Basically they are a very tall conventional racking (they can reach up to 25-30 levels) and length (reaching up to 60 - 80 m in some cases). In corridors it is placed a rail running through the stacker crane which slides itself. The chassis that carries the operator's cab or forks for handling pallets, moves vertically along the mast for positioning in height, while the mast itself moves horizontally for positioning in length.

Figure 7- Transelevator. Source: [Meca10]

# 3 Goods classification

They are called stocks all those goods that the company has for sale in the ordinary course of operation, or for processing. The concept of commodity includes any marketable sort, an object of sale treatment or that can be transported for commercial purposes. The factors taken into account when classifying the goods are the unit of loading, the special characteristics and handling capabilities of such goods ([LoGo04], p.28). The good determines the interpretation of the warehouse. Liquid assets are stored in storage tanks, pressure vessels, and gases in silos or stockpiles.

The unit loads shall be classified for storage planning depending on their volume, weight, support tools (container), type (eg flat, quaderformig or stored) or special requirements (eg cooling) and risks (eg fire or hazardous material). They are considered as foreground in general cargo warehouse for manufacturing industries. The more detailed classification is presented below. ([Roux03], p.53)

## 3.1 Classification of goods according to their nature,

### 3.1.1 Bulk Material:

Some items are stored or delivered in bulk (liquid or powder), and require special equipments for transport and storage. During the transport process usually changes its shape depending on where it is deposited. To establish means of transport or storage types have the characteristic physical and chemical properties of the bulk material to be known as accurately as possible. These properties are used for material classification. Bulk material is lumpy (for example, coal), grainy (for example, cereals) or dusty bulk (for example, cement). ([Mart04], p.64); ([Rupp91], p.183)

The bulk goods are transported without packaging of any kind. It is deposited in piles of merchandise to be delimited by workforce partitions fixed or mobile made of wood, steel or aluminum plates, etc. some kind of bulk goods such as plaster or cement is stored in silos. In this case, it is established a division between dry bulk (grain, coal, phosphate and other

minerals) and liquid bulk (water, oil and other chemical products or metals) ([LoGo04], p.28). Typical bulk material is for example: ore, coal, garbage, sand, cement, gravel, stones, grain, wood shavings, flour, coffee or cereals.

If it is possible, bulk store should be located near the place of consumption because transportation is expensive. It must make the material transportable and storable, so that it can be poured. Its contents should automatically be measurable; their extraction must be controlled and connected to a mean of transport.

If the solid has a low unit price and is impervious to the action of local weather, and processed in large quantities, is usually stored in large heaps in the open or in sheds without much protection: for example, include such solid coal, sulfur, pyrites, limestone, sand, common salt.

Solids alterable to weathering are stored in large closed sheds or silos. These are cylindrical containers with discharge by mechanical pneumatic conveying or spoon. The burden of solid materials delivery services or other process operations is usually done through hoppers, which are containers with gravity unloading containers from the bottom. The transport of continuous solids is made by conveyors and bucket elevators or chain hoists.

Bins, silos, bunkers and hoppers are the materials handling equipment most often identified with the storage of bulk materials. Bulk materials storage bins can be in many shapes. The most important factor is selecting the shape of the bin or hopper and the method of unloading it.

### 3.1.2 Single item sent

The individually packaged goods include not only packaged products in boxes or sacks, but also heavy single items such as vehicles, pieces of heavy equipment or blocks. ([Rupp91], p. 183)

Unit volumes of the articles are clearly important in the warehouse planning. For example, in a warehouse of spare parts of cars, there will be assigned areas and resources appropriate to the different morphologies of the pieces. Allow an area to store small parts that can be stored in small trays or drawers: bolts, light bulbs, electronic components, etc. A second area is dedicated to everything that can be stored on pallets or in containers of equal volume. A last area will house special forms parts: windscreen, spoilers of the body, chassis, etc.

The aim is to gather the material in units of transport and storage for full utilization increasing the capacity of a transport vehicle to get its economy.

Barrels, crates, packages, boxes or bags are the materials handling equipment most often identified with the storage of single items. General cargo is the cargo that moves on pallets, platforms that keep the load is placed at ground level in the hold, which facilitates stacking and shipment by truck. This load is packed in bags, boxes, cans, etc.

### 3.1.3 Liquids

The bulk liquids are stored in cylindrical tanks with wide base and not much height. For packaged liquid goods, tank containers are not necessary. For bulk commodity specifying means of transport fitted tank.

Volatile or flammable products are usually stored in floating roof tanks. In them the metal roof rests directly on the liquid through a flexible coupling. This minimizes the steam chamber and the risk of explosion and fire down considerably.

The small amount of fluids can also be stored in horizontal cylindrical tanks, more expensive but easier to transport and assembly ([Cos+04], p.85). Some liquids can be transported by pipeline or plumbing.

The most common types of liquids are: water, oil, wine, chemical products, metals, etc.

### 3.1.4 Gases

The gases are stored in many different ways depending on the conditions under which they are. The gasometers are large containers of mobile metal roof panel, whose purpose is to store gas at low pressure for delivery. They usually have a closing hydraulic device and are given pressure by the ratio between the weight of the roof and the cross section of the container.

Illuminating gas is so stored and hydrogen for combustion in some industries. The storage of gas in large amounts should be in terms of pressure and / or temperature different than normal ones to avoid having to dispose of huge volumes.

Easily liquefiable gases are stored as liquids at room temperature (eg butane, propane, $CO_2$) in spherical tanks (have better resistance to pressure by its symmetrical shape.) The gases that require very high pressures and low temperatures to liquefy are usually stored in liquid form at very low temperature and ambient pressure in very well insulated tanks, for example liquefied natural gas (LNG), liquid $O_2$, $N_2$ liquid. ([Cos+04], p.85)

Sometimes the gases to be used in not so large quantities are used compressed in gas phase at room temperature, in spherical or cylindrical deposits of elongated shape (cylinders, bottles) resistant to pressure. For example, compressed air $O_2$, $N_2$, $H_2$ and noble gases are so sold out.

The ratio of height to diameter tank of liquid is different according to the feature storage. Thus, the tanks whose surface has a high unit price - with sophisticated insulation, special alloys, etc. - will be higher to minimize the total area of the container. LNG tanks are a good example. In contrast, crude oil tanks are more flat, thus avoiding the use of thick plates, because the hydrostatic pressure at the bottom will be lower.

To maintain the volume of gaseous substances as small as possible, the compressed gases are stored in pressure containers. Small amounts of gases are stored and transported in

pressurized bottles. Large amounts of gas transported by tubular conduits. Compressors are used to compress gases at high pressure, whereby the temperature rises resulting from the heat of compression. These gases require special security measures that must be observed by the high pressure or particular flammability.

