ZELFSTUDIE: Chapter 8 – Transportation

Transport functionality

Transportation provides two major logistical services:

1. Product movement
2. Product storage

Product movement
= to move inventory to specified destinations throughout the supply chain

Transportation consumes:

- ✓ Time
- ✓ Financial resources
- ✓ Environmental resources

Transportation has e restrictive element because inventory is generally inaccessible during the transportation process.

In-transit inventory = inventory captive in the transport system

→ when designing logistical systems, manager strive to reduce in-transit inventory to a minimum

Transportation impacts environmental resources directly and indirectly:

- Directly: represents one of the largest consumers of fuel and oil in the US
- Indirectly: impacts the environment through congestion, air pollution and noise pollution

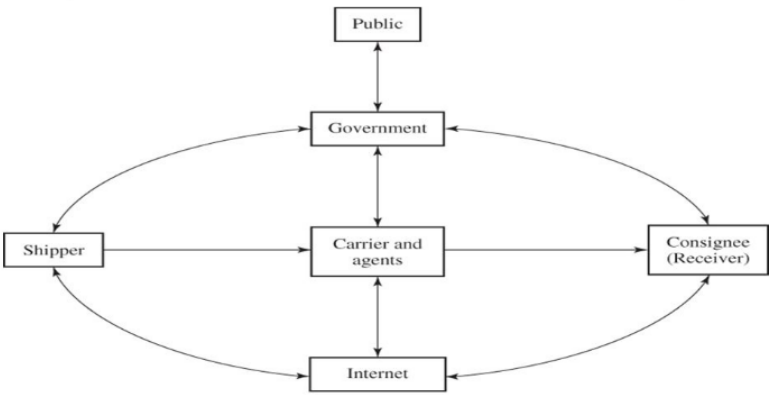
Product storage
= When a product is in a transportation vehicle, it is being stored

Diversion = occurs when the original shipment destination is changed after a product has been shipped. (while in transit, but before arriving the original destination) → total cost may be justified

Transport participants

Transportation decisions are influenced by sic parties:

1. Shippers (consignor)
   Completing a sale or purchase transaction (at lowest cost)
2. Destination party (consignee)
   Completing a sale or purchase transaction (at lowest cost)
3. Carriers and agents
   = a business that performs as a transportation service
   Want to charge their customers the highest freight rate possible while minimizing their costs
4. Government
   Critical importance of reliable service to economic and social well-being
   Desires a stable and efficient transportation environment to support economic growth.
5. Internet
   Ability to share real-time information with customers and suppliers
6. The public
   Concerned with transportation accessibility, expense and effectiveness as well as environmental protection, security and safety.



From regulation to a Free Market System

P 388 - specific regulations and acts are not to be known (daarom leg ik hier gewoon enkele begrippen uit)

ICC = Interstate Commerce Commission

MC 80 = Motor Carrier Act of 1980

Staggers Act = Staggers Rail act

STB = Surface Transportation Board

DOT = Department of transportation

ASA PATRIOT

C-TPAT = Customs-Trade Partnership against Terrorism

WTO = World Trade Organization

SSS = Short Sea Shipping

Cabotage laws = maritime law = trade from one port to another within the territorial limits of that nation

LTL = less-than-truckload

Transportation Modal Structure

Mode = a basic transportation method or form

Five basic transportation modes:

1. Rail
2. Truck (= motor carrier/highway)
3. Water
4. Pipeline
5. Air

(eventueel p391-p395 lezen voor extra achtergond van elke mode)

Enkele begrippen:

COFC = container-on-flatcar

NAFTA = North American Free Trade Agreement

ISPs = integrated logistics service providers

TL = truckload

LTL = less-than-truckload

UPS = United Parcel Service

	Fixed cost	Variable cost
Rail	High (for equipment, terminals, tracks etc.)	Low
Truck	Low (Highways in place and provided by public support)	Medium (fuel, maintenance, etc.)
Water	Medium (ships and equipment)	Low (capability to transport large amount of tonnage)
Pipeline	Highest (rights-of-way, construction, requirements for control stations, and pumping capacity)	Lowest (no labor cost of any significance)
Air	Low (aircraft and handling and cargo systems)	High (fuel, labor, maintenance, etc.)

Characteristics:

- Speed: elapsed movement of time → airfreight is the fastest
- Availability: the ability of a mode to service any given pairs of locations → highway carriers have the greatest
- Dependability: potential variance from expected of published delivery schedules → pipeline rank highest
- Capability: the ability of a mode to handle any transport requirement, such as load size → water transport
- Frequency: the quantity of scheduled movements → pipeline

Specialized transportation services

Transportation services can be improved by combining modes.

Prior to deregulation, government policy limited carriers to operating in a single mode. This to promote competition between modes and limit the potential for monopoly practices.

Overview of the current range of specialized services offered by different carriers:

1. **Package service**
   A serious problem existed in the availability of small-shipment transportation
   Overhead costs forced motor carriers to implement a minimum charge
   As a result, an opportunity existed for companies offering specialized service to enter small-shipment or package-service market

   The most recognizable carriers:
   FedEx Federal Express – **UPS** United Parcel Service – **USPS** United states postal Service

2. **Intermodal**
   Combines two or more modes to take advantage of the inherent economies of each and thus provide an integrated service at lower total cost.
   Piggyback service = integrated rail and motor service
   Best known and most widely used intermodal systems:
   TOFC = trailer on a flatcar
   COFC = container on a flatcar

   Fishyback, trainship, and containership are examples of the oldest form of intermodal transport. They utilize waterways, which are one of the least expensive modes for line-haul movement.
   Line-haul Movement of cargo between two major cities or ports, especially those more than about 1500 kilometers or 1000 miles apart.

