



Chapter 2

Logistics – Basic Concepts & Characteristics

COUrier Routing through Innovative Emulation Learning program



Contents

1. OVERVIEW OF SUPPLY CHAIN
2. LOGISTICS DECISION MAKING
3. LOGISTICS SYSTEM DESIGN & PLANNING
4. DISTRIBUTION NETWORKS
5. TRANSPORTATION



Origin of Logistics

- ❑ The concept of “**Logistics**” started many years before Christ and was used by Greek generals (Leon the Wise, Alexander the Great) in order to describe all the procedures for the army’s procurement on food, clothing, ammunition, etc.
- ❑ Alexander the Great was a big fan of the mobility of his troops and he didn’t want his troops to stay in one place waiting for supplies from Macedonia. Thus, he tried to resolve the issues of supplies by using supplies from the local resources of his defeated enemies.
- ❑ For many years, logistics were always an issue in war affairs. Kingdoms and generals with strategic planning on logistics were those who won the war.
- ❑ World War II was the major motivation of logistics to increase recognition and emphasis, following the clear importance of their contribution toward the Allied victory.
- ❑ Starting from the early ‘60s, many factors, such as deregulation, competitive pressures, information technology, globalization, profit leverage, etc., contributed to the increase of logistics science in the form we now it today.

The Scope of Logistics in Business

Logistics / Supply Chain in a business aim to the following contributions:

- Achieve maximum customer service level
- Ensure high product quality
- Achieve minimum (possible) cost
- Be flexible in the constant market changes

Logistics management tries to have the “right product”, in the “right quantity”, at the “right place”, at the “right time”, with the “right cost”

Logistics management must balance 2 basic targets:

- Quality of Service
- Low Cost



What is Logistics (Defining Logistics)

One quite widely accepted view shows the relationship as shows:

Logistics = Supply + Materials management + Distribution

Lately, a more scientific definition was used :

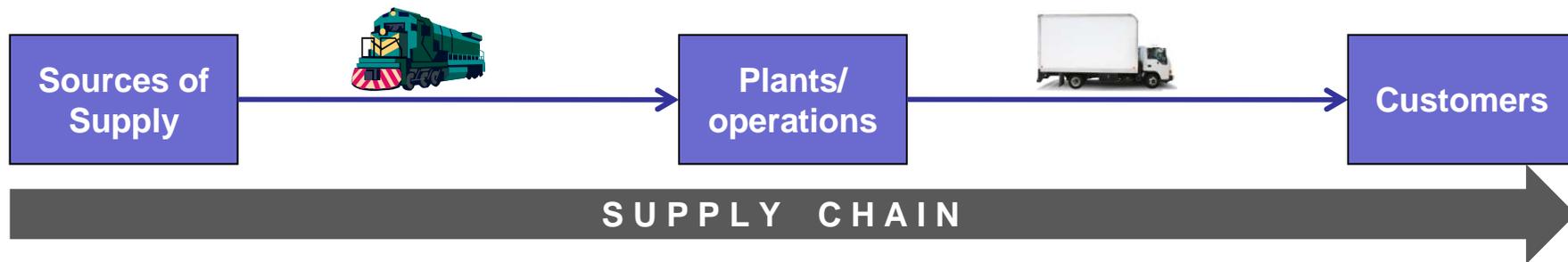
Logistics is the . . .

“process of planning, implementing, and controlling the efficient, effective flow and storage of goods, services, and related information from point of origin to point of consumption for the purpose of conforming to customer requirements.”

Council of Logistics Management

What is Supply Chain Management

The *'supply chain'* encompasses all activities associated with the flow and transformation of goods from the raw materials stage to the end user (along with the associated information flow).

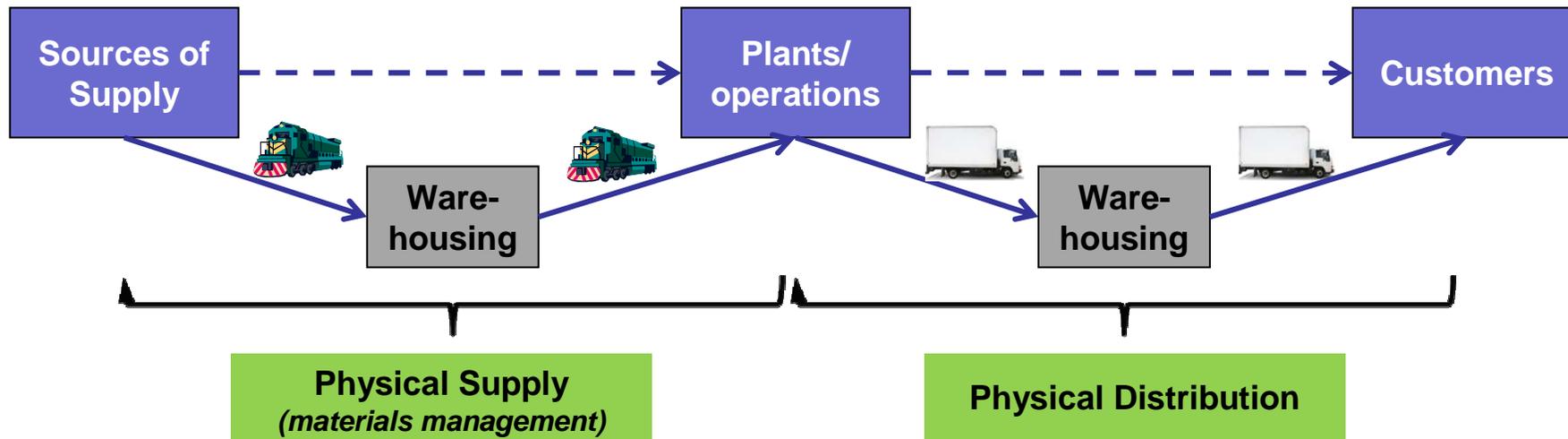


Supply Chain Management is the...

“integration of these activities, through improved supply chain relationships, to achieve a sustainable competitive advantage”

Robert B. Hanfield & Ernest L. Nichols Jr., Introduction to Supply Chain Management

Supply & Distribution Logistics



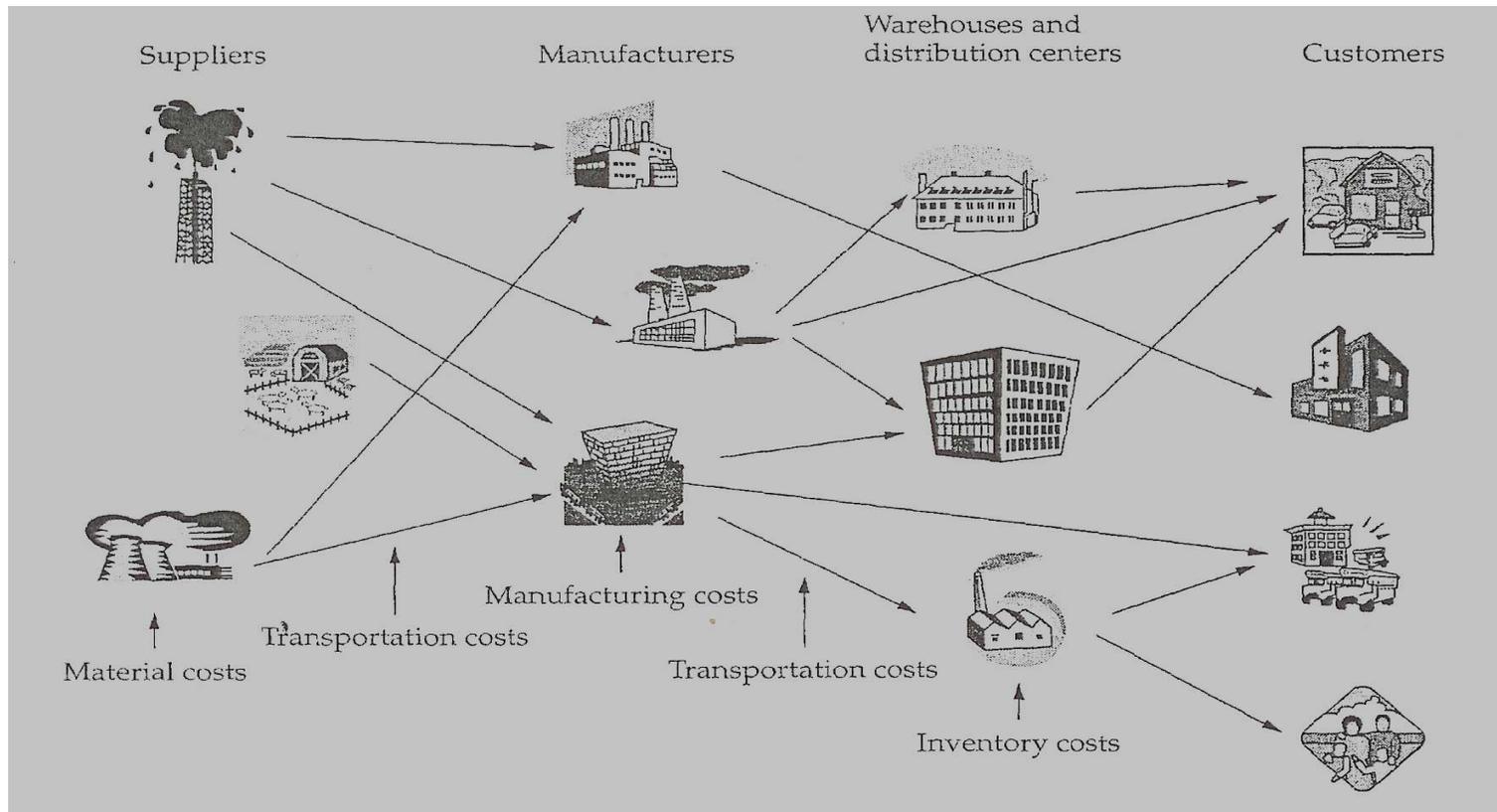
- ❑ The '*physical supply channel*' refers to the time and space gap between a firm's immediate material sources and its processing points.
- ❑ The '*physical distribution channel*' refers to the time and space gap between a firm's processing points and its customers