### 3.1.5 Long goods

The use of long loads requires special ways of storage and manipulation. The handling of long loads requires storage means and special handling means. Each of the means of storing and handling provides a different level of land use and accessibility to each reference and required investment levels. ([Maul03], p.172)

Some stores must accommodate loads which lengths are important and variable, such as profiles for sale. The storage is then carried out on cantilever arm racks, shelves or cantilever.

Some of the most common long goods are: tubes, rods, sticks, profiles, planks, sheet metal, etc.

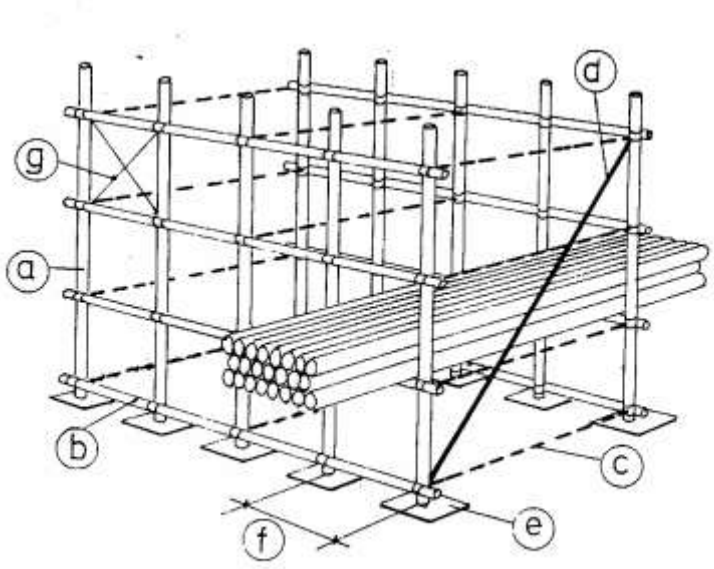


Figure 8- Structure to support long loads: a) jamb, b) stringer, c) crossbar, d) diagonal, e) foot, f) body, g) pigeonhole. Source: ([Maul03], p.175)

### 3.1.6 Small goods

Some common small goods are made of paper, wood, plastics, etc. They are also small packets to sell retail products such as tea, sweets and spices.

## 3.2 Classification of goods according to their properties or characteristics

The goods have very different properties and characteristics, the most important ones are shape and dimensions, amount, weight, temperature, high-risk products, sensibility, perishability, physical properties, market value, need for administrative controls, and substitutability. ([Rus+06], p.112); ([Roux03], p.53); ([Hein04], p.65); ([Rupp91], p. 183). Some of them might even belong to more than one group in which this classification has been divided.

### 3.2.1 Shape and dimensions:

The most important geometrical characteristics are length, width, height and diameter. Volume and weight characteristics are commonly associated, and their influence on logistics costs can be significant. For example, to place small goods near the exit points can minimize the costs of handling.

The shape may also be important. There are products on a regular basis, snap, or irregular. It may happen that one side has different dimensions to the others (considerably larger or smaller). The volume may be small, medium or large.

A high volume to weight ratio, tends to be less efficient for distribution. Typical products include paper tissues, crisps, disposable nappies… Most companies measure their logistics costs on a weight basis (cost per ton) rather than a volume basis (cost per cubic meter). Thus, a low-volume/high-weight product will best utilize the handling cost component of storage.

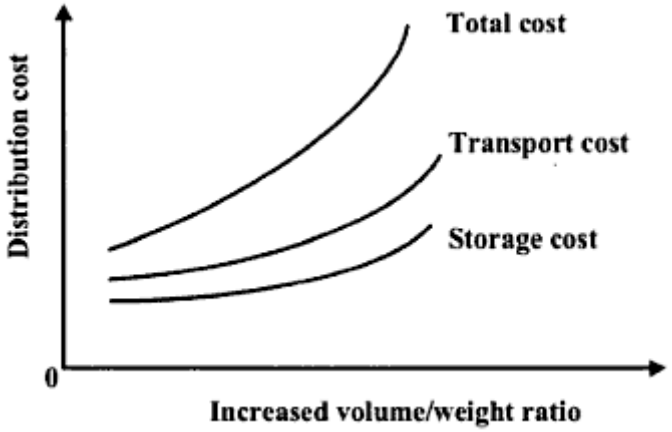


Figure 9- Effect of product volume to weight ratio on logistics costs. Source: ([Rus+06], p.113)

Unit volumes of the articles are clearly important in the warehouse planning. Furthermore, there are a lot of different external forms such as rod-shaped, ring, post, tubular, plate, cubic, cylindrical, spherical, conical, or closed on all sides.

There are also different kinds of surfaces. We can emphasize plain, flat, rough, corrugated, striated, curve or interrupted surfaces. Some examples are flat surfaces such as sheets, particle board, or glass panes; long goods such as profiles, tubes, or rods; and winding material like paper or wire coils.

### 3.2.2 Amount:

The number of items is directly related with its nature. Also, the quantity of stored goods is related to weight and volume. Parts or small products are grouped into containers, forming a unit load. It can be distinguished, individual packaged goods such as work piece, machine part or the package; and bulk cargo such as parcel post, castings or bags.

### 3.2.3 Weight:

The gross weight means the weight of the goods plus the weight of packaging used. Both weight and size of the articles, is important in the definition of warehouse. There are different

types of shelves, as they are designed to withstand heavy loads or accommodate light but bulky packages. For example, storage of pillows or soft toys accepts very light structures, made of mesh. On the other hand, storage of metal parts shall require otherwise. ([Roux03], p.53)

The optimization of the warehouse will be achieved by occupying the greatest volume and avoiding open spaces. Particular care should be taken when storing goods to be lightweight and irregular volume as it may happen that large spaces are wasted. In addition it will prevent damaged goods during the period of storage or process of loading and unloading.

### 3.2.4 Temperature:

Articles which need special environmental conditions must maintain a controlled temperature. For serum, photography products or food is required that the temperature not differ more than 1 or 2 degrees from the indicated value.

If it is necessary to store products that require temperature controlled areas, it is important to consider the safety of employees and protect them from sudden temperature changes. The handling of the products can also be slower due to the limited time you can spend in the temperature-controlled environment.

The Maximum Safe Storage Temperature (MSST) is the highest temperature to store a chemical (like organic peroxide) above which slow decomposition and explosion may occur.

A special type of cargo is called reefer cargo and it concerns refrigerated goods, which usually comes packaged. They can be considered general merchandise, but requires certain weather conditions because they are perishable goods that need a specific temperature to preserve them. There are hygiene rules that determine the maximum allowable temperatures for storing food which largely depend on food type and they are designated storage conditions. These conditions include not only temperature, but also humidity.