   MARAD = Maritime Administration
   Land bridge = concepts that moves containers in a combination of sea and rail transport.
   (commonly between Europe and the Pacific Rim)

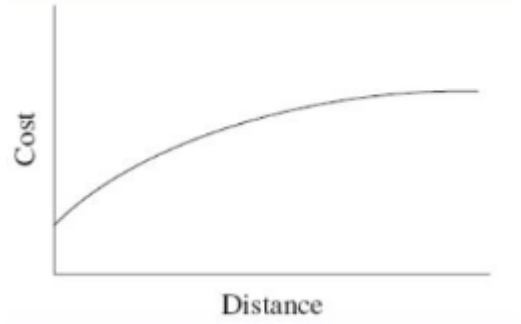
3. **Nonoperating intermediaries**
   Several businesses that do not own or operate equipment. They broker services of other firms.
   Find economic justification by offering shippers lower rates for movement between two locations than would be possible by direct shipment via common carrier.

   Freight forwarders = for-profit businesses that consolidate small shipments from various customers into a bulk shipment and then utilize a common surface or air carrier for transport.
   Shipper associations = they consolidate small shipments into large movements to gain cost economies. (voluntary nonprofit entities) Typically means improved speed of delivery.
   Brokers = intermediaries that coordinate transportation arrangements for shippers, consignees, and carriers. They typically operate on a commission basis.

Transportation Economics and Pricing

Are driven by multiple factors that influence rates (discussed from shipper's perspective):

1. **Economy of distance**
   Is a major influence since it directly contributes to variable expense, such as labor, fuel an maintenance.

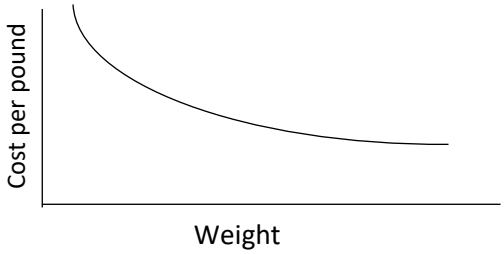


Doesn't begin at 0 because of fixed costs (shipment pickup and delivery regardless the distance)

Tapering principle = cost curve increases at e decreasing rate as function of distance

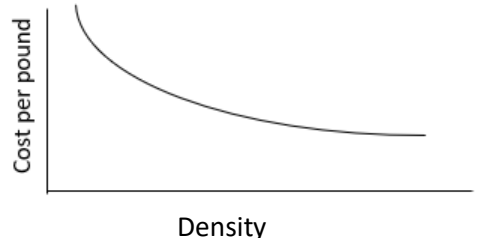
2. **Economy of weight**
   Transport cost per unit of weight decreases as load size increases. This occurs because the fixed costs of pickup, delivery, and administration are spread over incremental weight. This relationship is limited by the size of the transportation vehicle.

   Managerial implication: small loads should be consolidated into larger loads to maximize scale economies



3. **Economy if density**
   This is the combination of weight and volume. These are important since transportation cost for any movement is usually quoted in dollars per unit of weight.

   Higher-density products allow fixed transport costs to be spread across more weight



Declining transportation cost per unit of weight as product density increases

4. **Other pricing factors**
   Stowability = how product dimensions fit into transportation equipment.

   This is influenced by several factors:
   1. Handling costs
      Special handling equipment may be required to load and unload
   2. Liability costs
      Includes product characteristics that can result in damage.
   3. Market costs
      For example: Lane volume and balance
      Transport lane = movement between origin and destination points
      2 manieren op terug te keren: find a **back-haul laod** or return **deadheaded empty**

5. **Costing freight**
   = transportation costs are classified into 4 categories:
   1. Variable
      Change predictable in some level of activity
   2. Fixed
      Do not change in the short turn and must be paid, even when a company is not operating
   3. Joint
      Expenses created by the decision to provide a particular service
   4. Common
      Are incurred on behalf of all or selected shippers
      (often allocated to the number of shipments with a particular shipper)

6. **Pricing freight**
   = traditional pricing mechanics used by carriers

   a. Class rates
      Rate = price per hundredweight to move a specific product between two locations
      Tarrifs = rate listed on pricing sheets or on computer files
      Cass of rate = all products transported by common carriers are classified for pricing purposes

   b. Freight classification
      All product transported are grouped together into uniform classifications (takes into consideration the characteristics of a product of commodity that influence the cost of handling or transport)
      Rating = the particular class that is assigned to a product or commodity
      This is thus not the price, but just the characteristics in comparison to other commodities

   c. Rate determination
      One a classification rating is obtained for a product, the rate must be determined.
      Minimum charge = the amount a shipper must pay to make a shipment, regardless of weight
      Surcharge = an additional charge designed to cover specific carriers costs.

   d. Cube rates
      = density rates = replaces the 18 traditional freight classifications of the NMFC with five cube groupings
      Under the cube concept, shippers complete a cube shipping document (**CSD**) which replaces the traditional bill of lading. To further identify freight characteristics, shippers provide the total weight of both stackable (**ST**) and nonstackable (**NST**) freight included in the shipment.

   e. Commodity rates
      = used when a large quantity of a product moves between two locations on a regular basis
      This is without regard to classification and usually indicated in a contract between carrier and shipper (only on specific periods)

f. Exception rates
= published to provide lower than the prevailing class rates
The original purpose of the exception rate was to provide a special rate for a specific area, origin/destination, or commodity when justified by either competitive of high-volume movements. Rather than publish a new tariff, an exception to the classification or class rate was established.

Aggregate tender rate = utilized when a shipper agrees to provide multiple shipments to a carrier in exchange for a discount or exception from the prevailing class rate
Limited service rate = utilized when a shipper agrees to perform selected srvices typically performed by the carrier, such as trailer loading, in exchange for a discount

Common example: **shipper load and count rate**, where the shipper takes responsibility for loading and counting the cases
Another example: **released value rate**; which limits carrier ability in case of loss or damage

g. Special rates and services
= are available for use in logistical operations.