Four (4) KEY PLAYERS

1. Suppliers - Vendors
2. Manufacturers
3. Wholesalers (& Retailers)
4. Customers



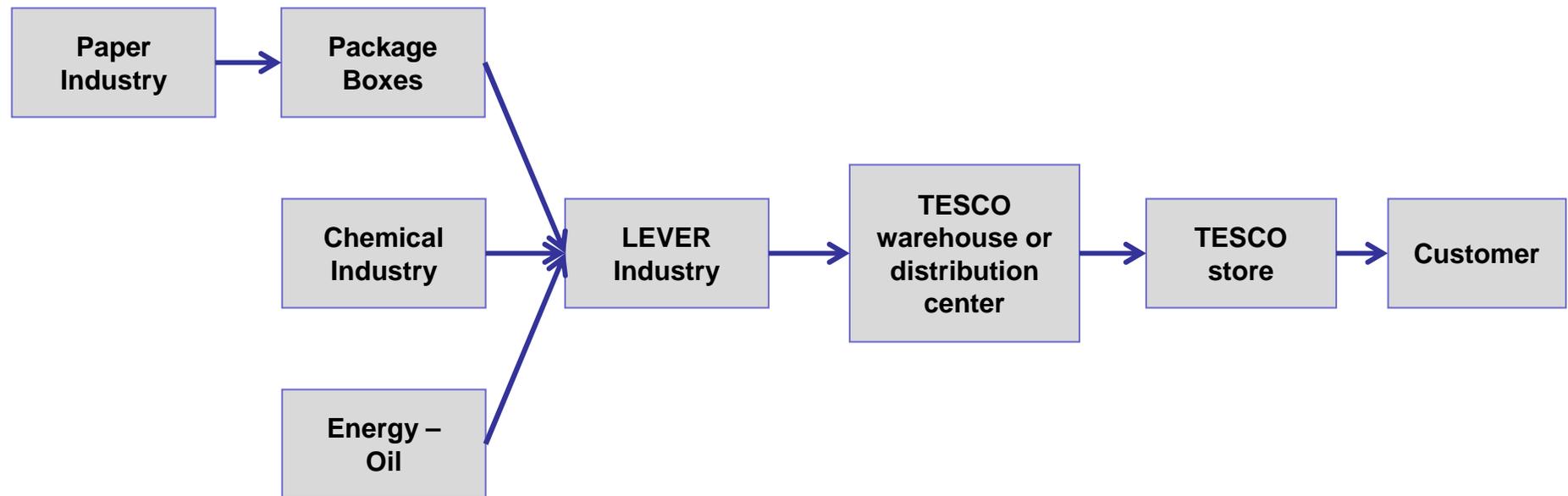
The Supply Chain



The Supply Chain – An example



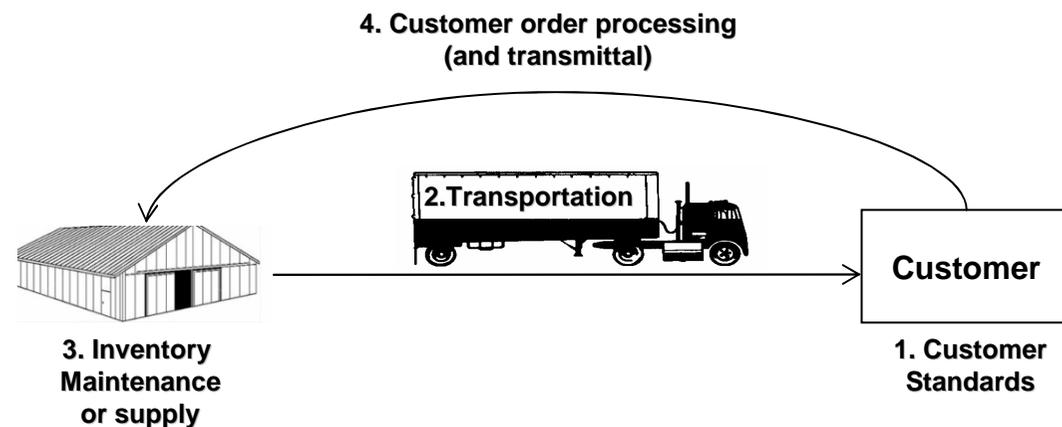
Example for TESCO supermarkets



Key components of Logistics – Key activities

- The logistics activities can be classified into a) core and b) supporting
- The core activities take place in every supply channel (as can be seen from the figure).
- They contribute the most to the total cost of logistics or they are essential to the effective coordination and completion of the logistics task.
- These are mentioned below:

1. Customer service (typically defined by marketing)
2. Transportation
3. Inventory management
4. Information flows and order processing



Source: Ballou H. Ronald, Business Logistics/Supply Chain Management, 5th Edition

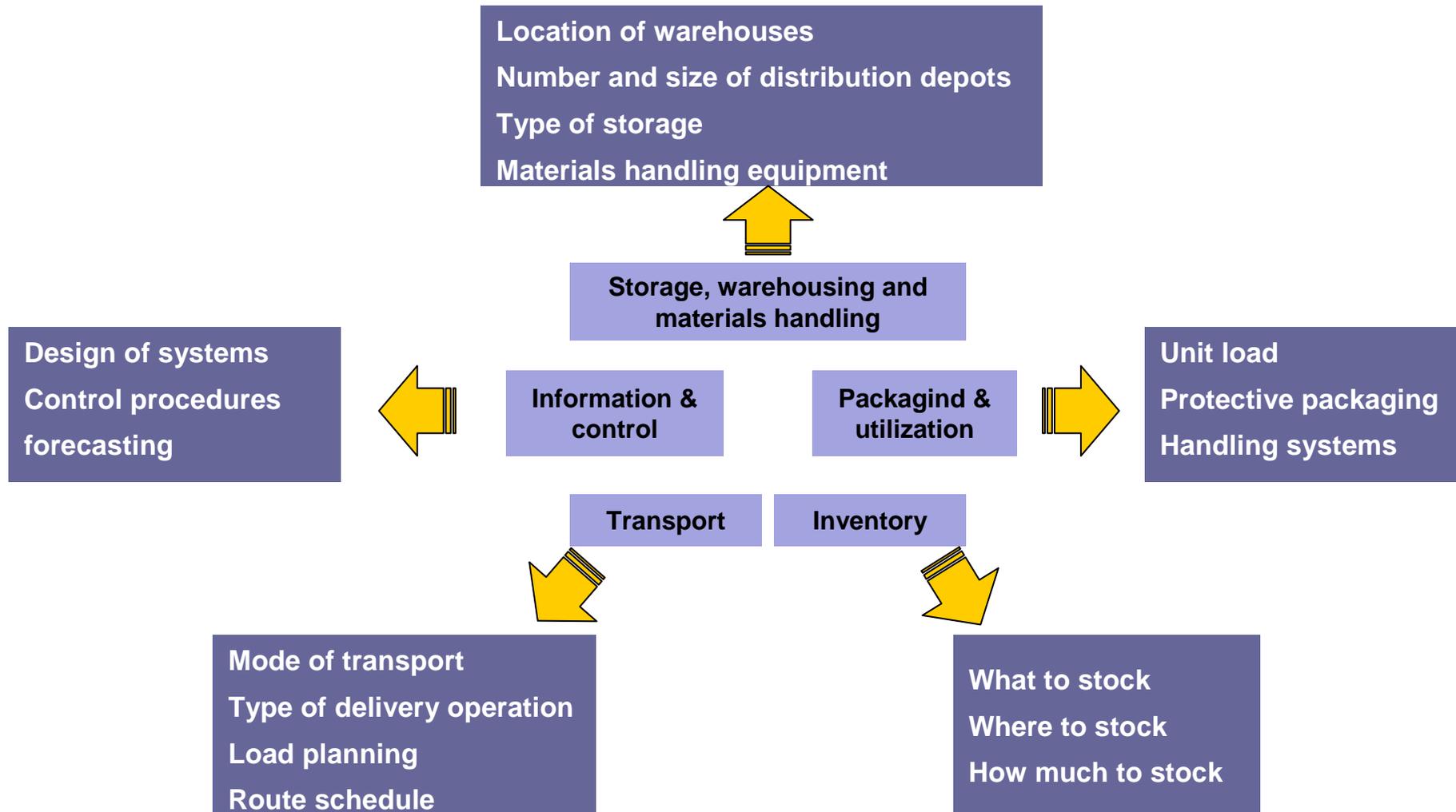
Key components of Logistics – Support activities

- Support activities vary from company to company
- A comprehensive list includes:
 1. **Warehousing** (Space determination, stock layout, configuration, stock placement)
 2. **Materials handling** (equipment selection & replacement policies, order-picking procedures, stock storage & retrieval)
 3. **Purchasing** (supply source selection, purchase timing, purchase quantities)
 4. **Protective packaging** (designed for handling, storage, protection from loss/damage)
 5. **Cooperate with production/operations** (specify aggregate quantities, sequence & time production output, schedule supplies)
 6. **Information maintenance** (info collection, storage & manipulation, data analysis, control procedures)

Source: Ballou H. Ronald, Business Logistics/Supply Chain Management, 5th Edition



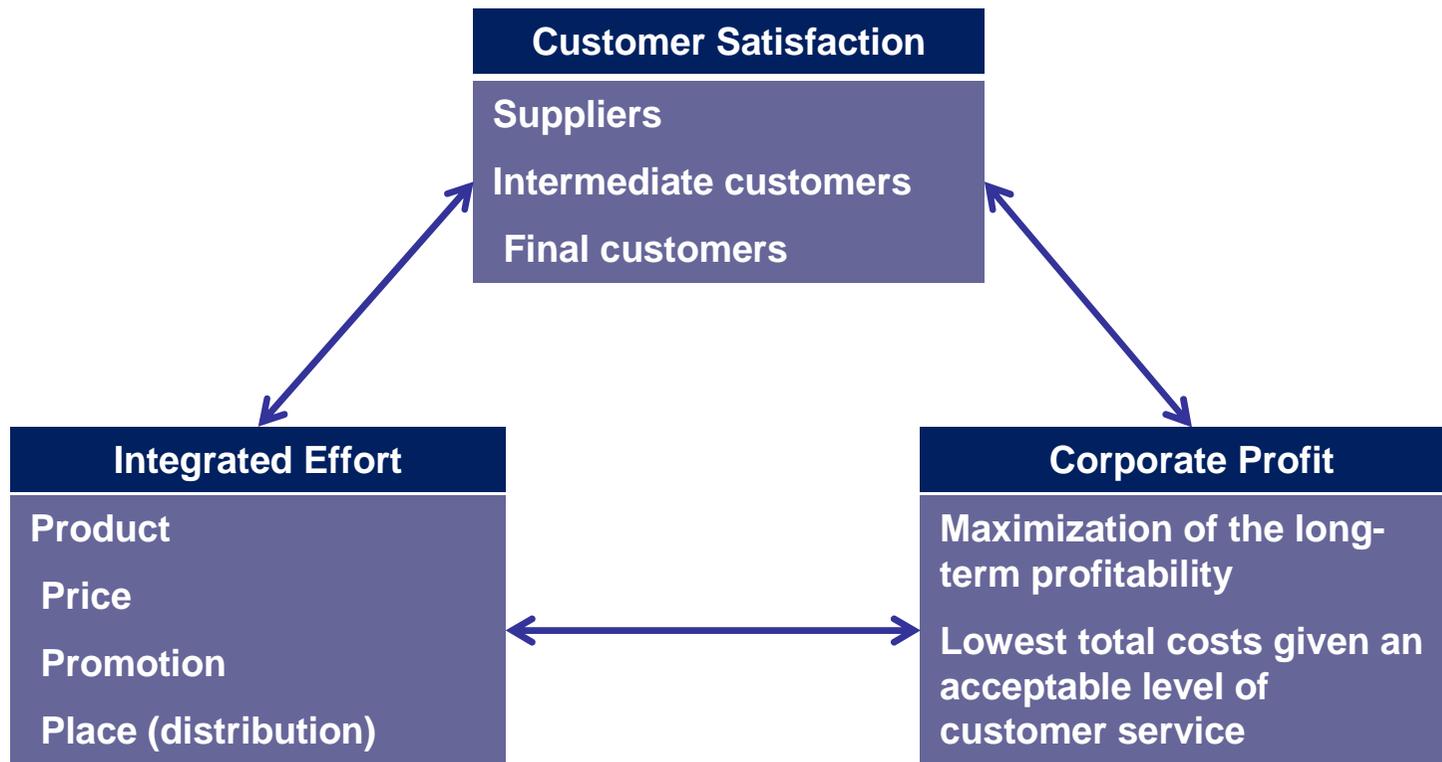
Key components of Logistics – Illustrative



Source: Rushton, A., Croucker P., Baker P., The handbook of logistics & distribution management, 3rd Edition

The Role of Logistics in an Organization

Logistics in an organization are considered as a continuation of marketing. Logistics play a critical role in each of the three critical elements of the marketing concept (customer satisfaction, integrated effort/systems approach and corporate profit) in several ways.