It should give special attention to the location and dimensions of the cold-storage rooms inside the store. Preference is square or rectangular shapes, with no major differences between the sides in order to achieve a homogeneous distribution of cold air, avoiding the creation of areas that are poorly refrigerated. The access doors are often the elements that generate losses, therefore, also they have to be constructed so as to be good insulators, and they must provide watertight seal to the camera. If the movement of vehicles is common, it is desirable to create a camera or prior entry tunnel leading directly to the refrigerated. ([PaDe98], p.363) The soil will be covered with slip-resistant materials, providing ease of cleaning of the chamber, where conditions of hygiene should be higher.

The evaporator, cold diffuser type is currently used mostly for cold storage. This can be placed on the floor or hung from the ceiling. Forced ventilation is used to provide a rapid air movement and maintain uniform temperature in the warehouse. Very few units provide the means to maintain high relative humidity, apart from that the product produce for his breathing and the one that result from a good design. It helps to have an evaporator as large as economic, so as to maintain high relative humidity in the store. With a small size evaporator, evaporator temperature decreases and humidity in the air condenses on its surface, and thus reduces the relative humidity of the air. ([HaSa68], p.173)

Due to the diversity of temperatures that products require, it will be created separated zones within the chamber, if it is possible with variable capacity, even with the possibility of individually chilled at different temperatures. At least it will be provided four zones of temperature: from + 10 to 8 ° C for fruits, vegetables and legumes, + 8 to + 4 ° C for dairy products, + 4 to - 4 º C for cold food, cooked, boiled, frozen, meat, etc., And - 4 to - 18 ° C or lower for frozen products.

### 3.2.5 High-risk products. Sensibility:

There are products submitted to particular statutes as e.g. these that need quarantine (alcohols, pharmaceutical products that includes toxic products, hazardous substances and drugs; certain petroleum products…). They all need a separately storage and often a security system.

The quarantine is the time required to carry out checks for deciding whether a product is usable or not. This requirement is common in the pharmaceutical and agro-food, and more generally in the workshops practicing quality control on raw materials that come from abroad. The quarantine also applies to finished products. A product in quarantine, though physically be present, it is not available. It is like "frozen" before passing the checks. ([Roux03], p.57)

The characteristics of some products present a degree of risk associated with their distribution and storage: fragility, dirtiness, hazard/danger, contamination potential and extreme value. It's a legal obligation to minimize this kind of risk. As with any form of specialization, there will be a cost incurred.

The storage of explosives may require electrical installations have adapted: intrinsic safety, enhanced protection anti exploder materials, etc. ([Roux03], p.98)

Hazardous goods may require special packaging, a limited unit load size, special labeling, isolation from other products, and regulations for the movement. It is not allowed to store large quantities of hazardous materials. It is available security metal containers to store flammable solvents.

Volatile or flammable liquids are usually stored in floating roof tanks. In them the metal roof rests directly on the liquid through a flexible coupling. This minimizes the steam chamber and the risk of explosion and fire down considerably. ([Cos+04], p.85)

Fragile products require packaging to take account of handling and transport stocks. It should be prevented no caused crashes, shocks or vibrations.

### 3.2.6 Perishability:

To store the goods, it must be taken into account certain standards related to food storage. There are hygiene rules that determine the maximum allowable temperatures for storing food which largely depend on food type and they are designated storage conditions. Through the proper storage, it is trying to keep the highest quality of food from the time of purchase until its use.

The storage conditions must comply with the storage temperature and humidity, and hygiene rules and expiration dates. Besides, the place where they will store food must meet basic characteristics: it must be a place not too hot (do not have large swings in temperature), in which does not shine lots of light and it must be built with strong materials, insulators and easy cleaning. The storage temperature must be monitored with extreme caution, especially when it comes to store any perishable product, since the multiplication of microbes is closely related with temperature. ([Gilm00], p.11)

Perishable goods in many instances require special conditions and equipment for their distribution (e.g. refrigerated storage and transport facilities for frozen and chilled food). Typical examples of highly perishable products are newspapers and unpackaged bread. The company must find a balance between the likelihood of having to bear costs and losses when occur lower demand than availability, or missed opportunities, i.e., not make a profit if there are higher demands on availability. If it is a commodity whose remaining stock of one day is not usable the next day, the problem would be to calculate the optimal amount to produce. ([Parr05], p.184)

Time-constrained products, for example all foods that have ‘best before’ dates or seasonal deadlines, daily newspapers, fashion goods with a fixed season, and agrochemicals such as fertilizers and insecticides have fixed time periods for usage. In the group of perishable

products with expiration date would find certain agricultural products like fruits and vegetables, dairy, and fresh cheese and yogurt, pharmaceuticals, soft drinks, etc.

### 3.2.7 Physical properties:

Some goods have special physical properties to consider such as density, pressure, relative humidity, heat, cooling, lighting, radiation, internal friction, hardness or angle of repose. The change in any of the following magnitudes can have very negative consequences on the product to be stored. Depending on how the material behaves, it is classified as magnetic, electrostatic, corrosive, explosive, toxic, combustible, greasy or sticky.

Other products are subjected to mechanical tests to determine their properties. Some of these features are: breakable, fragile, changeable, destructive, permanent, stretchable, sharp edges, friction coefficient, slip angle or position of gravity center (unstable, stable, indifferent or changeable).

### 3.2.8 Market value:

Product value is also important to the planning of a logistic strategy. This is because high-value products are more able to absorb the associated distribution costs.

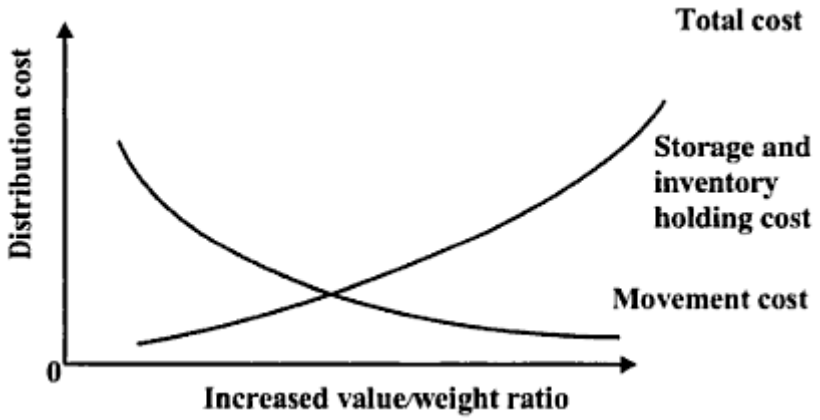


Figure 10- Effect of product value to weight ratio on logistics costs. Source: ([Rus+06], p.114)

In certain products must be taken into account the market value of the good, because it can oblige storage in an adapted local, even in a strong and safe box.