- **Freight-all-kind (FAK) rates**: important to logistics operations/
  A mixture of different products is transported under a negotiated rating
- **Local rate**: when a commodity moves under the tariff of a single carrier (= single-line rate)
  Joint rate: if more than one carrier is involved in the freight
- **Transit services**: permit a shipment to be stopped at an intermediate point between initial origin and destination for unloading, storage, and/or processing. The shipment is then reloaded for delivery to the destination
- **Diversion and reconsignment**: change routing, destination, or even consignee after a shipment is in transit.
  Diversion: changing destination prior to its arrival at the original destination
  Reconsignment: change in consignee prior to delivery
- **Split delivery**: desired when portions of a shipment need to be delivered to different destinations.
- **Demurrage**: charges assessed for retaining freight cars or truck trailers beyond specified loading or unloading time. Here by railroads for holding a railcar beyond 48 hours before unloading the shipment.
- **Detention**: charges assessed for retaining freight cars or truck trailers beyond specified loading or unloading time. Here to cover similar delays
- **Environmental services**: refer to special control of freight while in transit, such as refrigeration, ventilation and heating.
- **Special equipment charges**: refer to the use of equipment that the carrier has purchased for a shipper's convenience

Transportation management

(geen idee of dit eigenlijk echt belangrijk is, p412 – p414)

Generalized functionality of a TMS can be described in terms of 5 capabilities:

1. **Operational management**
   Key elements:
   - Equipment Scheduling and Yard management
   - Load planning
   - Routing and Advanced Shipment Notification (ASN)
   - Movement Administration

2. **Consolidation**
   Traditional approach to freight consolidation was to combine LTL or parcel shipment moving to general location

3. **Negotiation**
   Letterlijk wat we in Engels zagen

4. **Control**
   Tracing = a procedure to locate lost or late shipments
   Expediting = involves the shipper notifying a carrier that is needs to have a specific shipment move through the carrier's systems as quickly as possible
   FMCSA = Federal Motor Carrier Safety Administration
   HOS = hours of service

5. **Auditing and claims administration**
   When transportation service or charges are not performed as promised, shippers can make clams for restitution.
   Loss and damage claims = occur when a shipper demands the carrier to pay for partial or total financial loss resulting from poor performance (usually hen product is lost or damaged while in transit)
   Overcharge/undercharge = claims result when the amount billed is different from that expected and are typically resolved through freight bill audit procedures.

   Agreements stipulate the proper procedure for filing claims and help define which parties are responsible.

   The purpose of auditing is to ensure freight bill assurance.
   There are two types of freight audits:
   - **Preaudit** = determines proper charges prior to payment of a freight bill
   - **Postaudit** = makes the same determination after payment has been made.

   Auditing may be either internal or external
   - **External** = specialized freight-auditing companies are employed (more efficient) payment is usually based on a percentage of recovered overcharges. (crucial a highly ethical firm is be employed, because they deal with sensitive information, which need to be held in confidence)
   - **Internal** = the use of internal personnel (who may not have the same level of expertise

Documentation

A change of ownership occurs during transportation.

The three primary types of transport documentation:

1. **Bill of lading**
   = the basic document
   = is serves as a receipt and documents products and quantities shipped. For this reason, accurate product description and count are essential. In case of loss, damage, or delay, the bill of lading is the basis for damage claims.
   The information contained on the bill of lading determines all responsibilities related to timing and ownership.

   It specifies terms and conditions of carrier liability and documents responsibilities for all possible causes of loss or damage except those defined as **force majeure**

   In addition to the **uniform** bill of lading other commonly used types are:
   - **Order-notified (negotiable) bill of lading** = a credit instrument. It provides that delivery not be made unless the original bill of lading is surrendered to the carrier. (often send to third party, bank, who sends it when he got the payment)
   - **Export bill of lading** = permits a shipper to use export rates, which may be lower than domestic rates.
   - **Government bill of lading** = may be used when the product is owned by the US government
2. **Freight bill**
   Represents a carrier's method of charging for transportation services performed. It is developed by using information contained in the bill of lading.
   Prepaid bill = means that transport cost is paid by the shipper prior to performance
   Collect shipment = shifts payment responsibility to the consignee

3. **Shipment manifest**
   = lists individual stops or consignees when multiple shipments are placed on a single vehicle. Each shipment requires a bill of lading.
   The manifest lists the stop, bill of lading, weight and case count for each shipment
   The objective: provide a single document that defines to overall contents of the load without requiring review of individual bills of lading.
   For single-stop shipments is the manifest the same as the bill of lading.

Product pricing and transportation

Trend: **debundle** the price of products and materials so that services such as transportation, which were traditionally included in delivery price, become separate and visible items.

Two pricing methods:

1. **FOB Pricing**
   FOB = Free on board/ Freight on board
   A number of variations:
   - **FOB origin**: the simplest way to quote price. The seller indicates the price at point of origin and agrees to tender a shipment for transportation loading, but assumes no further responsibility the buyer selects the mode of transportation, chooses a carrier, pays transportation charges, and takes risk of in-transit loss and/or damage
   - **FOB destination pricing**: product ownership title does not pass to the buyer until delivery is completed. The seller arranges for transportation and the charges are added to the sales invoice. The firm paying the freight bill does not necessarily assume responsibility for ownership of goods in transit, for freight costs, or for filling of freight claims. These are issues of negotiation that are critical to supply chain collaboration

2. **Delivered pricing**
   = the seller establishes a price that includes transportation. (transportation is not a separate item)
   A number of variations:
   - **Single-zone delivered pricing**
     = buyers pay a single price regardless of where they are located. The typically reflect the seller's average transportation costs. This is mostly used when transportation costs are a relatively small percentage of selling price. The main advantage to the seller is the high degree of logistical control. For the buyer, despite being based on averages, such pricing systems have the advantage of simplicity

   - **Multiple-zone pricing**
     = establishes different prices for specific geographic areas. The underlying idea is that logistics cost differentials can be more fairly assigned when two or more zones – typically based on distance – are used to quote delivered pricing.

   - **Basepoint pricing system**
     = most complicated and controversial
     = the final delivered price is determined by the product's list price plus transportation costs from a designated base point, usually the manufacturing location. This point is used for computing the delivered price whether or not the shipment actually originates from the base location. This type is common in shipping assembled automobiles from manufacturing plants to dealers.
     (voorbeeld p418)

ZELFSTUDIE: Chapter 9 - Warehousing

Warehousing incorporates many different aspects of logistics operations

Strategic warehousing

Geschiedenis p 422.