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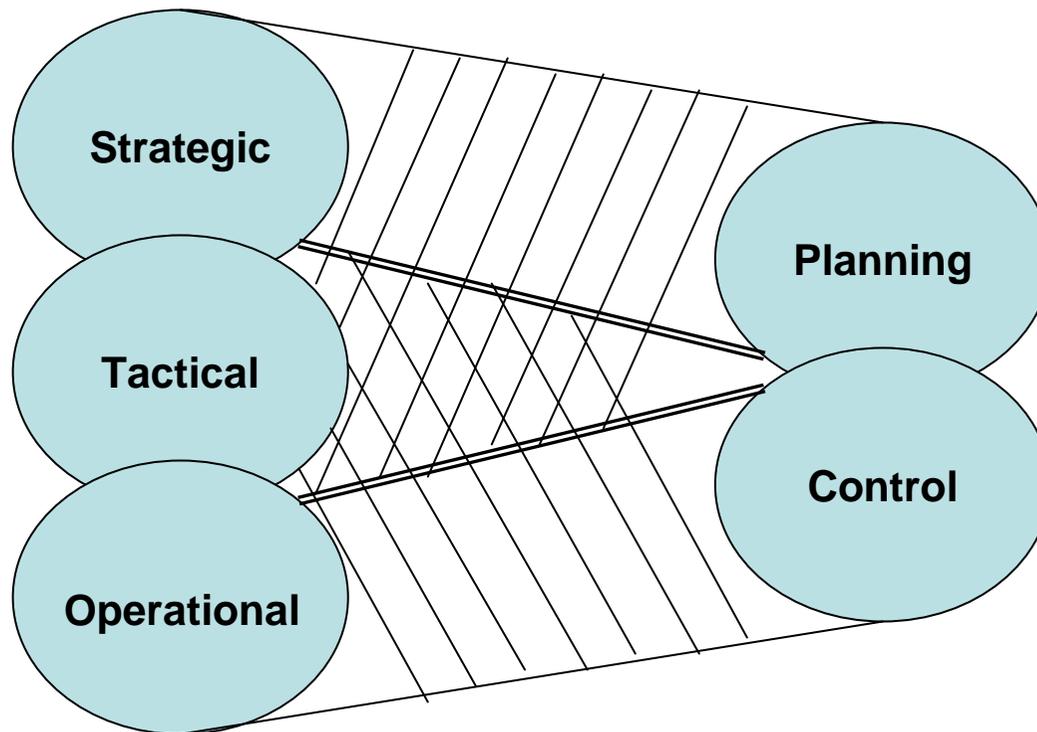
Logistics Strategy

- ❑ Selecting a good logistics strategy may yield a competitive advantage. It must not be seen as a less creative process than developing the corporate strategy.
- ❑ It is suggested that a logistics strategy has three (3) objectives:

Strategy	Description	Sample Issues
Cost Reduction	<ul style="list-style-type: none"> ❑ Minimizing the variable costs associated with movement and storage. 	Evaluate alternative courses of action: <ul style="list-style-type: none"> ❑ choosing among different warehouse locations, or ❑ evaluate alternative transport modes
Capital Reduction	<ul style="list-style-type: none"> ❑ Minimizing the level of investment in the logistics system. ❑ Maximizing the return on logistics assets 	<ul style="list-style-type: none"> ❑ Shipping direct to customers to avoid warehousing, ❑ choosing public warehouses over privately owned, ❑ selecting a just-in-time supply approach rather than stocking to inventory
Service Improvement	<ul style="list-style-type: none"> ❑ Recognizing that revenues depend on the level of logistics services provided 	<ul style="list-style-type: none"> ❑ Provide different and better services than the competition

Logistics planning hierarchy – Decision Phases

- ❑ In order to ensure a successful supply chain management, it is essential that a strong planning approach is adopted.
- ❑ Planning should be undertaken according to a certain hierarchy that reflects different planning horizons and spans of decisions.



- ❑ Ensure the operation is set up to run properly
- ❑ Prepare the operation effectively
- ❑ Operation is doing “the right thing”
- ❑ Operation is running “efficiently”

Source: Rushton, A., Croucker P., Baker P., The handbook of logistics & distribution management, 3rd Edition

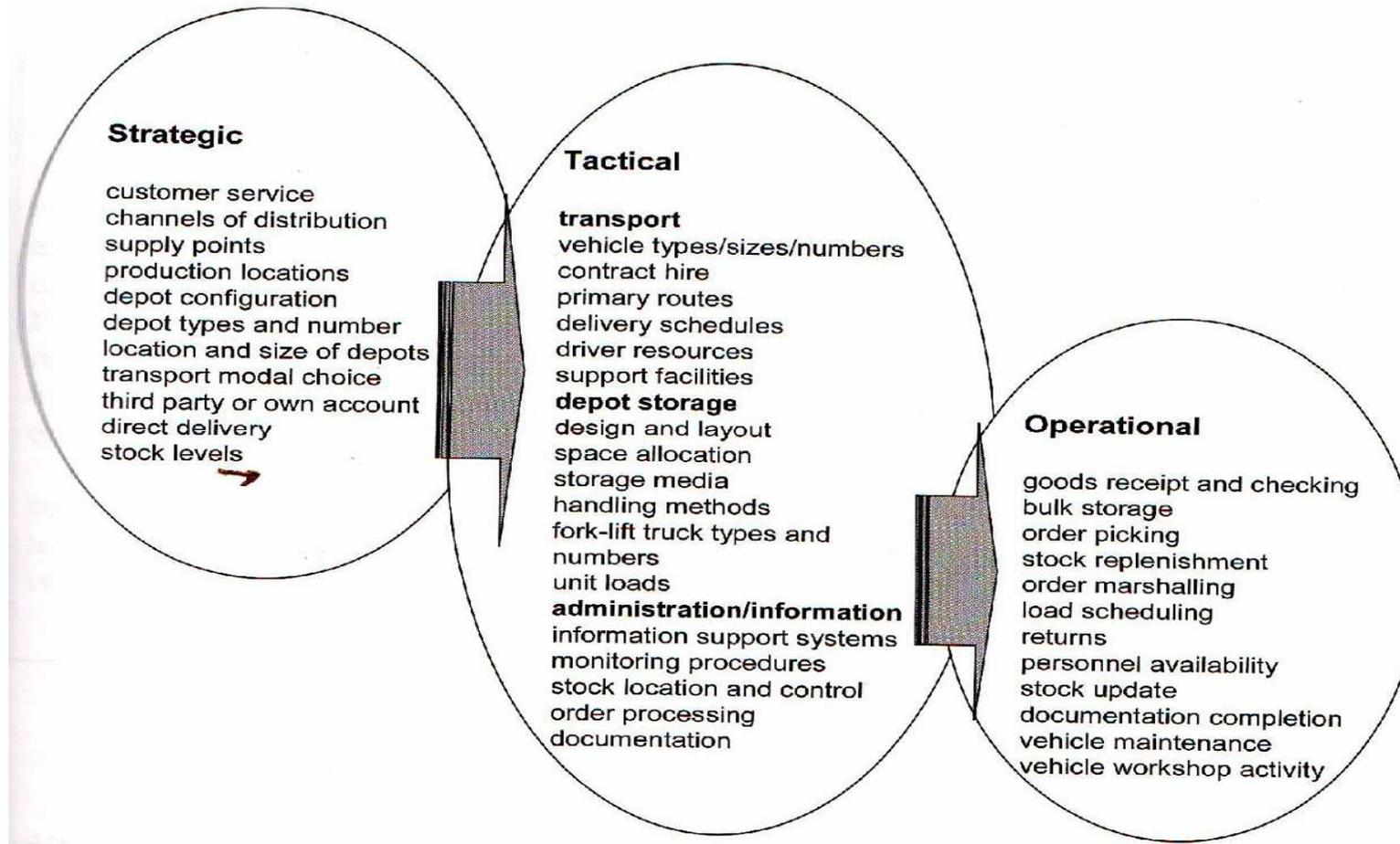
Logistics decision hierarchy: Critical Questions

1. Strategic	2. Tactical / Planning	3. Operations
<p><u>Warehousing</u></p> <ul style="list-style-type: none"> <input type="checkbox"/> How many? <input type="checkbox"/> Where to place? <input type="checkbox"/> Management? <input type="checkbox"/> Owned or rented? <input type="checkbox"/> Size? <p><u>Storage – Material Handling</u></p> <ul style="list-style-type: none"> <input type="checkbox"/> Raw materials policy? <input type="checkbox"/> Ready materials policy? <p><u>Technology</u></p> <ul style="list-style-type: none"> <input type="checkbox"/> Automation level? <p><u>Transportation</u></p> <ul style="list-style-type: none"> <input type="checkbox"/> Warehouse replenishment/ transportation? <input type="checkbox"/> Distribution to clients? 	<p><u>Warehousing</u></p> <ul style="list-style-type: none"> <input type="checkbox"/> Rent or buy? <input type="checkbox"/> Location? <input type="checkbox"/> Capacity? <input type="checkbox"/> Arrangement? <input type="checkbox"/> Equipment? <p><u>Storage – Material Handling</u></p> <ul style="list-style-type: none"> <input type="checkbox"/> Size of pallets? <p><u>Transportation</u></p> <ul style="list-style-type: none"> <input type="checkbox"/> Buy or rent vehicles? <input type="checkbox"/> Fleet, mix, size? <input type="checkbox"/> Delivery vehicles, size? 	<p><u>Warehousing</u></p> <ul style="list-style-type: none"> <input type="checkbox"/> Personnel? <input type="checkbox"/> Working hours, shifts, overtime? <p><u>Storage – Material Handling</u></p> <ul style="list-style-type: none"> <input type="checkbox"/> Products for stock? <input type="checkbox"/> Desired amount of stock? <input type="checkbox"/> Order policy? <input type="checkbox"/> Which supplier? <input type="checkbox"/> Order picking & control? <p><u>Transportation</u></p> <ul style="list-style-type: none"> <input type="checkbox"/> What type of vehicles should be used? <input type="checkbox"/> Service region of each vehicle? <input type="checkbox"/> Routes of vehicles? <input type="checkbox"/> Maintenance of vehicles?

Source: Sifniotis, K., Logistics Management, Θεωρία και Πράξη, Εκδόσεις Παπαζήση,



Main Issues by Decision Level



Source: Rushton, A., Croucker P., Baker P., The handbook of logistics & distribution management, 3rd Edition

Making Trade-offs in Logistics is Important

- ❑ As seen from the previous sections, logistics affect many procedures and activities in a business, leading to increasing operational costs and decreased customer service in case of “bad” logistics management.
- ❑ Logistics interfere with many business areas and, thus, it is suggested to identify and determine several “**cost trade-offs**” in order to provide a positive benefit to the logistics system as a whole.
- ❑ Four (4) different levels of trade-off are proposed:
 - ❑ **Within distribution components**, e.g. the decision to use random storage locations compared to fixed storage locations in a depot. The first → better storage utilization, more difficult for picking; the second has the opposite results
 - ❑ **Between distribution components**: e.g. a company might increase the strength and thus the cost of packaging but find greater savings through improvements in the warehousing and storage of the product
 - ❑ **Between company functions**: e.g. a trade-off between optimizing production run lengths and the associated warehousing costs of storing the finished product. Long production runs produce lower unit costs (and thus more cost-effective production) but mean that more product must be stored for a longer period (which is less cost-effective for warehousing).
 - ❑ **Between the company and external organizations**: e.g. a change from a manufacturer’s products being delivered direct to a retailer’s stores to delivery via the retailer’s depot network might lead to mutual savings for the two companies.