Low value: ore, sand…etc.

High value: photographic equipment, computer equipment…etc.

### 3.2.9 Need for administrative controls:

There are some articles that need to pass through customs checks or declarations. They must comply with statutes and wait to pay customs duty.

### 3.2.10 Substitutability:

The degree to which a product can be substituted by another will also affect the choice of distribution system. When customers substitute a product with a different brand or type of goods, should be avoided stock-outs. Typical examples are many food products, where the customer can choose an alternative brand if the need is immediate and the first-choice name is not available. Commodities with high replacement (if there is not a brand of rice buy another), are forced to have large amounts of stock (storage expensive) or highly efficient distribution systems (transport expensive).

It must be remembered that if the average stock levels rise, it will increase costs.

# 4 Package classification

A container is a product that can be manufactured in a wide range of materials, that serves to contain, protect, handle, deliver and present goods at any stage of the production process, distribution or sale.

First, and in general terms, it must be distinguished between packaging and containers. The former are covers or wrappers that are generally irrecoverable and they are intended to protect the goods during transport and storage. The containers are containers or vessels that are sold together with the main product. For example, a unit of empty tetra brick milk carton would be container and a cardboard box where cartons of milk are stored in dozens would be packaging.

The most important functions of packaging are protection against pollution, climate, damage, hazard of the environment or lost of volume. In the utilization of warehouse or loading areas, package has a decisive roll; it is made a summary of handling units. It is because with the package is possible to simplify the manipulation and the resistance to stress decreases. ([Mart04], p.75)

There are special specifications related to the transport sector, there are some properties that not every good can use. The more important ones are stackable, foldable, with a crane, mobile tilting, mobile with wheels, shrink, attached with clamps, cast, consolidated, carried or sliding.

Often the stores should make deliveries of goods at retail. By definition, the amount of these items is less than the amount required by the secondary packaging standard. The store should therefore be made up, store and use appropriate packaging to shipping.

When transport, storage and loading equipment are taken into account, it is possible to differentiate between the most common kind of package such as container, box or pallet.

The packages must have a number of qualities: they must be sufficiently robust to enable the items to arrive at their destination in good condition, and they should be easily stacked to make it easier for carriers. The format must be optimal, small enough to reduce stocks and to facilitate the mechanization of the preparation and closure, and large enough to accommodate the order sizes and not lead it to "empty transport". It must be taken into account the organization adopted for the packaging operations: Pick and pack or "pick" and then "pack". They must be cheap, and finally, they must meet the demands of anti-pollution laws (Töpffer law, enacted in Germany for the green pulse, serves as a reference in much of Europe). ([Roux03], p.124)

There are a lot of kinds of package, depending on the use of them that it is needed. The choice of packaging means knowing the characteristics in size, weight permissible, and adaptation to different types of items (fragile, liquid, etc.).The different types of packaging can be separated in two groups:

## 4.1 Individual packaging

Some stores destined for the storage of spare parts, for example, can have parts in bulk containers, before giving them entry into the warehouse; each item will be put in a blister type of packaging or another. Eventually it may be necessary a labeling to identifying them with a bar code and / or sale price. ([Roux03], p.55) Some of the most common types of packaging for goods units are barrels, boxes, bales, boxes, bags, etc

- Drums: cylindrical container with a flat or warped background. They can be constructed of steel, aluminum, plastic, cardboard, etc. If the top cover is removable, it is called mobile lid drum, and fixed cover drum in case of having holes to fill and drain. Sometimes they have rolling hoops.

- Kegs, carafes or bottles, metal cans or plastic with rectangular or polygonal section, provided with one or more holes.

- Bags or sacks: paper flexible packaging, plastic sheeting, textile, etc.

- Boxes: packaging with complete rectangular or polygonal sides. They can be made of wood, cardboard, plastic, metal, etc. ([Gome09], p.59)


Figure 11-a) Drum, b) Carafe, c) Sack, d) Box. Source: ([Gome09], p.59)

Individual packaging can be classified according to its material. Some materials are more desirable to store a given substance:

### 4.1.1 Metal containers

Metal containers have features such as durability, cost / quality relationship and product protection, which have contributed to higher use for many years in the food and beverage sector. Metal containers used for food packaging and subsequent heat treatment can be made of steel or aluminum, the first being the most commonly used for reasons of cost and performance. Steel for packaging is usually in the form of tin. Thickness, and the level of tin coating is very variable, depending both on the size of the container and the product to be packaged. ([Rodr05], p.11)

The three-piece cans are used to package a large variety of products including condensed milk, vegetables, soups, fish, meats and fruits. These containers are available in various sizes from about one hundred grams to three kilograms, and they come in different forms. The most

common is the cylinder, but also flat, oval and square cans are used. The three-piece cans are made of steel coated internally with a thin layer of tin and a lacquer or varnish to prevent corrosion. Tin containers are larger, with capacities ranging from 2 to 20 kg, and they are used to package products such as milk powder or oil. Provide excellent protection in wet weather. Steel drums, from 20 to 200 liters capacity, are usually used to transport vegetable oils and fats. Due to its strength, they can be reused many times. They can also be used to transport chemicals and materials such as kerosene, fuel, etc. Under no circumstances should these drums used to store food. ([OtAx98], p.21)

### 4.1.2 Glass containers

Glass is probably the best choice as a material for containers for a variety of foods that will be subjected to heat treatment. Their properties, positive and negative, can be summarized in the following points: it is inert, impermeable to gases, aromas and flavors, plus a resistance to chemical attack against a variety of compounds that often food contains. Typically, they are transparent, allowing examination of the product by the consumer before purchase, though this feature can be a disadvantage when it comes to light-sensitive foods. There are green and brown bottles that protect against the light when it is necessary. Another advantage is that this type of packaging can be reused and recycled.