Distribution center = strategic inventory assortment. Captures the dynamic development in traditional warehousing
JIT = Just-in-time

Economic benefits of warehousing occur when overall logistics costs are reduced.

Four basic economic benefits:

1. **Consolidation and break-bulk**
   = reduce transportation cost by using warehouse capability to increase size of shipments

   Consolidation = the warehouse receives inventory, from a number of sources, that are combined into a large single shipment to a specific destination. The benefits are the realization of the lowest possible freight rate, timely and controlled delivery and reduced congestion at a customer's receiving dock.
   Break-bulk operation = receives a single large shipment and arranges for delivery to multiple destinations. Here we have again a larger shipment. They sort of split the larger shipment into individual orders for customers delivery.
   (vb p424)

2. **Sorting**
   = reconfigure freight as it is being transported from origin to destination.

   Three types:
   - **Cross-docking** = combine inventory from multiple origins into a customized assortment to meet the needs of specific customer. It requires precise on-time delivery from each manufacturer
   - **Mixing** = usually performed at an intermediate location between shipment origin and destination. Carloads or truckloads of products are shipped from origin to mixing facilities. These inbound shipments are planned to minimize inbound transportation cost.
   - **Assembly** = support manufacturing operations. Products and components are assembled from a variety of second-tier suppliers at an assembly facility located in close proximity to the manufacturing plant. While manufacturing organizations have traditionally performed assembly, it has become common to utilize value-added services performed by an **integrated service provider (ISP)** to sort, and deliver components when needed in manufacturing.

   Voorbeelden p 426

3. **Seasonal storage**
   = to accommodate either seasonal production or demand. It provides an inventory buffer, which allows production efficiencies within the constraints imposed by material sources and consumers

4. **Reverse logistics processing**
   A great deal of the physical work related to reverse logistics is performed at warehouses.
   It includes the activities to support:
   (1) Returns management
   Facilitate the reverse flow of product that did no sell or to accommodate recalls
   (2) Remanufacturing and repair
   Facilitates the reverse flow of product following its initial use for revitalization.
   (3) Remarketing
   Many computer and electronics manufacturers use it to enhance their profits after initial leases are over. Remarketers use coordination and reverse flow to position and resell product when te original user no longer needs it.
   (4) Recycling
   Involves returning product following its useful life with the objective of decomposing it to its component materials so that they can be effectively reused.
   (5) Disposal
   When material cannot be effectively reused, it still may require reverse logistics for appropriate disposal.

   Controlled inventory consists of hazardous materials and product recalls that have potential customer health or environmental considerations. The reclamation bust be performed under strict operating scrutiny that prevents improper disposal. Several governmental agencies are directly involved:
   - **CPS** = Consumer Product Safety Commission
   - **DOT** = Department of Transportation
   - **EPA** = the Environmental Protection Agency
   - **FDA** = Food and Drug Administration
   - **OSHA** = Occupational Safety and Health Administration

Warehouses have <u>service benefits</u> in three ways:

1. **Spot-stocking**
   Typically used to support customer requirements. Instead of maintaining inventory in a warehouse year-round, or shipping to customers direct from manufacturing plants, responsiveness in peak selling periods can be enhanced through temporary inventory positioning in strategic markets. For example seasonal sales. After the season, the stock can be reduced or eliminated

   Temporarily warehouse a narrow product assortment in a large number of warehouses for a limited time period

2. **Full-line stocking**
   The traditional way is to stock product inventory combinations in anticipation of customer orders. Restricted to a few strategic locations and operates year-round

   They improve service by reducing the number of suppliers that a customer must logically deal with. The combined assortment also make economical larger shipments possible

3. **Value-added services (VAS)**
   Any work that creates a greater value of customers. They typically change the physical features of configuration of products so they are presented to customers in u unique or customized manner.
   Brights = cans without a label
   Holding inventory as brights = a product is not committed to specific customers or carton configuration during initial manufacturing or processing

   Once a specific customer order is received, the warehouse can complete labeling and finalize packaging. Postponement provides two economic benefits:

   1) Risk is minimized because customized packaging is not performed in anticipation or customer orders or to accommodate a forecast
   2) Total inventory can be reduced by using inventory of the base product to aggregate demand across multiple customer's requirements.

<u>Warehouse Operations</u>

Consist of handling and storage.

Handling

Movement continuity = it is better using handling equipment to perform longer moves than to undertake a number of short handlings to accomplish the same overall inventory move

The three primary handling activities:

1. Receiving
   = unloading

2. In-storage handling or transfer
   = inventory movements performed within the warehouse.
   Two types:
   - Transfer
   - Selection

   RFID = radio-frequency identificatory = emerging technology = holds substantial promise in the area of warehouse layout, receiving, order selection and shipping. It has great potential to improve operational efficiency

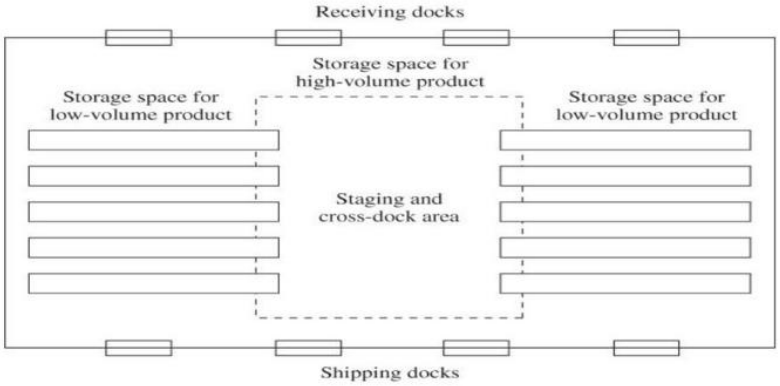
3. Shipping
   = consists of order verification and outbound transportation equipment loading.

Storage

= products to be assigned specific locations, calls **lots**, on the basis of individual characteristics.

- Velocity = major factor driving warehouse layout
- Weight
- Special storage requirements

High-volume product should be positioned in the warehouse to minimize movement distance, etc.



A typical warehouse is engaged in a combination of active and extended product storage alternatives.