Examples of Trade-offs between company functions

Trade-off	Finance	Production	Distribution	Marketing
Longer production runs	Lower production unit costs	Lower production unit costs	More inventory & storage required	Lower prices
Fewer depots	Reduced costs	No impact	Less complicated logistics structure	Service reduction due to increased distance of depots from customers
Lower FG stocks	Reduced costs	Shorter production run so higher production unit costs	No need to expand storage facilities	Poorer product availability for customers
Lower RM & component stocks	Reduced costs	Less efficient production scheduling due to stock unavailability	Lower stock-holding requirements	No direct impact
Less protective transport packaging	Reduced costs	No impact	Reduced transport modal choice	No impact
Reduced warehouse supervision	Cost savings through lower headcount	No impact	Reduced efficiency due to less supervision	Lost sales due to less accurate order picking

Source: Rushton, A., Croucker P., Baker P., The handbook of logistics & distribution management, 3rd Edition



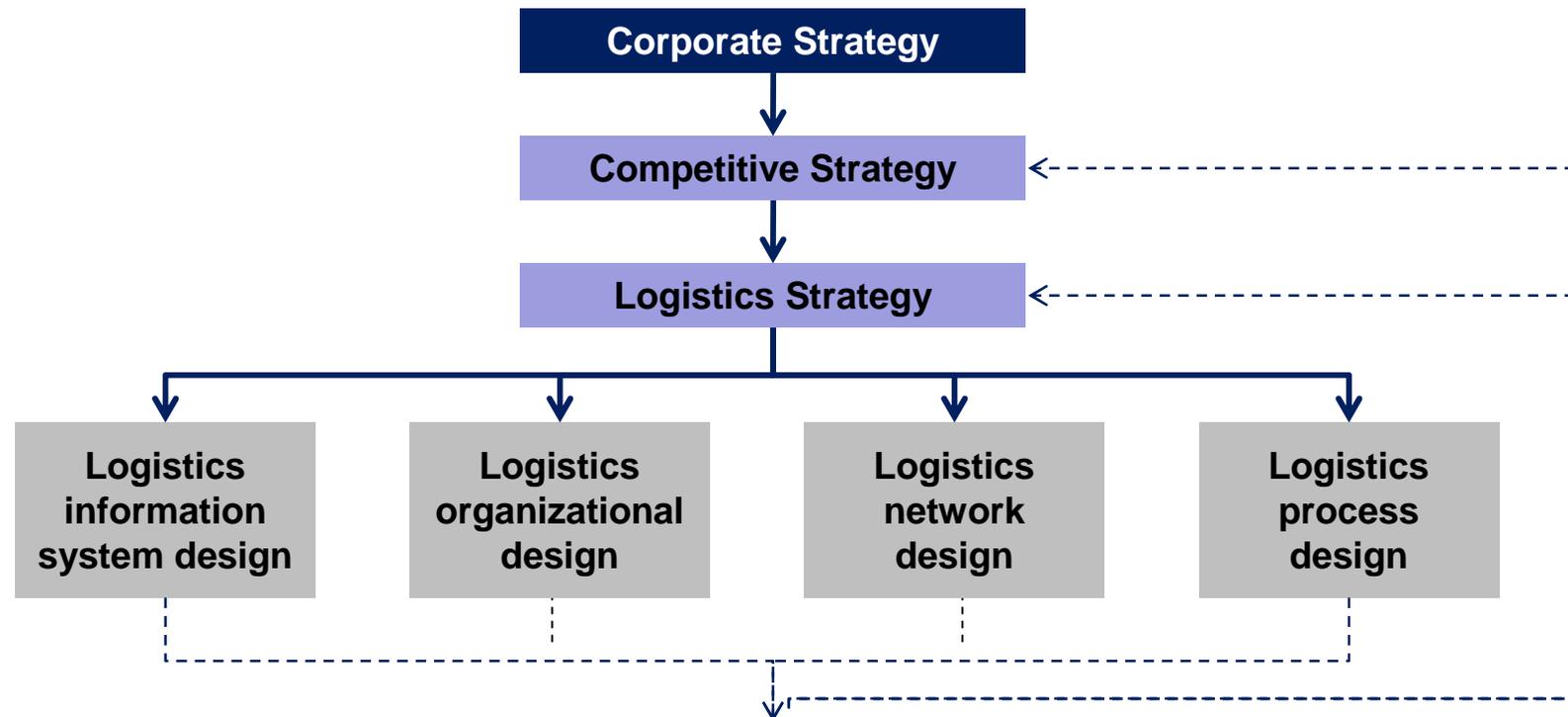
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Logistics Design Strategy

- ❑ The main issue of the logistics design strategy is that a company needs to link the logistics or distribution plan directly with the corporate strategy.
- ❑ This is best achieved by ensuring that logistics is an integrated part of the corporate plan and that factors related to these functions are used as inputs in the overall planning process.



Source: Rushton, A., Croucker P., Baker P., The handbook of logistics & distribution management, 3rd Edition

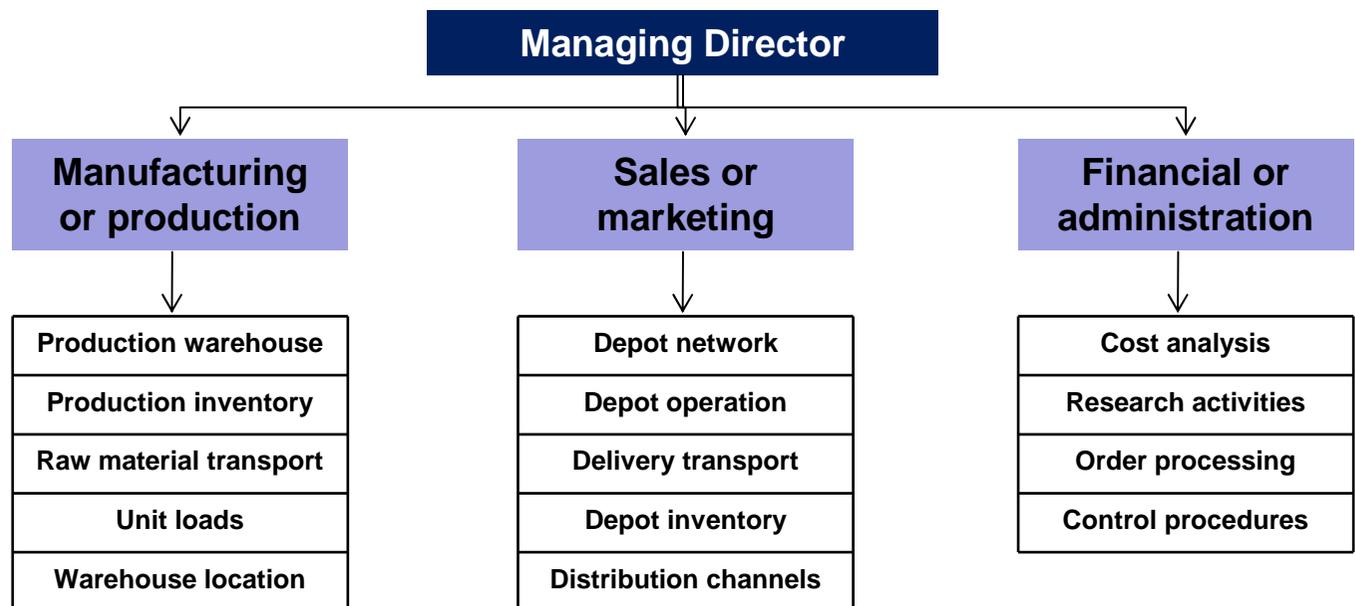
Logistics Information System Design

- ❑ This strategy should include all of those information-related factors that are vital to support the processes and the physical structure of the operation.
- ❑ For this area of design it is important to recognize that there are many enterprise-wide information systems (enterprise resource planning – ERP), which may support logistics process and network design.
- ❑ Typical information systems that may support logistics process/network design might be:
 - ❑ Electronic point of sale (EPOS)
 - ❑ Electronic data interchange (EDI) between companies
 - ❑ Barcodes / radio frequency identification (RFID)
 - ❑ Warehouse management systems
 - ❑ Forecasting & Inventory management systems
 - ❑ Vehicle routing / scheduling softwares / Fleet management systems
 - ❑ Others...
- ❑ *Many of these tools will be described in detail in different section (Chapter 7).*

Logistics Organizational Structure

- ❑ The experience of many companies is that an inadequate organizational structure can lead to substantial problems:
 - ❑ Sub-optimization whereby functions tend to concentrate on their own operation in isolation from the rest of the company
 - ❑ Different functions and their managers compete against one another and develop antagonistic attitudes

- ❑ Traditionally, a typical organizational structure is the one depicted in the figure, showing the key logistics functions

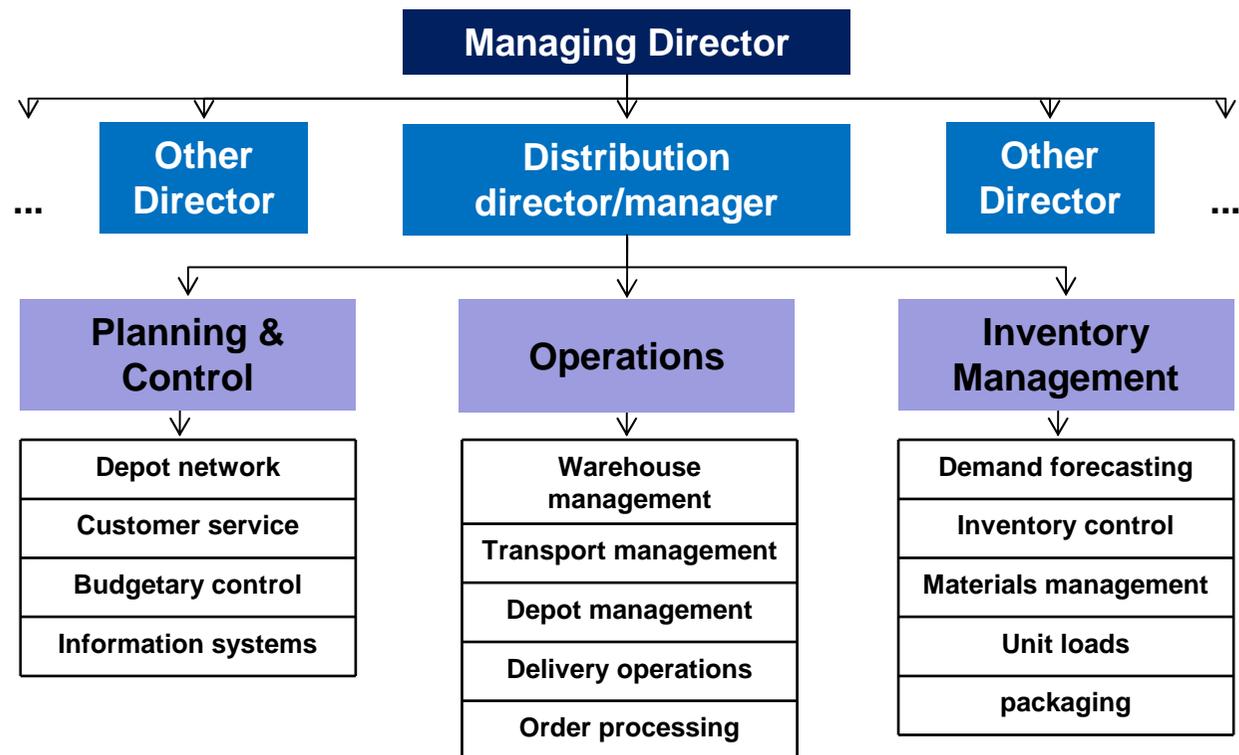


Source: Rushton, A., Croucker P., Baker P., The handbook of logistics & distribution management, 3rd Edition

Logistics Organizational Structure

- ❑ The problem with the previous type of organizational structure is that lines of communication are unclear. Thus, it is often impossible to optimize the efficiency of the different logistics subfunction.
- ❑ Several of the more forward-looking logistics oriented companies have seen the need for some formal organizational change to represent the recognition now being given to the distribution and logistics activity.