They present a drawback to its fragility. Conductor heat is bad, so a sudden change in temperature, usually above 60-65 ° C, can cause a range of dangerous tensions result of thermal shock. However, sudden cooling is more dangerous because the tension generated on the surface. Another disadvantage is the high weight compared to alternative materials used in the manufacture of containers, which contributes to an increase in transportation costs. ([Rodr05], p.18)

### 4.1.3 Wood containers

Wood is a strong material used to make various types of boxes and crates to store fish, fresh fruits and vegetables. It is also used to make barrels, commonly used for storing and transporting liquids such as wine. Due to its resistance, the wooden containers provide good

protection against damage such as breaking or crushing, and they have the advantage of easily stacked. Wooden containers can be reused many times. However, during use it must be taken care that the resin from wood not contaminates the product with its smell or taste. ([OtAx98], p.14)

### 4.1.4 Paper/cardboard containers

As the paper absorbs moisture easily and is a very soft material, it is a material not suitable for storing products with a high average content of moisture if storage is intended for an extended period. There are two main types of paper: Kraft and sulfite paper. The Kraft paper is strong and is commonly used in multilayer food packaging bags, for storing flour, cereals, legumes, fruits and heavier products such as potatoes. They are easy to handle and store, it can be used for packaging oily foods. The sulfite paper is more thin and fragile; it is used in candy bags and sheets. It loses its properties when it gets wet.

The cardboards are similar to the paper, but they are thicker and stronger, and offer greater protection against breakage and injury. Its main features are its thickness and its ability to bend without cracking. A small-scale system, they are available pulp paper molding systems that require a lot of labor, in which recycled paper can be molded into egg cartons and various forms of disposable plates and containers. They are used to package some sterilized and pasteurized food, such as milk or fruit juice, using different types of plastic and laminated cardboard. This kind of boxes is known as Tetrapacks. They require large-scale production. ([OtAx98], p.18)

## 4.2 Collective packaging

There are packages that are used not for each item but for a group of them. In this classification, it is possible to noun pallets, cardboard, metal or plastic tubs, containers of wood, metal or grating, etc. In Europe there are a range of standard containers (plastic or metal) whose dimensions are sub-multiples of the European pallet size. They are described below, the more used collective packaging:

### 4.2.1 Pallet

It is the most universal storage group, and in particular the European pallet 800 x 1200 mm. Its length corresponds to slightly less than half the maximum width of the trucks, regulated by the code of road (2.5 meters), which streamlines the filling rate of the vehicles. Simply choose the combination that offers the highest fill rate, which presents less risk of flooding and better stability of the loads by the alternating layers. A quality of the pallets that it is not always taken into account is dry wood. If the wood is not dry enough, the pallet with the load, takes a curved shape. The package also covers the load on the pallet and if the store management should monitor the pallets. The pallets must meet several standards: AENOR, DIN and ISO, and the tab 435.2.0 of the International Union of Railways.

### 4.2.2 Container

Finally we should speak of containerized goods. Such goods are transported in closed and sealed boxes, called containers which facilitate handling and transport of goods.

Container has been a revolution in all modes of transport. Initially this type of packaging was used only in sea lanes and road, but over time would be extended to rail and air. It is sealed metal boxes for transport of goods, avoiding the deterioration of the charges. The most common are steel, but aluminum is also used (usually for refrigerated containers) and wood or fiberglass, though less used, because despite its light weight materials are not as strong as steel. ([LoGo04], p.29)

Transport by container, in whatever form (sea, land, air or rail) is a way of transport increasingly booming and rapidly evolving. The reason for this rapid evolution is that the goods transported in this way are not altered to the warehouse, the point of destination. Although there are also disadvantages, since both the port and terminal infrastructure and equipment require high investment.

There are two classifications of containers; in the first place, according to their shape and, secondly, to the general conditions in respect of the goods they carry. In the first classification

(by shape), we discussed of: standard containers for general cargo goods (Dry van container) closed container (box container), container platform (Flat container), standard high-capacity container (high cube container), and open side container, open top container, folding container or igloo container. In the second category (according to the goods carried), the containers are classified as bulk containers, insulated container with a heating system (calorific container), container Europallet (parallel stacking with two pallets of European measure), insulated container, temperature controlled container, refrigerated containers (reefer / to-air container), container hangers for clothes and tank container for liquid cargo.

### 4.2.3 Box

They are small containers for parts and manual fast preparation orders. Sometimes the boxes replace the shelf items, by having greater adaptability, and they may be used equally as a means of transport and as a storage medium in the workshop.

Cardboard boxes are the most used. The FEFCO and the ASSCO have issued an international code that normalizes the main types. Among the boxes with flaps, the American box is very used, since it has an excellent surface-volume carton useful. Its use, widespread, has led many builders propose shaping machines and close them. Telescopic boxes offer the advantage of having a variable volume, hence reducing the number of different sizes required. They have the disadvantage of not protecting the contents against crushing, so it is reserved to a bit fragile items. ([Roux03], p.124)

A solution must be found to limit the number of cartons of different sizes without the need to transport volumes increase so too significant. The automatic sewing machines of cards do not support adequately the diversity of formats; it seems that the maximum is 3 or 4. The format change requires a period of adjustment that practically prevents the production of different cartons in a chain. We must work in spurts and have a stock of cards available and trained. The "just in time" does not work.

Wooden boxes can serve as external containers for transporting food by volume, or small packets to sell retail products such as tea, sweets and spices. These containers do not provide much protection against climatic effects, but when they are lined with plastic film or aluminum foil and covered, they can counteract the effects of air. For example, for packing of tea, production countries often use plywood boxes lined with metal sheets. These containers are inexpensive and they are effective to keep the area in good condition. ([OtAx98], p.15)

### 4.2.4 Silos

They are prismatic or cylindrical tanks. A silo is a structure designed to store grain and other bulk materials. The most common are cylindrical in shape, resembling a tower, built of wood, concrete or metal. There are flat silos, reinforced, unreinforced and hopper silos. The dimensions are according to the capacity of the silo and the company that manufactures them.

Its diameter usually varies from 3 to 20 m. and height of 2.5 to 20 m. The capacities of the silos in general, can vary from 3 tons to 18,000 tons. Usually a silo employs mechanical appliances for loading and unloading from the top. It is not advisable to store in the same silo different types or grades of grain. It is used for storage of agricultural products, animal feed, cereals, seeds and other bulk products, but also to store various products like cement.

## 4.3 Hazardous materials packaging

An essential aspect for the safety of hazardous materials is made up for the containers in which they are contained. Containers can be grouped and protected by a package or overpack. One determined type of container will be valid for a wide range of materials more or less wide.

- Bottles: Containers specially designed to withstand the pressure exerted by the subject. They are mainly used for gases, both compressed and liquefied, or dissolved under pressure. They are usually metal and thick walls to ensure high resistance (in some cases pressures up 300 $kg/cm^2$). Blocks are a set of cylinders joined together by a manifold so that they are used and transported as an inseparable whole. For the

transportation of cryogenic gases (liquefied at very low temperature), it is used a type of special packaging, like a thermos, keep the cold, preventing the liquid becomes gas by heat.