1) Active storage
   = warehouses that directly serve customers
   Must provide sufficient inventory to meet the forecast demand of the service area

   This includes **flow-through or cross-dock distribution**, which uses warehouses for consolidation and assortment while maintaining minimal or no inventory in storage.
   Most appropriate for high-volume, fast-moving products where quantities are reasonably predictable
   It does require that the product be quickly unloaded, de-unitized,…

2) Extended storage
   = for speculative, seasonal, or obsolete inventory and for a longer time than required for normal customer stock.
   Uses handling processes and technologies that focus on maximum space utilization with minimal neer for quick access.

<u>Warehouse ownership arrangements</u>

Private warehouse
= is operated by the enterprise that owns the merchandise handled and stored in the facility. (building owned/leased)
Major benefits: control, flexibility, cost and range of intangibles
They are relatively fixed and difficult to change because buildings have to be constructed, expanded as necessary and sold when no longer acquired

Public warehouse
= is operated as an independent business offering a range of for-hire services, such as storage, handling and transportation. Generally offer a menu of relatively standardized services to customers. (short or longterm)

Traditionally classified based on operational specialization:
(1) General merchandise
    Designed to handle package products
(2) Refrigerated
    Frozen or cooler capacity designed to protect food, medical,…
(3) Special commodity
    Designed to handle bulk material or items requiring special handling such as tires or clothing
(4) Bonded
    are licensed by the government to store goods prior to payment of taxes of import/export duties.
(5) Household goods and furniture
    Specialize in handling and storing large, bulky items such as appliances and furniture

They provide flexibility and shared services benefits
From a financial perspective, they may be able to achieve lower operating costs than private facilities. Due to lower wage scales, better productivity and shared overhead among clients.

Public warehouse typically do not require capital investment on the part of their customers.
They also offer flexibility concerning size and number of warehouses, thus allowing user to respond to supplier, customer and seasonal demands
They have the potential to share scale economies since the combined requirements of users can be leveraged. This spreads fixed costs and may justify investments in state-of-the-art handling equipment.

Major benefits: variable cost, range of services and flexibility

A public warehouse charges clients a basic fee for in and out handling plus storage.
In the case of handling, the charge is assessed on the cases or pounds moved
For storage, the charge is assessed on the cases or weight in storage over time
Special or value-added services are typically priced on a negotiated basis.

Contract warehousing
= a customized extension of public warehousing, combines the benefits of private and public warehousing. It is a long-term business arrangement that provides unique or tailored logistics services for a limited number of customers.
A long-term contractual relationship will typically result in lower total cost than a public warehouse

One integrated service provider (ISP) may own and operate facilities in multiple key manufacturing or distribution locations. Thus, one provider may be able to meet a customer's requirements in a combination of markets. At the same time, contract warehouse operations can provide benefits of expertise, flexibility, scalability and economics of scale by sharing management, labor, equipment and information resources across multiple clients.

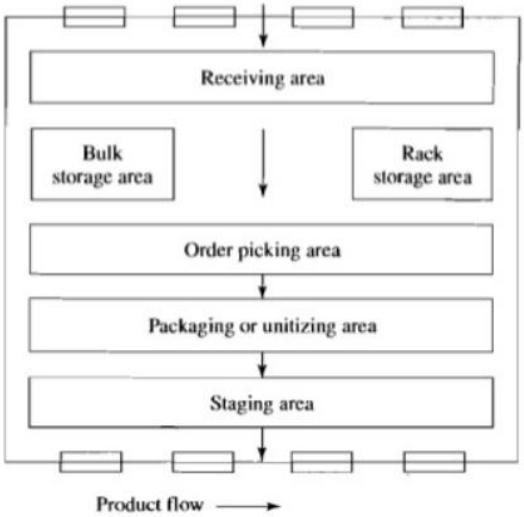
<u>Warehouse decisions</u>

1 Site selection
= location
After a location is determined, a specific building site must be identified.
The factors driving site selection are: service availability & (land) cost.

Beyond procurement cost, setup and operating expenses such as transport access, utility hookups, taxes and insurance rates require evaluation. There must also be adequate room for expansion, utilities must be available, …

2 Design
Must consider product movement characteristics. Three factors:

1. Number of floors to include the facility
   Ideal warehouse design: one-floor building that eliminates the need to more product vertically
2. A cube utilization plan
   Must maximize cubic utilization
3. Product flow
   Warehouse design should facilitate continuous straight product flow through the building.



3 Product-mix-analysis
The design and operation of a warehouse are both dependent on the product mix

4 Expansion
Should be considered during the initial planning phase. It is common to establish 5 to 10 year expansion plans. Building design should also accommodate future expansion

5 Handling
This is the basic driver of a warehouse design. It is important that the handling system must be selected early in the warehouse development process.

6 Layout
Should be planned to facilitate product flow. The layout and handling system are integral.
Slotting = the placement of specific products in selected pallet locations (voorbeeld p438)
Selection/Picking area = products positioned in a specific area of the warehouse for order selection
Storage area = when products are received, they are palletized and moved into the storage area
(voorbeeld p438)

7 Sizing
There are several methods. Each method begins with a projection of the total volume expected to move through the warehouse during a given period. The projection is used to estimate base and safety stocks for each product to be stocked in the warehouse

Warehouse Management Systems (WMS)
= training warehouse personnel. This to standardize work procedures and facilitate best practice.
Main uses: coordinate order selection. This with two basic methods:

1. Discrete selection
   A specific customer's order is selected an prepared for shipment as the work assignment. Often used when order content and handling selection are critical
2. Wave selection = bath selection
   Can be designed and operationalized in a variety of ways.
   - Can be coordinated by an area of warehouse wherein all quantities of all products required to complete all customer orders are selected at one time. Here, employees are typically assigned responsibility for a specific portion of the warehouse
   - Can also be planned around a specific shipment destination and/or carrier. This because each employee has a thorough knowledge of a specific warehouse selection area of shipping procedure, fewer selection errors typically result using wave picking.