- ❑ A typical structure is shown in the figure. This functional approach emphasizes the need for logistics to be planned, operated and controlled as one overall activity.



Source: Rushton, A., Croucker P., Baker P., The handbook of logistics & distribution management, 3rd Edition

Logistics Network Design

- ❑ These planning issues include aspects related to the physical flow of the product through a company's operation, such as
 - ❑ The manufacturing location from which a product should be sourced
 - ❑ The inventory that should be held
 - ❑ The selection of the proper distribution network
 - ❑ The number and location of depots
 - ❑ The use of stockless depots
 - ❑ The final product delivery

- ❑ Logistics network design refers to traditional elements of logistics strategy and, thus, it will be described more detailed in the next slides.

Logistics Process Design

- ❑ Logistics planning concerning the processes tackles four (4) major problem areas:
 1. *Customer service levels*
 2. *Facility location*
 3. *Inventory Decisions*
 4. *Transportation Decisions*
- ❑ Except for setting a desired customer service level (customer service level is a result of the strategies formulated in the other three areas), logistics planning may be formed as a triangle of logistics decision making.
- ❑ These problems are interrelated and should be planned as a unit. Each one has an impact on the system design.

Logistics Process Design

3. Inventory Strategy

- Inventory levels
- Deployment of inventories
- Control methods

4. Transport Strategy

- Modes of transport
- Carrier routing/ scheduling
- Shipment size/ consolidation

1.
Customer
Service Goals

2. Location Strategy

- Number, size & location of facilities
- Assignment of stocking points to sourcing points
- Assignment of demand to stocking points or sourcing points
- Private/public warehousing

**TRANSPORTATION IS THE
MAJOR CONCENTRATION
AREA OF THIS LESSONS.
THUS, WE WILL FOCUS ON
THAT**

Source: Ballou H. Ronald, Business Logistics/Supply Chain Management, 5th Edition

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Distribution Networks: Definitions

❑ Physical Distribution Networks:

is the term used to describe the method and products by which a product or a group of products are physically transferred, or distributed, from their point of production to the point at which they made available to the final customer.

❑ Trading/transactional channels:

is concerned with the non-physical aspects of the product's transfer. These aspects concern the following sequence: negotiation, buying and selling of the product, and ownership of the goods as they are transferred through the various distribution systems.

Source: Rushton, A., Croucker P., Baker P., The handbook of logistics & distribution management, 3th Edition



Key Players

Manufacturer

- They have the purchasing power when customers demand their product
- Market trends recently have pushed their power to the retailers
- Retailers such as WalMart became key players of the market, by reducing the strength of manufacturers (introducing new products competitive to the traditional brands)

Wholesaler

- Wholesalers are the intermediaries in distribution chains
- Their strength is maximized when retailers give small orders
- In some industries, like pharmaceutical, wholesalers control both distribution and wholesales

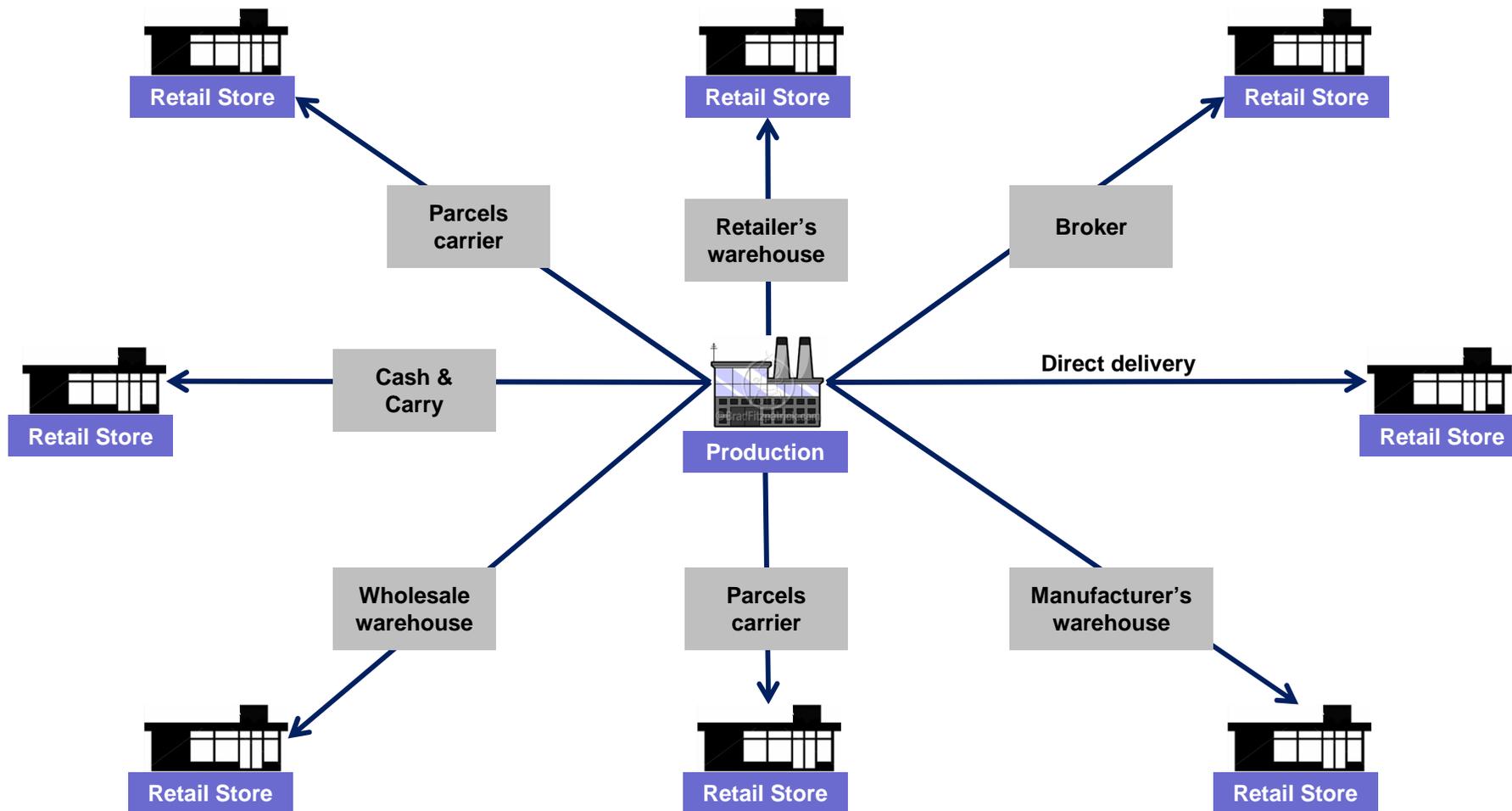
Retailer

- They are the last ring in the supply chain: their strength is the direct communication with the customer
- Financial activities and size of the retailer play important role and affect all the other members of the supply chain

Source: Rushton, A., Croucker P., Baker P., The handbook of logistics & distribution management, 3rd Edition



Distribution Networks: Main Supply Chain Structures



Source: Rushton, A., Croucker P., Baker P., The handbook of logistics & distribution management, 3rd Edition



Distribution Networks: Main Supply Chain Structures

Manufacturer direct to retail store:

- This channel is used when full vehicle loads are being delivered, e.g. food companies

Manufacturer via manufacturer's distribution operation to retail store:

- The manufacturer or supplier holds its products in a finished goods warehouse, a central distribution center (CDC) or a series of regional distribution centers (RDCs), e.g. the case of motorcar industries
- Since the '70s, the use of this type of physical distribution channel has decreased in importance due to a number of developments in alternative channels of physical distribution.

Manufacturer via retailer distribution operation to retail store:

- Consists of manufacturers supplying their products to national distribution centers (NDCs) or RDCs which are sites run by the retail organizations.
- These centers act as consolidation points, as goods from the various manufacturers and suppliers are consolidated at the site.
- The retailers then use their own delivery vehicles to deliver full vehicle loads of all the different manufacturers' products to their own stores.

Source: Rushton, A., Croucker P., Baker P., The handbook of logistics & distribution management, 3rd Edition



Distribution Networks: Main Supply Chain Structures

❑ **Manufacturer to wholesaler to retail store:**

- ❑ Wholesalers have acted as the intermediaries in distribution channels
- ❑ Usually, they use their own distribution centers and vehicle fleets (e.g. Sony)

❑ **Manufacturer to cash-and-carry wholesaler to retail store:**

- ❑ In this channel, small independent shops (e.g. mini-markets) collecting their orders from regional cash-and-carry wholesalers (e.g. Makro)
- ❑ Products are not delivered in this channel, but collected

❑ **Manufacturer via third-party distribution service to retail store:**

- ❑ Third-party distribution has grown very rapidly in recent years
- ❑ Main reasons for this trend are: a) the extensive rise in distribution costs, b) the constantly changing and more restrictive distribution legislation that has occurred and c) the difficulties and complexity of costing the warehousing activities
- ❑ These companies consist of those offering general distribution services (usually storage and distribution) as well as those that concentrate on providing “specialist” service for one type of product (e.g. china or glass) or for one type of company.

Source: Rushton, A., Croucker P., Baker P., The handbook of logistics & distribution management, 3th Edition



Distribution Networks: Main Supply Chain Structures

Manufacturer via small parcels carrier to retail store:

- These companies provide a “specialist” distribution service where the product is any small parcel.
- There has been an explosion in the 1980s and 1990s of small parcel companies, specializing particularly in next-day delivery (e.g. UPS, FedEx)

Manufacturer via broker to retail store:

- This is a relatively rare type of channel
- A broker is similar to a wholesaler in that it acts as intermediary between manufacturer and retailer.
- Its role is different because it is often more concerned with the marketing of a series of products, and not really with their physical distribution (e.g. Johnson & Johnson)
- A broker may use third-party distributors, or it may have its own warehouse and delivery system

Source: Rushton, A., Croucker P., Baker P., The handbook of logistics & distribution management, 3rd Edition



Distribution Networks: Alternative Supply Chain Structures

There are several additional channels that bypass the retail store and not fit within the structure of the previous figure. These are:

Mail Order

- The use of mail order or catalogue shopping has become very popular recently.
- Goods are ordered by catalogue and delivered to the home by post or parcel carriers.
- The physical distribution channel is, thus, from manufacturer to mail order house and then to consumer's home, bypassing the retail store.