Figure 12- Different types of bottles and blocks. Source: ([Gome09], p.61)

- Composite packaging: means a set built for a plastic inside container, glass, porcelain or stoneware, and external protection (metal, cardboard, plastic, plywood, etc.). This set is an inseparable; it is filled, stored, dispatched and emptied as such.

- Overpack: it is an enclosure used by a single consignor to contain one or more packages, making them a unit easy to handle and stowed for transport. An overpack is widely used to shrink-wrap pallet. Labels and UN mark of the package must still be visible from the outside or otherwise added to overpack. In the latter case, must also be equipped with the mark "overpack" clearly visible. For international transportation, it requires that the mark is in a language of the country of origin (and in English, French or German if it was not any of these.)

- IBC (intermediate bulk containers): mobile, rigid or flexible container, designed to be handled mechanically (eg by forklift) and resist efforts to be subjected during handling and transport. It is allowed a big number of construction materials: metals, plastics, textile, etc. Its main feature is to have an intermediate capacity between typical packaging, seen above, and containers. Usually they have the dimensions of a pallet. The use of these containers, relatively new in the transportation of hazardous materials, is expanding rapidly due to its significant advantages: higher capacity,

mechanical handling, lower packaging costs, increased product protection, etc. ([Gome09], p.61)

Figure 13- Different types of IBC (intermediate bulk containers). Source: ([Gome09], p.61)

Containers used for hazardous materials must be approved, for it must pass certain tests of stacking, dropping, side impact, etc. The severity of these tests will depend on the characteristics of the materials that the package is allowed to contain. All packages must be properly marked and labeled. Packaging shall be constructed and closed so as to prevent loss of content. Packages will not carry dangerous goods remains affixed to the outside. Parts of packaging which are in direct contact with dangerous substances will not suffer alterations produced by these materials.

When containers containing liquids, it should leave ullage to allow expansion of the liquid during transport (you cannot fill 100%). Otherwise, by heat, the contents may leak or distort the container, and can even pop it. In cases where the content can release gases that cause pressure, the container may be fitted with a vent (where the gas produced does not lead to danger.) Before being filled and offered for transport, it must be ensured that all packaging is in perfect working order, free from corrosion, contamination or other damage. Otherwise, it cannot be used.

The responsibility for the correctly environmentally management of industrial packaging is the final holder. Discarded containers that contain residues of dangerous goods should be

transferred to a licensed waste manager to their treatment. Mixed packing consists in transport in the same outer packaging two or more different materials placed in separate inner packaging.

Each container or package shall bear markings which are durable, legible and visible, describing the type of container, building material, year of manufacture, approval, etc.

# 5 Relationship between goods and packaging

To verify the relationship between the goods and containers, it will be given score indicative. There are various options of packaging required by the product. There shall be a numeric value of 0 points for a commodity that cannot be stored in a given container. It will be marked with a 1 in the case that this type of packaging can be used but it is not recommended for other issues. Finally, it will be given a score of 2 points so as to those goods to be stored using that particular container for a variety of production issues, cost savings, protection of goods from external agents, etc.

## 5.1 Relationship between packaging and goods according to their nature

| | | **Goods according to their nature** | | | | | |
|---|---|---|---|---|---|---|---|
| | | Bulk material | Single item | Liquid | Gas | Long good | Small good |
| **Individual packaging** | Metal container | 2 | 2 | 2 | 2 | 0 | 2 |
| | Glass container | 1 | 2 | 2 | 1 | 0 | 0 |
| | Wood container | 0 | 2 | 2 | 0 | 0 | 2 |
| | Paper/cardboard | 2 | 2 | 0 | 0 | 0 | 2 |
| **Collective packaging** | Pallet | 0 | 2 | 0 | 0 | 0 | 2 |
| | Container | 1 | 2 | 2 | 0 | 1 | 2 |
| | Box | 1 | 2 | 0 | 0 | 0 | 2 |
| | Silo | 2 | 0 | 2 | 2 | 0 | 0 |
| **Hazardous materials packaging** | | 2 | 2 | 2 | 2 | 1 | 0 |

Table 2- Relationship between packaging and goods according to their nature.

In the table above, depending on the nature of goods stored, it can be noted that individual products (single item), present no difficulty to be packaged in different types of packaging

(with the exception of silos). However, when it comes to long materials, packaging storage options are minimal. When the materials are in liquid or gas, they have drawbacks due to its nature as a material of this kind tends to occupy the entire volume of the container in which it is located.

## 5.2 Relationship between packaging and goods according to their properties or characteristics

In the case of classification according to properties or characteristics of goods, it will be related to different types of packaging as noted in the table below. There are sometimes problems with glass or wood containers, especially when it comes to weight, physical properties or market value. Products with a high value in the market cannot be stored in any container, it must be an appropriate one according on what is carrying.

| | | **Goods according to their properties or characteristics** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | [a] | [b] | [c] | [d] | [e] | [f] | [g] | [h] | [i] | [j] |
| **Individual packaging** | Metal container | 2 | 2 | 2 | 1 | 2 | 2 | 2 | 1 | 1 | 2 |
| | Glass container | 1 | 1 | 1 | 2 | 2 | 2 | 1 | 0 | 1 | 2 |
| | Wood container | 2 | 2 | 1 | 1 | 1 | 2 | 1 | 0 | 1 | 2 |
| | Paper/cardboard | 2 | 2 | 0 | 1 | 0 | 2 | 1 | 0 | 1 | 2 |
| **Collective packaging** | Pallet | 2 | 2 | 2 | 1 | 1 | 2 | 2 | 0 | 1 | 2 |
| | Container | 2 | 2 | 2 | 2 | 1 | 2 | 2 | 1 | 1 | 2 |
| | Box | 2 | 2 | 1 | 1 | 1 | 2 | 2 | 1 | 1 | 2 |
| | Silo | 1 | 2 | 1 | 2 | 2 | 1 | 2 | 0 | 0 | 1 |
| **Hazardous materials packaging** | | 2 | 2 | 2 | 1 | 2 | 1 | 2 | 1 | 1 | 2 |

Table 3- Relationship between packaging and goods according to their properties or characteristics.

[a] Shape / dimensions

[b] Amount

[c] Weight

[d] Temperature

[e] High-risk products. Sensibility

[f] Perishability

[g] Physical properties

[h] Market value

[i] Need for administrative controls

[j] Substitutability

In case of doubt in the choice of one kind of package or another, it will be sought to choose the package with the highest affinity for the type of goods to be stored, i.e. the one which has the larger value of the table.