WMS also coordinates work procedures that are important for receiving and shipping. Personnel must have knowledge of trailer loading practices

TMS = transportation management system

Table 10.2 WMS Functionality and Decision Support

Selected Functionality	Decision Support Benefits
Put-away	Improved productivity and cube utilization.
Task interleaving	Routing of fork trucks on demand as contrasted to predetermined assigned tasks, areas, or sequences.
Pick/replenishment	Direct picking from single or multiple locations including pick to assure expiration date compliance. Facilitates replenishment of pick location inventories when appropriate.
Slotting	Variable slot or product placement locator assignment to enhance space utilization.
Cross-docking	Facilitate direct receipt to shipment flow.
Inventory visibility	Tracking specific inventory lots by warehouse location as well as daily visibility of receipts. Date specific lot control.
Work queue resolution	Identification of alternative ways to rapidly or efficiently resolve work constraints or queues.
Picking strategy	Routines to perform selected picking strategies.
Error correction	Ability to identify, resolve, and correct data errors in real time.
	Ability to identify and resolve differences in purchase orders or advanced shipment notifications (ASN) and actual quantities or product received.
Simulations	Performance of real-time decision support scenarios to assist in operational decision making.
Return goods	Facilitate processing and audit compliance for reverse logistics programs.
Cycle counts	Ability to conduct and resolve real-time inventory counts.

Yard Management Systems (YMS)

Couples the warehouse with inbound and outbound transportation equipment. This by arranging dock appointments for receiving ordered merchandise and transportation equipment for shipping outbound

The YMS is as the software that links and coordinates transportation TMS with the warehouse WMS.

Accuracy audits

WMS functionality requires verification of inventory accuracy to maintain operational effectiveness. This is typically maintained by annual physical inventory counts or by counting specific portions of the inventory on a planned basis.

Cycle counting = is the audit of selected inventory on a cycle schedule.

Audits related to inventory accuracy are only one type of audit that is typically used to maintain and improve warehouse operating efficiency. Audits are also common to maintain safety, assure compliance to security regulations, drive procedural improvement, and facilitate work changes.

Security

= protection against merchandise pilferage, deterioration and any form of operational disruption.

1. Pilferage
   Protect against theft by employees and thieves as well as from riots and terrorist-related disturbances. Inventory control and order processing systems help protect. (voorbeelden p442-443)

2. Damage
   Most obvious form of deterioration is damage from careless handling. Another form is incompatibility of products stored or transported together (voorbeeld p443)

Safety an Maintenance

Accident prevention is a concern. A comprehensive safety program requires constant examination of work procedures and equipment to locate and take corrective action to eliminate unsafe conditions before accidents result.

ZELFSTUDIE: Chapter 10 – Packaging and handling

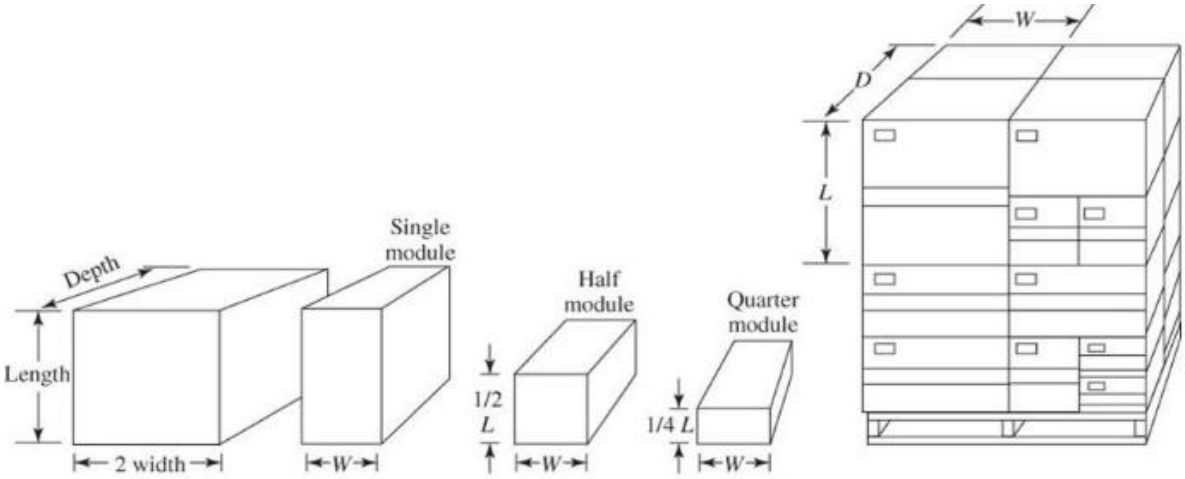
Packaging perspectives

Packaging is typically viewed as being either consumer, focused primarily on marketing, or industrial, focused on logistics.

Primary concern: industrial package design

Master cartons = containers used to group individual products
Containerization/unitization = cartons grouped into larger units for handling
Unit load = when multiple master cartons are grouped together for handling the composite

A prime objective in logistics is to design operations to handle a limited assortment of standardized master cartons. (voorbeeld p447)
However, the most important point is that master carton standardization facilitated supply chain integration. Naturally, few organizations can reduce their master carton requirements to one size fits all. When master cartons of more than one size are required, extreme care should be taken to arrive at an assortment of compatible units.



Utilizing four standard master carton sizes, that achieves modular compatibility.

Of course, logistical considerations cannot fully dominate packaging design. The ideal package for materials handling and transportation would be a perfect cube having equal length, depth and with, while achieving maximum possible density. Seldom will such a package exist. The important point is that logistical modularity should be evaluated along with manufacturing, marketing and product design considerations in finalizing master carton selection.

Another logistical packaging concern is the degree of desired protection. Package design and material must combine to achieve the desired level of protection without incurring the expense of overprotection.
Arriving at a satisfactory packaging solution involves defining the degree of allowable damage in terms of expected overall conditions and then isolating a combination of design and materials capable of meeting those specifications

For package design, there are two key considerations:

1. The cost of absolute protection will, in most cases, be prohibitive
2. Final package construction will be a blend of protection and handling considerations.

A final logistics packaging consideration is the relationship between the master carton size, order quantity and retail display quantity.