Factory direct to home

- This channel is a relatively rare alternative.
- It can occur by direct selling methods, often as a result of newspaper advertising.
- It is also commonly used for one-off products that are specially made and do not need to be stocked in a warehouse to provide a particular level of service to the customer. (e.g. Dell Computers)

Source: Rushton, A., Croucker P., Baker P., The handbook of logistics & distribution management, 3rd Edition



Distribution Networks: Alternative Supply Chain Structures

Internet and shopping from home

- Websites can now be used whether from the retailers or specialized companies (e.g. e-shop.gr)
- They are similar to the those used by mail order operations/ post and parcels carrier
- They are almost all run by third-party companies. Deliveries are made mostly by post and parcels carrier companies

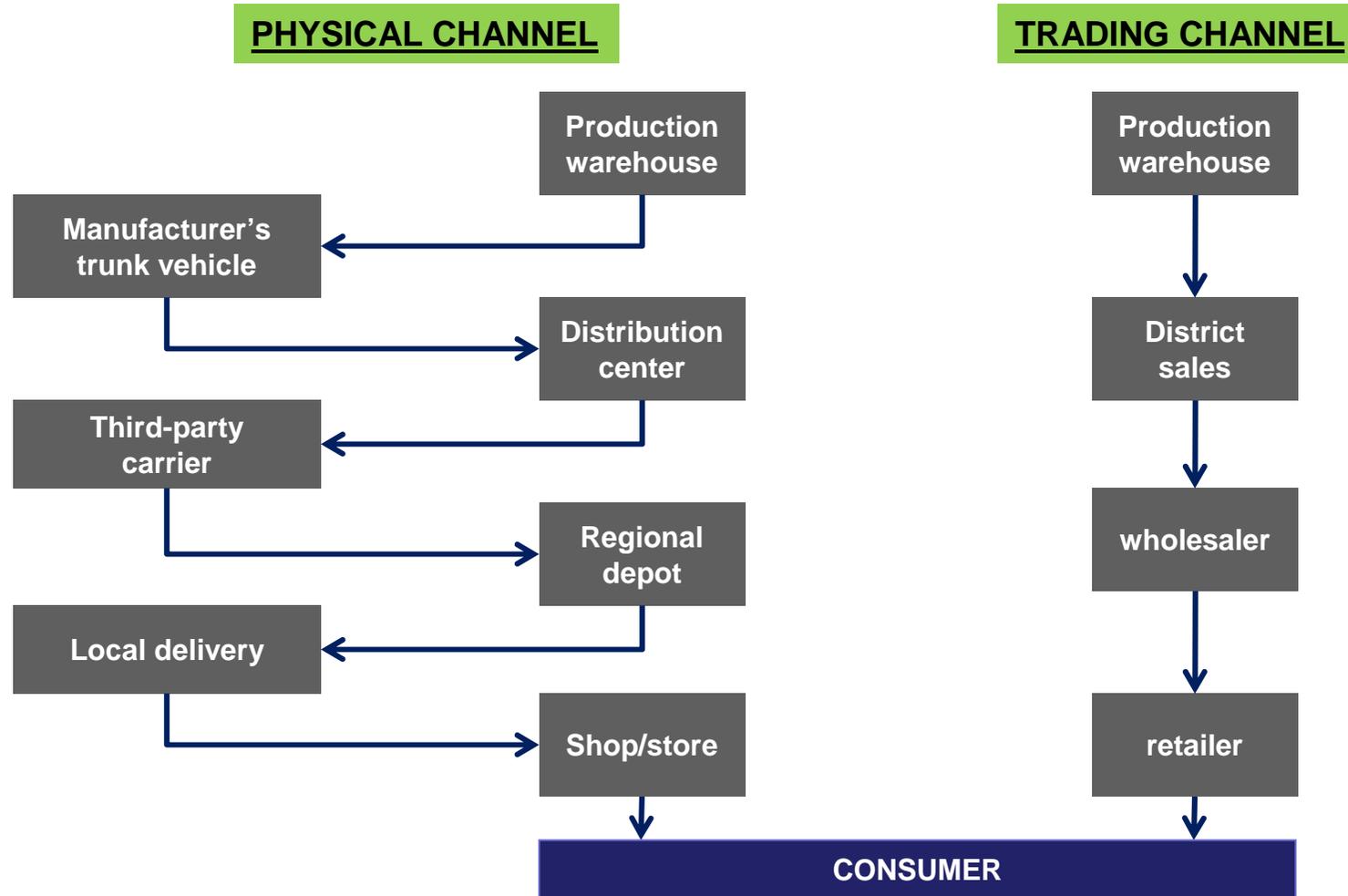
Factory to factory/business to business

- This is an extremely important supply channel, as it includes all of the movement of industrial products
- These products may cover raw materials, components, part-assembled products, etc.
- Options vary according to the type and size of product and order. May range from full loads to small parcels, and may be undertaken by the manufacturers themselves or by third-party. (e.g. Bridgestone, BMW)

Source: Rushton, A., Croucker P., Baker P., The handbook of logistics & distribution management, 3rd Edition



Distribution Networks: Physical vs trading channel



Source: Rushton, A., Croucker P., Baker P., The handbook of logistics & distribution management, 3rd Edition



Selecting a distribution network (1/2)

A distribution network should:

Make Products Available to Customers (in the right Market Places)

- Products should be placed in the right places (stores, markets, etc.)
- The proper physical distribution channel should be selected

Enforce the Potential Sales Share

- Good placement into the stores and good presentation in racks, etc.
- Salesmen should support continuously the sales
- Products placement should make products visible, accessible and appealing

Eliminate distribution related problems

- Communication between shippers and customers should exist
- Accurate forecasting and order size should be determined
- Distribution related issues should be confronted (i.e. vehicle sizes, time restrictions in distributions, etc.)

Source: Rushton, A., Croucker P., Baker P., The handbook of logistics & distribution management, 3th Edition



Selecting a distribution network (1/2)

Through the selected distribution network:

The Customers Service Level should be Improved

- Continuous cooperation between Suppliers and Final Customers (i.e. Retailers)
- Service Level is used as a benchmarking tool from the customers perspective and thus, influence their future decisions on orders from Suppliers

The General & Logistics Cost should be minimized

- Distribution network costs affect the final product prices
- Distribution Costs should be related to the transported goods (low price transported goods with low profit margins should distributed through well-designed and near-optimal networks (i.e. courier services)

Accurate and On-time Information Sharing should be present

- Information should be present in all distribution procedures and communicated properly (i.e. delivery notifications, Proof-of delivery, Vehicle Locations, etc.)
- Information should include: Sales records ,Inventories, Expenses records, product related records

Source: Rushton, A., Croucker P., Baker P.,The handbook of logistics & distribution management, 3th Edition

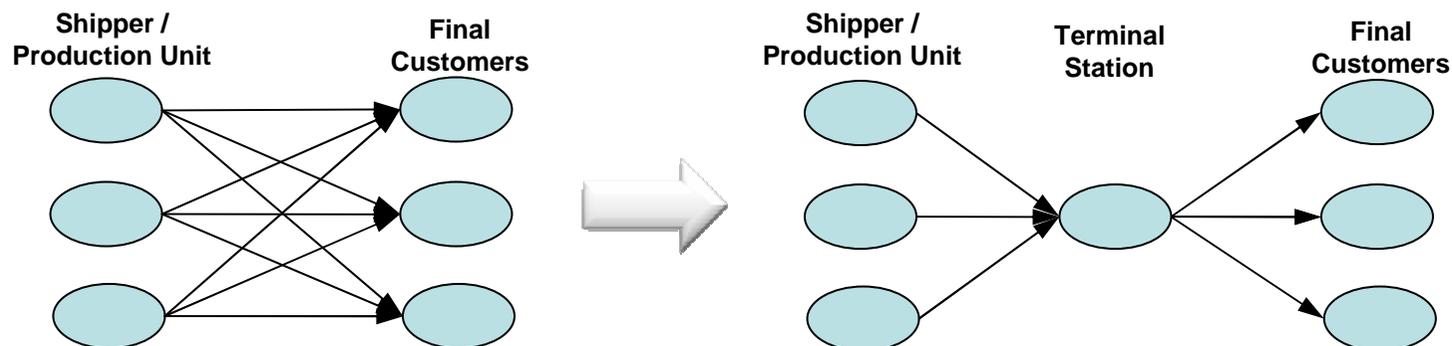


Terminals/Hubs in Distribution Networks

- ❑ Terminal / Distribution Centers / Hubs are facilities where loading / unloading, sorting and storage of transported commodities is taking place in order to efficiently utilize the transportation means.
- ❑ Main scope is to consolidate commodities arrivals from different locations, in order to reduce transport costs and increase transport efficiency.
- ❑ They provide increased efficiency when transport goods volume is less-than-truckload where shipments are merged and larger vehicles may be used.

Illustrative Simplification of a Transportation Network using a Single Terminal Station

Commodities are transported to the terminal station, where they are sorted and grouped based on final destination and then they loaded to the appropriate vehicles and transported to their final destination



Source: S. Papadimitriou, O. Sxinas, Introduction to Logistics (greek), Stamoulis, 2004, Athens

Terminals/Hubs in Distribution Networks

In order to take full advantage of a terminal station, several parameters have to be taken under consideration:

Cost Reduction	Commodities are transported in larger quantities using larger trucks that cover long distances while smaller vehicles serve local and regional areas.
Transport Time Increase	Due to the existence of an intermediate stop (terminal station), transport time to final destination is increased because of the loading / unloading, sorting / grouping activities. Also, waiting times between arrivals and departures to / from the terminal station add to the total time.
Potential Damages and Losses	The loading / unloading of goods to different vehicles as well as the storage in a terminal station may led to damages and losses of the transported goods.

In order to deal with the aforementioned parameters and to effectively serve an overall network (international, national, regional and local transportation), three main types of terminal stations topologies exist:

- Independent Terminal Stations
- Single-Level Multiple Terminal Stations
- Hierarchical Multiple Terminal Stations

Source: S. Papadimitriou, O. Sxinas, Introduction to Logistics (greek), Stamoulis, 2004, Athens



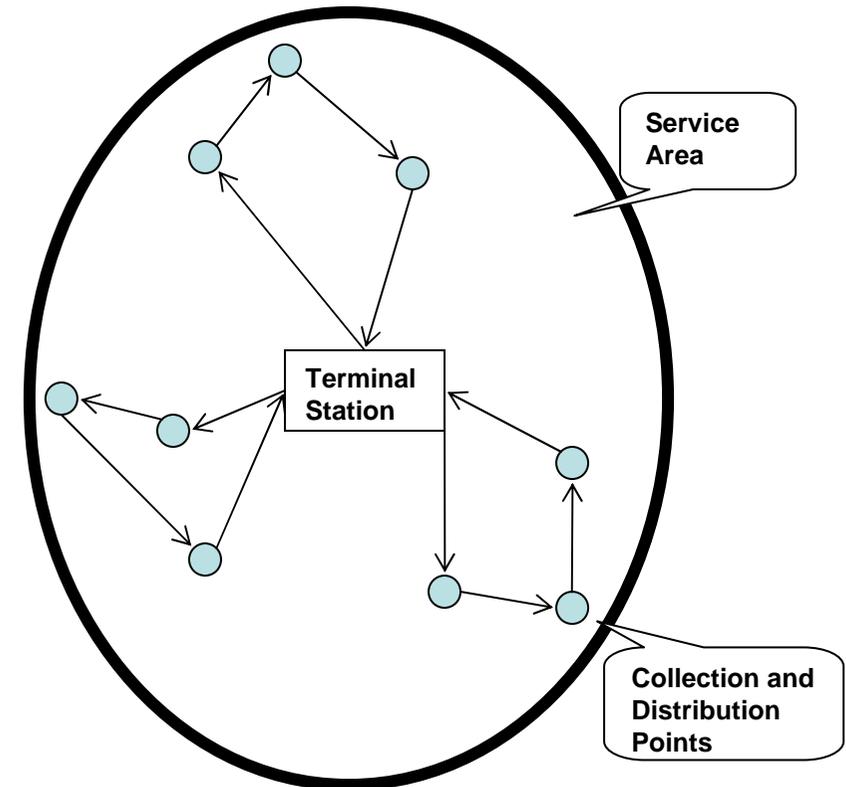
Independent Terminal Stations

A single terminal station serves the whole service area. Collection and distribution takes place at the terminal station.