# 6 Relationship between warehouses and packaging

The relationship between storage and packaging is established based on the size of these containers hold in store, depending on the type of store in question. We must plan the space for storage in order to achieve the set objectives and profitability in the logistics plan. They will be established the same criterion score between 0 and 2 points, according to fitness in the relationship between the store and package.

## 6.1 Relationship between packages and warehouses depending on the nature of items stored

| | | **Warehouses depending on the nature of items stored** | | | | | |
|---|---|---|---|---|---|---|---|
| | | Raw materials | Semi-processed | Finished goods | Spare parts | Auxiliary materials | Info files |
| **Individual packaging** | Metal container | 2 | 1 | 2 | 2 | 2 | 1 |
| | Glass container | 2 | 1 | 2 | 0 | 2 | 0 |
| | Wood container | 2 | 2 | 2 | 2 | 1 | 2 |
| | Paper/cardboard | 2 | 2 | 2 | 1 | 1 | 2 |
| **Collective packaging** | Pallet | 2 | 2 | 2 | 2 | 2 | 1 |
| | Container | 2 | 2 | 2 | 2 | 2 | 1 |
| | Box | 2 | 2 | 2 | 2 | 2 | 2 |
| | Silo | 2 | 2 | 2 | 0 | 1 | 0 |
| **Hazardous materials packaging** | | 2 | 2 | 2 | 1 | 2 | 0 |

Table 4- Relationship between packaging and warehouses depending on the nature of items stored.

In this case, the classification of stores depending on the nature of the items stored, it should be noted that the only type of store that presents disadvantages is the information files

warehouse. For example, raw materials and finished products can be stored and transported in all types of packaging of our study. It has no sense to store spare parts in glass containers or in silos, for these reasons it is written 0 punts in both categories.

## 6.2 Relationship between packages and warehouses according to its role in logistics

| | | Warehouses according to its role in logistics | | |
|---|---|---|---|---|
| | | In plant | Field stores | Transit/platform |
| **Individual packaging** | Metal container | 2 | 2 | 2 |
| | Glass container | 2 | 2 | 2 |
| | Wood container | 1 | 2 | 2 |
| | Paper/cardboard | 1 | 2 | 2 |
| **Collective packaging** | Pallet | 2 | 2 | 2 |
| | Container | 2 | 2 | 2 |
| | Box | 2 | 2 | 2 |
| | Silo | 1 | 1 | 1 |
| **Hazardous materials packaging** | | 2 | 2 | 2 |

Table 5- Relationship between packaging and warehouses according to its role in logistics.

For the classification of stores according to their role in logistics, there is no type of store that present problems in the packaging. Only the silos are less desirable because they have more difficulties in the process. The rest should be emphasized that glass or metal containers are widely used in either type of store, and in the case of collective packaging, especially pallets, containers and boxes. Specialized packaging for hazardous substances applies to any of the

types of storage, always taking into account the rules and safety measures for these substances.

## 6.3 Relationship between packages and warehouses according to its location

| | | Warehouses according to its location | |
|---|---|---|---|
| | | Covered storage | Outdoor store |
| **Individual packaging** | Metal container | 2 | 2 |
| | Glass container | 2 | 0 |
| | Wood container | 2 | 2 |
| | Paper/cardboard | 2 | 1 |
| **Collective packaging** | Pallet | 2 | 1 |
| | Container | 2 | 1 |
| | Box | 2 | 1 |
| | Silo | 1 | 2 |
| **Hazardous materials packaging** | | 2 | 1 |

Table 6- Relationship between packaging and warehouses according to its location.

All types of packaging may be stored in covered storage. The silos, which have large dimensions are placed majority outdoors, but we can also find them inside a warehouse. Not recommended to keep outside are the glass containers because they deteriorate the product contained in, due to the light and temperature changes. Wood packaging also breaks down when it is stored outside, mainly in humid climates.

## 6.4 Relationship between packages and warehouses according to its legal status

| | | Warehouses according to their legal status | | |
|---|---|---|---|---|
| | | Itself warehouse | Warehouse for rent | Leasing warehouse |
| **Individual packaging** | Metal container | 2 | 2 | 2 |
| | Glass container | 2 | 2 | 2 |
| | Wood container | 2 | 2 | 2 |
| | Paper/cardboard | 2 | 2 | 2 |
| **Collective packaging** | Pallet | 2 | 2 | 2 |
| | Container | 2 | 2 | 2 |
| | Box | 2 | 2 | 2 |
| | Silo | 2 | 2 | 2 |
| **Hazardous materials packaging** | | 2 | 2 | 2 |

Table 7- Relationship between packaging and warehouses according to their legal status.

In this case, the classification of the stores according to their legal status, it is noteworthy that there is no difference between whether or not to use one or another type of packaging. This is due to the fact that the store owner is an individual; a public entity or if it is under rent contract or under leasing one, does not involves substantial influence on the type of packaging. For this reason all possibilities have 2 points, because it doesn´t matter whatever the legal regime. There are other parameters that decide whether it is preferable to one or other type of packaging.

## 6.5 Relationship between packages and warehouses according handling techniques

| | | Warehouses according to handling techniques | | | | |
|---|---|---|---|---|---|---|
| | | Conventional | In Block | Compact Drive-in | Dynamic | Automatic |
| **Individual packaging** | Metal container | 2 | 2 | 2 | 2 | 2 |
| | Glass container | 2 | 0 | 2 | 1 | 2 |
| | Wood container | 1 | 2 | 2 | 2 | 2 |
| | Paper/cardboard | 2 | 1 | 2 | 2 | 2 |
| **Collective packaging** | Pallet | 2 | 2 | 2 | 2 | 2 |
| | Container | 2 | 1 | 1 | 1 | 2 |
| | Box | 2 | 1 | 2 | 2 | 2 |
| | Silo | 1 | 0 | 0 | 1 | 0 |
| **Hazardous materials packaging** | | 2 | 1 | 1 | 1 | 2 |

Table 8- Relationship between packaging and warehouses according to handling techniques.

When we compare the packaging according to the types of stock handling techniques, we can reach the following conclusions: glass containers and silos cannot be stacked in blocks, in the case of glass containers because they are a brittle material, and in the case of silos for its rounded shape. Conventional stores with shelves allow the use of nearly all the packaging with warranties, usually also have the proper handling of an employee. Automatic warehouses can also be used in all cases except for the silos because the silos precise the help of a worker to cleaning them, and cannot be fully automated.

# 7 Example: Milk storage

To implement the classification made in the preceding paragraphs, it will be explained a practical example consisting of the way in which milk can be stored. It will be considered that the same substance can be stored in different containers according to at which point in production process is, or depending on to whom the product is directed.