The four most common causes of product damage in a logistical system are vibration, impact, puncture and compression

Packaging for handling efficiency

Handling efficiency is significantly influenced by these three:

1 Package design

Product packaging in standard configuration and order quantities facilitates logistical efficiency.
Cube minimization is most important for lightweight such as assembled lawn furniture that **cubes out** a transport vehicle before weight limits are reached. On the other hand, heavy products like steel ball bearings or liquid in glass bottles specially **weight out** transport vehicles before cube capacity is filled. When a vehicle or container weights out, the firm ends up shipping empty cube space that can't be filled with product.

2 Unitization (= containerization)
= the process of grouping master cartons into one physical unit for materials handling of transport.
The concept includes all forms of product grouping, from taping two master cartons together to the use of specialized transportation equipment.

All types of unitization have the basic objective of increasing handling and transport efficiency.
Many benefits:

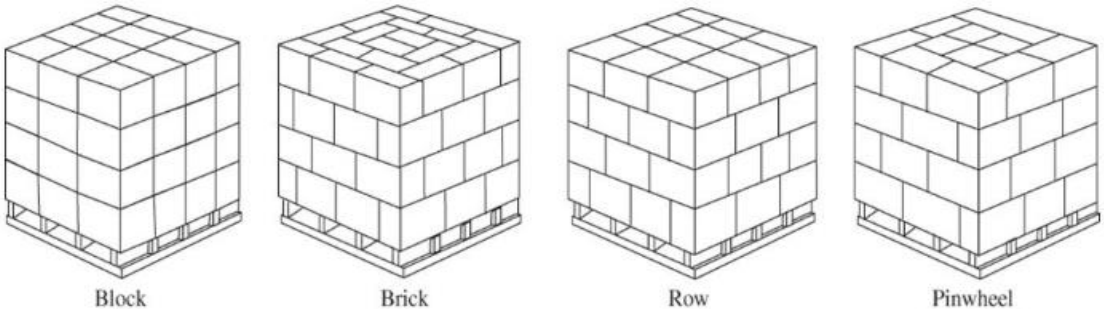
1) Unloading time and congestion at destination are minimized
2) It facilitated handling (1/5 of time need for manual (un)loading
3) Inbound shipments verification simplified as receipts can be bar coded
4) Inventory can be positioned rapidly in warehouses for order selection
5) In-transit damage is reduced by unit load shipping

Unitization devices that fit within de capacity of standard transportation equipment:

- Rigid devices
  = provide an enclosure within which master cartons of loose products are unitized.
  The premise is that placing products inside a sealed container will both protects them and facilitate handling.

  Benefits:
  - Improves overall material movement efficiency
  - Reduces damage in handling and transit
  - Reduces pilferage
  - Reduces protective packaging requirements
  - Provides greater protection from environmental elements
  - Provides a shipment unit that can be reused a substantial number of times, thereby reducing waste and need to dispose of container

- Flexible devices
  = no not protect a product by complete enclosure.
  Most common type of nonrigid unitization is umtyaton stacked master cartons on either **pallets or slipsheets.**
  Advantage slipsheet: cost and weight



  The use of flexible unitization can increase damage potential if it is not properly contained during handling or transport.

3 Communication = information transfer

The most obvious communication role is identifying package content for all channel members.
Typical information includes:

- Manufacturer
- Product
- Count
- UPC = universal product code
- EPC = electronic product code

And may be communicated using bar code or RFID technology

Package tracking is critical for effective internal operations. Bus also for customers, who want to track their onw package.

Handling

Some basic handling considerations and alternative system solution:

1 Basic handling considerations

Logistical handling occurs throughout the supply chain.

- The handling of bulk materials: includes situations wherein the products is handled without first being placed in master cartons. Specialized equipment is required for handling bulk products such as solids and pellets (by using pipelines of conveyers)
- Nonbulk handling wherein products are shipped in master cartons. Four possible systems:

- **Mechanized Systems**
  = a combination of labor and handling equipment is utilized to facilitate receiving, processing and/or shipping. Generally, labor constitutes a high percentage of the overall cost. This system is most common

  Most common used types of equipment:
  - Lift trucks = forklifts
    Can move master cartons both horizontally and vertically but are limited to handling unit loads.
    (extra info p454)
  - Towlines
    In-floor or overhead-mounted cable or drag devices
    Utilized to provide continuous power of four-wheel trailers.
    Main advantage: continuous movement (but far less flexible as lift trucks)
    (extra info p 454)
  - Tractor Trailers
    A driver-guided power unit towing one or more four-wheel trailers.
    Man advantage: flexibility (not so economical, each tow unit requires a driver)
  - Conveyers
    Used widely in shipping and receiving operations and serve as basic handling device for number of order selection systems
    (extra info p455)
  - Carousels
    Moves inventory to the order selector
    Consists of a series of bins mounted on an oval track or rack
    (extra info p455)

- **Semiautomated Systems**
  = a combination of mechanical and automated systems is used to handle material.
  Typical equipment utilized:
  - Automated Guided Vehicles (AGV)
    Typically replaces mechanized tow tractors and trailers.
    They are automatically routed, positioned, and activated without a driver
    (extra info p455)
  - Sortation
    Typically used in combination with conveyers
    Two primary benefits: a reduction in labor + significant increase in speed and accuracy of order selection
    (extra info pp456)
  - Robotics
    A machine that can be programmed to perform one or more handling activities without intervention of an attendant or driver.
    Economic justification of robotics:
      (1) Space limitation
      (2) Faster order to delivery cycle time requirements
      (3) Predictable and substantial throughout volume
      (4) High labor costs
      (5) Restrictive work environments such as frozen food warehouse order selection