❑ Since, all transported goods are collected in a single place, there is a high utilization of the terminal station productivity and a high concentration of transported goods.

❑ Travelled distances between the source points and the final destination points is increased due to the transshipment of products.

Terminal stations (hubs) are installations where the loading, unloading, picking, sorting and storage of transported goods is taking place in order to optimize the performance and efficiency of the transportation means.

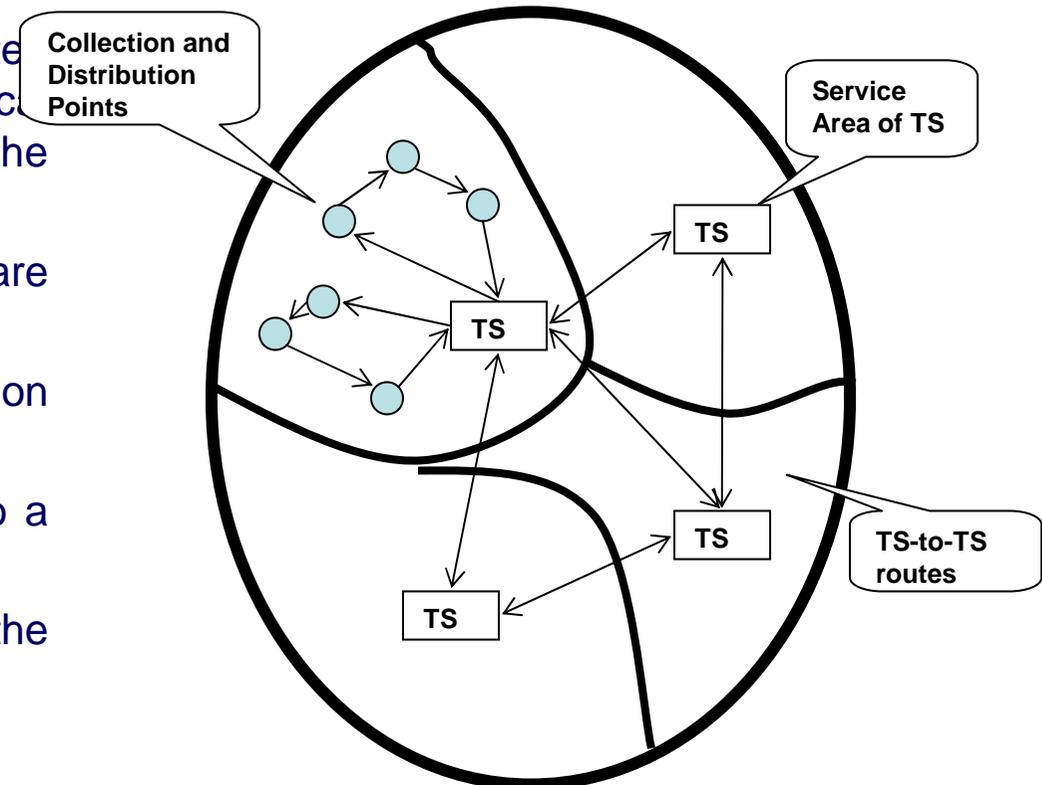


Source: S. Papadimitriou, O. Sxinas, Introduction to Logistics (greek), Stamoulis, 2004, Athens

Single-Level Multiple Terminal Stations

Several terminal stations (TS) exist in connected network. Each terminal station serves (a) a local service area and (b) as a long-distance hub with the other terminal stations.

- ❑ Offers higher customer service since TSs are closest to demand origins.
- ❑ Travelled distances for collection and distribution (to/ from customers) are minimized.
- ❑ Processed volumes are less (in comparison to a single TS system) in each TS.
- ❑ The existence of multiple TSs increases the installation and inventory costs.

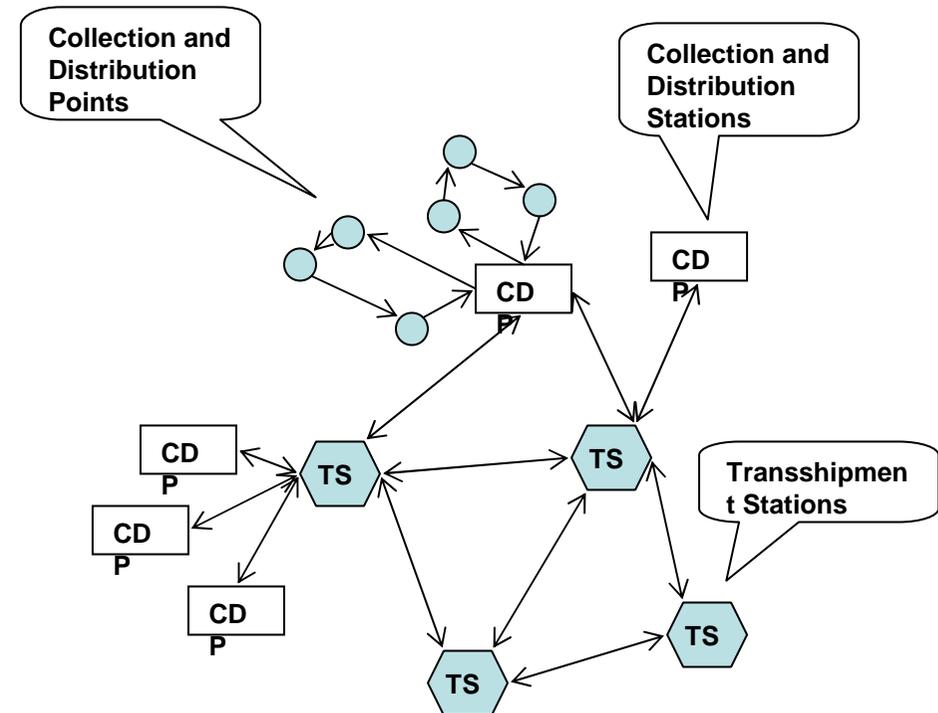


Source: S. Papadimitriou, O. Sxinas, Introduction to Logistics (greek), Stamoulis, 2004, Athens

Hierarchical Multiple Terminal Stations

In an hierarchical system there are several different types of terminal stations (TS). Collection and Distribution Points (CDP) connects with one or more local Transshipment Stations (Hub) which operates the line-haul transportation (transportation between TSs).

- ❑ Higher installations operating cost.
- ❑ Lower transportation costs due to minimization of long-distance travels and to the existence of many CDPs.
- ❑ Attractive to distribution of small transported goods (letters, parcels, etc.) with long-distance destinations.
- ❑ Higher utilization of vehicles in long-distance routes.



Source: S. Papadimitriou, O. Sxinas, Introduction to Logistics (greek), Stamoulis, 2004, Athens

Contents

1. OVERVIEW OF SUPPLY CHAIN
2. LOGISTICS DECISION MAKING
3. LOGISTICS SYSTEM DESIGN & PLANNING
4. DISTRIBUTION NETWORKS
5. TRANSPORTATION

Transportation: Overview

- ❑ Transportation provides the flow of materials, products and persons between production facilities, warehouses, distribution centers, terminals and customer locations.
- ❑ Large attention has been given to *Transportation* since it consumes a major proportion (usually between $1/3$ και $2/3$) of the total logistics costs.
- ❑ Transportation Planning targets to:

Customer Satisfaction (Quality of Service)	<ul style="list-style-type: none"> ❑ On-time Delivery ❑ Minimum Delays / Damages / Losses
Productivity Efficiency	<ul style="list-style-type: none"> ❑ Transit Time Reduction ❑ Lower Variability of Transit Times
Cost Minimization	<ul style="list-style-type: none"> ❑ Vehicle Acquisition / Fuel Consumption Minimization ❑ Minimization of Overtimes and excess Personnel Costs

Source: Kasilingam R.G., Logistics And Transportation, Kluwer, 1998

Components of Transport Systems

- ❑ The components of a transportation network can be separated into 3 categories

<p>Facilities</p>	<ul style="list-style-type: none"> ❑ Facilities are the fixed components of a transportation network ❑ They include: <ul style="list-style-type: none"> ❑ User-specific Facilities: Warehouses, Terminals, Distribution Centers, Hubs, Docks, etc. ❑ Common Facilities: Roadways, Rail tracks, Waterways
<p>Equipment</p>	<ul style="list-style-type: none"> ❑ Consists of the various parts of a transportation network. Usually equipment belongs and is maintained by the shippers or the carriers and includes: <ul style="list-style-type: none"> ❑ Containers, Trailers, Vehicles (trucks, scooters), Rail (Cars, locomotives), aircrafts, vessels
<p>People</p>	<ul style="list-style-type: none"> ❑ People that are involved in transportation-related or transportation supportive functions are one of the crucial components of transportation networks. ❑ Related working positions are Operating Personnel (Drivers, Pilots, etc), Supportive Personnel (Maintenance, Loading/ Unloading, etc) and Managerial Personnel (Logistics Directors, Dispatchers, Administration)

Source: Kasilingam R.G., Logistics And Transportation, Kluwer, 1998



Transportation: How to Transport ?

- ❑ Each shipper (company) has a number of options to forward a number of items to their final destination (consignee, customer, warehouse, etc.). These options can be separated in three major categories:
 - ❑ Usage of privately owned transportation means (vehicles, airplanes, etc.)
 - ❑ Usage of a common carrier (airlines, rail transportation, freight road transporters, etc.)
 - ❑ Usage of a freight forwarder (companies that consolidate products and undertake transportation and other services on behalf of many shippers)
- ❑ Regardless of the aforementioned options, another critical aspect to decide on is the transportation mode to carry the shipments.

Source: Kasilingam R.G., Logistics And Transportation, Kluwer, 1998



Types of Transport Modes

Type of Transport	
Air	<ul style="list-style-type: none"> <input type="checkbox"/> Although air transportation is considered as expensive, it offers long-distance transportation in short time periods. <input type="checkbox"/> Air transportation depends heavily on weather conditions and delays schedule deviations may occur.
Sea	<ul style="list-style-type: none"> <input type="checkbox"/> Sea Transportation offers the ability to carry large quantities of commodities (.000 tones) using specialized cargo ships. <input type="checkbox"/> Sea Transportations offers low flexibility in determining routes and schedules. <input type="checkbox"/> Depends on weather conditions (not as hard as in air transportation)
Rail	<ul style="list-style-type: none"> <input type="checkbox"/> Rail transportation is considered as a slow transport mode. <input type="checkbox"/> Low cost materials and Raw Materials are usually transferred. <input type="checkbox"/> Weather conditions do not influence rail operations. <input type="checkbox"/> Many stops in local areas can be made in order to load / unload commodities.
Road	<ul style="list-style-type: none"> <input type="checkbox"/> Offers lower capacity and quantity capabilities in comparison with rail transportation <input type="checkbox"/> Advantage of road transportation is the ability to offer door-to-door services and the existence of many different and specialized vehicles <input type="checkbox"/> Weather conditions do not influence rail operations.
Pipeline	<ul style="list-style-type: none"> <input type="checkbox"/> Used to transport Liquids and Gases (i.e. Oil, Natural Gas) <input type="checkbox"/> Although transportation is slow (3-4 miles per hour), the ability to operate 24 hours a day makes it an efficient transportation mode of these product types. <input type="checkbox"/> As in rail transportation, offers a specific network with specific stops, intersections, etc. <input type="checkbox"/> Weather conditions do not influence rail operations and limited technical problems may occur.