Germany is the largest milk producer in Europe with an annual production of 28.488 thousand tonnes of milk. Milk production increased uniformly, while the number of cows on farms decreases. 47% of milk production is used as liquid milk, 25% for the manufacture of butter and the rest for evaporated milk, condensed milk, cheese and ice cream. The average milk consumption of milk in Spain was in 2006, of 100 liters per person. [Mapa06] The aim is to produce and maintain fluid milk clean, healthy and acceptable smelling, taste and appearance. The bacterial quantity of milk is used as an indication of their quality (it must be less than one million per $cm^3$).

Common materials whose surface is in contact with milk are aluminum, tin and stainless steel. They don't affect the taste and they are used in milking buckets. It must be cooled rapidly to 4.5 ° C to maintain the quality of fresh milk. There is a considerable difference in taste and smell of raw milk and that which is bought in bottles and cartons after processing, because the product is treated with heat during pasteurization. In the heat treatment, they are produced slight changes in taste and flavor of the product. The aim of pasteurization is to destroy organisms which produce disease and to inactivate certain chemicals known as enzymes, so as to achieve a longer shelf life of the product. The ultra pasteurization (UHT = Ultra High Temperature) uses a higher temperature than pasteurization. It removes all bacteria less the lactic acid. No refrigeration is required rear and it has yet no microorganisms. ([HaSa68], p.30)

The packages are tailored to the characteristics that the product requires. The density of milk changes with fat content and temperature. As the temperature increases, the density or weight

decrease. Milk does not absorb food flavors and animals through the air or by close proximity to them.

It is distinguished two types of packaging and storage, depending on the function that is intended. For the same product, in this case milk, it will be established several possibilities:

## 7.1 Collective packaging for distribution and treatment

- Tanks of milk, they cool and store milk in bulk, some to pressure and others in vacuum. A milk tank is a tank tub used to cool and preserve milk at low temperature until it can be withdrawn by a milk collection truck. Usually they are made of stainless steel, and may be open or closed. They can be of various sizes; silos for milk reach over 10,000 liters and are used by large producers. The normal temperature of tank is 3 or 4 º C.

Figure 14- Milk tank. Source: [Gala10]

- There are also milk jugs but there are not so used as milk tanks. The milk jugs have a capacity of 38 liters. The milk is cooled in a cooler surface and the pots can be put in cold storage in dry atmosphere.

## 7.2 Individual packages for retail

Colored bottles and packages made of plastic or cartons reduce the effect of sunlight, as this is detrimental to the product.

- Tetrabrik: is the trade and registered name of the brick built by Tetra Pak, it becomes synonymous with a phenomenon par excellence. It is a mixed multilayer container, composed of three different materials: 21 g of cardboard (from virgin pulp), 5.8 g of polyethylene plastic and 1.4 g of aluminum. This is a special cardboard sanitized box, covered internally with a glossy film. Its capacity can be of a quart, pint or liter.

- Glass and plastic bottles: milk bottles can be packed in a glass or plastic quart, pint or liter.

- Bags and cans: dry milk, also known as milk powder, can be presented in bags for easy transport and storage. Evaporated or condensed milk is stored in cans, because in this way, it can keep in excellent condition up to 1 year at temperatures below 18 ºC.



On the one hand we have the primary packaging, which includes packaging that is in direct contact with the goods carried. In a new instance, we have the secondary packaging, which is commonly used for the removal of certain primary packaging or products contained within their respective containers. In the case of milk, we can say that after filling the bottles or cartons, containers are placed in their cases. The boxes are transported to the storage, keeping refrigerated temperatures next 1 - 4ºC.

The milk cartons are stored in the following way: a group of 6, 8, 10 or 12 cartons are packed in cardboard boxes, and after this, they are placed in a pallet. When it joins a specific number of boxes on the pallet, the load is protected with plastic wrap and stored in a semitrailer for onward transport. For example, if it is bought milk in packages of 1 liter brik, it will have the following types of groups:

1 case = 12 cartons = 12 liters

1 pallet = 864 cartons 1.200x800

A semi-trailer 12.20 m = 30 pallets

# 8 Summary and Outlook

Each store is different. It is therefore necessary to establish mechanisms to classify and differentiate the stores, one from each other. In designing the store, we have to limit us to the physical space built and the needs required for goods to be stored. It has to be taken into account the description, shape, size, weight and physical properties of the products stored therein. It must be planed the space for storage in order to achieve the set objectives and profitability in the logistics plan by testing it before making the distribution, it is necessary to know the type of legal regime of the store, its location and which are essentially, techniques manipulation that in it are carried out.

One of the main factors to consider when defining industrial flows is the product itself. The product is perceived as an amalgam of their physical nature, its price, its packaging and how is it served. The physical characteristics of a product, any specific requirements for the packaging and the type of cargo unit, are very important factors to try to minimize the total costs for given service levels.

For this reason, we have developed in this thesis a system for selecting the most appropriate storage according to the type of goods and packaging. It has been made a thorough study of the types of storage, types of goods and types of packaging. These three concepts are related in a way that containers can perform the function of bringing together smaller or store goods (warehouses function), and in turn a warehouse store such containers. So it is necessary to know the specifics of each one of them.

Through the evaluation and comparison is possible to find an adequate solution, but if you want to reach a single solution, it would need to know more detail of the production process to achieve a solution that encompass not only the most appropriate and convenient, but also one that can reduce costs, that is what every company is looking at after all.

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# List of abbreviations

| | |
|---|---|
| ADIF | Physical Distribution Warehouse |
| AENOR | Asociación Española de Normalización y Certificación |
| ASSCO | European Solid Board Organisation |
| CNC | Computer Numerical Control |
| DIN | Deutsches Institut für Normung |
| e.g. | exempli gratia (for example) |
| etc. | etcetera |
| FEFCO | European Federation of Corrugated Board Manufacturers |
| FIFO | First In, First Out |
| i.e. | id est (it is said) |
| IBC | Intermediate Bulk Container |
| ISO | International Organization for Standardization |
| LIFO | Last In, First Out |
| LNG | Liquefied Natural Gas |
| LP | Long Play |
| MSST | Maximum Safe Storage Temperature |
| UHT | Ultra High Temperature |
| UN | United Nations |
| UNE | Una Norma Española |

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# Eidesstattliche Erklärung

Hiermit versichere ich, die vorliegende Arbeit selbständig, ohne fremde Hilfe und ohne Benutzung anderer als der von mir angegebenen Quellen angefertigt zu haben. Alle aus fremden Quellen direkt oder indirekt übernommenen Gedanken sind als solche gekennzeichnet. Die Arbeit wurde noch keiner Prüfungsbehörde in gleicher oder ähnlicher Form vorgelegt.

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