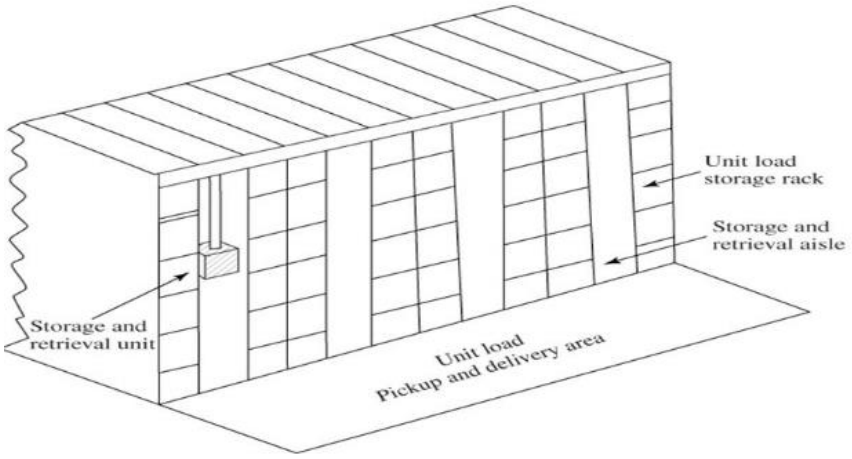
    (extra info p456 – 457)
  - Live Racks
    A device commonly used to reduce manual labor in warehouses
    Product automatically flows to selection position
    Contains roller conveyers and is constructed for loading from the rear
    Significant benefit: the potential for automatic rotation of product as a result of rear loading (FIFO)
    (extra info p457)

- **Automated Systems**
  = attempt to minimize labor a much a possible by substituting equipment capital investment.
  Focus on automated high-rise storage and retrieval systems
  Primary barriers: high capital investment + low degree of flexibility

  - Potential to automate
    The appeal for automation is that it substitutes capital equipment for labor. And it operates faster and more accurately with less product damage than its mechanized counterpart.
    A major disadvantage of automation: its dependency on proprietary information technology networks. To reduce such dependency, newer automated systems are being hosted by cloud computing resources.

  - Order selection
    Een hele uitleg over een order selection device. P458-459

  - Automated storage/retrieval (AS/RS)
    = an automated unit-load handing system, using high-rise storage



    Typically automated from receiving to shipping
    Because humans are not an integral part of AS/RS, these facilities are often referred to as **lights-out** facilities.

    The four primary components:

    (1) Storage racks
        The initial function of the storage and retrieval equipment is to reach the desired storage location rapidly. A second function is to insert or remove merchandise from the rack.

    (2) Storage and retrieval equipment
        The storage and retrieval machine is essentially a combined lift truck an pallet holder built into a movable crane. It moves up and down the aisle to insert or remove a unit load from a storage bin.
        Numerous transfer arrangements and layouts have been developed. Transfer units may be dedicated or nondedicated.
        - **Dedicated transfer car** = is always stationed at the end of the aisle in which the storage and retrieval equipment is working .
        - **Nondedicated transfer car** = works a number of aisles and retrieval machines on a scheduled basis to achieve maximum equipment utilization.

(3) input/output system
is concerned with moving loads to and from the rack area.
Two types of movement are involved:
- Loads must be transported from receiving docks or production lines to the storage area.
- Within the immediate peripheral area of the racks, loads must be positioned for entry or exit

P/D = picking and discharge station

(4) Control system
Similar to the automated order selection systems described earlier. In addition, it handles inventory control and stock rotation. Is also tracks product location within the AS/RS, storage bin utilization and crane operation.

(extra info p459-460)

- **Information-Directed Systems**
= uses information technology to direct mechanized or automated handling equipment.

Three common examples of information-directed materials handling systems:

(1) RF Wireless (Wi-Fi)
Uses standardized materials handling equipment coordinated by information technology to provide operator directions and control in real time.
The basic use of Wi-Fi to instruct movement of lift trucks is expanded in an information-directed application to become a highly integrated materials handling system.

Main advantage: to improve speed and flexibility of lift truck operations.
Real-time communication to central data processing systems.

Task interleaving = the process of assigning lift trucks to continuous assignments
(extra info p461)

(2) Radio-Frequency Identification RFID
Creates the opportunity for two-way communication between specific products and lift truck operators.
Can identify the exact location in the warehouse.

Chaotic design = build on the flexibility of using RFID technology to allow a warehouse to be stocked an operated to maximize inbound and outbound movement efficiency.
(extra info p461-462)

(3) Light-directed operation (LDO)
= **pick-to-light**
Applications is a carrousel system variation that is becoming increasingly common.
Order selectors pick designated items directly into cartons or onto conveyers from lighted carousel locations or storage bins. A series of lights or **light tree** in front of each pick location indicates the number of items to pick from each location.
A variation of the pick-to-light system is **put-to-light**, where order selectors place product in lighted containers. Each container or tote is assigned to a specific order or customer, so the light is telling which customers are the receive a specific product.

2 Special handling considerations

Primary mission of handling = to facilitate flow in an orderly and efficient manner from manufacturer to point of sale.

Special considerations important so selection and operation of materials handling equipment:

- E-fulfillment
  (1) To serve end customers, an e-fulfillment facility typically must process a large number of very small order. This means that it is difficult to achieve any substantial economies of scale for picking operations.
  (2) E-fulfillment facilities must generally deal with a wide range of product, which translates to large inventories and the use of flow-through practices to consolidate orders for shipment. Firms electing to consolidate orders must have the capability to effectively receive and merge a large number of very small orders rapidly.
  (3) Increased consumer expectations regarding shipment information require many activities within the warehouse and with the carrier be electronically scanned and tracked/

  In many cases, these e-tailers are outsourcing fulfillment to integrated service providers (ISP)

- Environmental Concerns
  Increased concern regarding environmental impact of packaging and handling
  Also increasing interest regarding the handling and disposal of hazardous materials used or stored in warehouse operations
  Firms have to ensure that such materials are disposed of properly to avoid pollution liability

- Regulatory Environment
  Warehouse is one of the most labor-intensive operations
  It is also one of the most dangerous as numerous injuries occur annual
  (extra info p463)

- Returns processing
  Merchandise may be recalled by or returned to a manufacturer
  Normally such reverse logistics is not of sufficient quantity or regularity to justify unitized movement, so the only convenient method for processing reverse flows of merchandise is manual handling.
  Many firms are choosing to have returns processed by an integrated service provider to separate flows and reduce the chance for error or contamination.