Source: Ballou H. Ronald, Business Logistics/Supply Chain Management, 5th Edition



Characteristics of Transport Modes

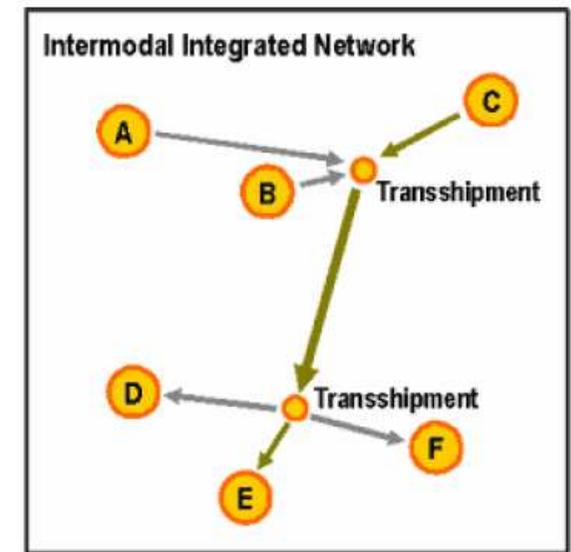
Transport Types					
Components	Air	Sea	Road	Rail	Pipelines
Facilities	Facilities are the fixed components of a transportation network				
	<input type="checkbox"/> Airports, <input type="checkbox"/> Cargo Terminals <input type="checkbox"/> Control Towers	<input type="checkbox"/> Ports <input type="checkbox"/> Docks <input type="checkbox"/> Waterways	<input type="checkbox"/> Distr. Centers <input type="checkbox"/> Warehouses <input type="checkbox"/> Hubs	<input type="checkbox"/> Rail Hubs <input type="checkbox"/> Rail Tracks	<input type="checkbox"/> Pipes <input type="checkbox"/> Pumps Stations <input type="checkbox"/> Storage
Equipment	Consists of the variables parts of a transportation network. Usually equipment belongs and maintained by the shippers or the carriers and includes:				
	<input type="checkbox"/> Aircrafts <input type="checkbox"/> Containers	<input type="checkbox"/> Vessels <input type="checkbox"/> Containers	<input type="checkbox"/> Vehicles (tracks, scooters) <input type="checkbox"/> Containers	<input type="checkbox"/> Cars <input type="checkbox"/> Locomotives <input type="checkbox"/> Containers	<input type="checkbox"/> Control Units
People	People that are involved in transportation-related or transportation supportive functions are one of the crucial components of transportation networks. Related working positions are Operating Personnel, Supportive Personnel and Managerial / Administrative Personnel				
	<input type="checkbox"/> Pilots <input type="checkbox"/> Air Traffic Controllers Maintenance Personnel <input type="checkbox"/> Loading / Unloading	<input type="checkbox"/> Vessel Personnel <input type="checkbox"/> Loading / Unloading Personnel <input type="checkbox"/> Port / Docks Personnel <input type="checkbox"/> Maintenance Personnel	<input type="checkbox"/> Drivers <input type="checkbox"/> Loading / Unloading Personnel <input type="checkbox"/> Maintenance Personnel	<input type="checkbox"/> Locomotive Operators <input type="checkbox"/> Loading / Unloading Personnel <input type="checkbox"/> Terminal Stations Personnel <input type="checkbox"/> Maintenance Personnel	<input type="checkbox"/> Control Personnel <input type="checkbox"/> Maintenance Personnel



Consolidation of Transport Modes

- Given the transportation modes presented, a combination of them may be used in order to achieve lower costs & better customer service quality

Multimodal Transport	The basic feature of multimodal transport is that at least two modes of transport are used. Sometimes, multimodal transport is connected to the international transport of containers and the need for transport facilitation.
Intermodal Transport	The movement of goods in one and the same loading unit or road vehicle, which uses successively two or more modes of transport without handling the goods themselves in changing modes.
Combined Transport	A related term is combined transport. “Combined transport” is defined as intermodal transport where the major part of the European journey is by rail, inland waterways or sea and any initial or final legs carried out by road are as short as possible. Defined environment-friendly intermodal transport, involving as little road transport as possible



(2)

(1)

Source: (1) Rodrigue, J. P., Comtois, C. (2004), <http://people.hofstra.edu/geotrans/eng/ch3en/conc3en/ch3c5en.html>
 (2) UNESCAP, http://www.unescap.org/ttdw/Publications/TFS_pubs/Pub_2285/pub_2285_Ch1.pdf

Consolidation of Transport Modes

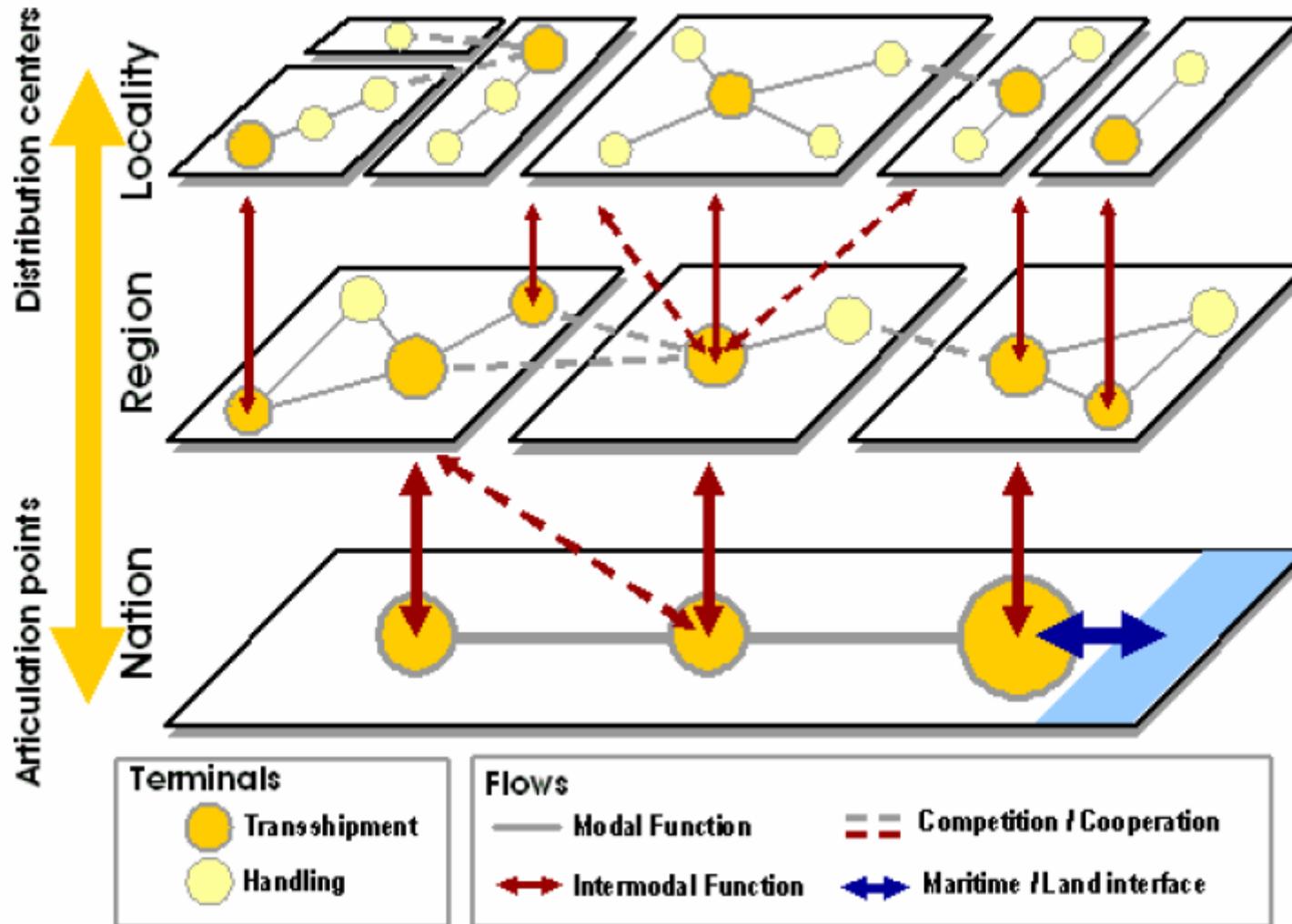
- ❑ Basic characteristic of the combined transportation (intermodal) is the combination of different transport modes by using / interchanging equipment (i.e. a track container may be directly loaded to a rail-car or cargo aircraft).

- ❑ There are 10 types of combined transportation:
 - ❑ Rail – Road (piggyback)
 - ❑ Rail - Sea
 - ❑ Rail - Air
 - ❑ Rail - Pipeline
 - ❑ Road - Air
 - ❑ Road – Sea (fishyback)
 - ❑ Road – Pipeline
 - ❑ Sea – Pipeline
 - ❑ Sea – Rail
 - ❑ Air – Pipeline

Source: Ballou H. Ronald, Business Logistics/Supply Chain Management, 5th Edition



Consolidation of Transport Modes



Source: Rodrigue, J. P., Comtois, C. (2004), <http://people.hofstra.edu/geotrans/eng/ch3en/conc3en/ch3c5en.html>

An Indicative Comparison of Transport Modes

- Selecting which modes to combine and how is a decision that is based on the following parameters:

Mode	Parameters				
	Cost (Price)	Delivery Time	Time Variability	Geographical Coverage	Loss & Damage
Rail	3	3	4	2	5
Road	4	2	3	4	4
Sea	1	5	5	1	2
Air	5	1	1	3	3
Pipeline	2	4	2	5	1
Legend	1 ⇨ Cheap 5 ⇨ Expensive	1 ⇨ Fast 5 ⇨ Slow	1 ⇨ Small 5 ⇨ Large	1 ⇨ Good 5 ⇨ Poor	1 ⇨ Safest 5 ⇨ Least Safe

Source: Ballou H. Ronald, Business Logistics/Supply Chain Management, 5th Edition

Transport Goods & Unit Loads

- ❑ Selecting the appropriate storage units for the transported goods has major impact in the transportation cost, susceptibility to damages, loading / unloading efficiency.
- ❑ Some of the storage units used are: Bottles, Boxes, Metal dispensers, Pallets, Roll-pallets, Sacks, Barrels, etc.
- ❑ Many combinations between different storage units can be made in order to achieve better space utilization and better handling of the transported goods (i.e. boxes on a pallet)
- ❑ Selection of storage units depends on:
 - ❑ Shape, size and weight of transported goods
 - ❑ Ability to stack units on top of each other
 - ❑ Other handling criteria (transport means loading ability, ability to carry certain storage types, Warehouse gates dimensions)
- ❑ Special attention has to be given to Pallets and Containers

Source: Kasilingam R.G., Logistics And Transportation, Kluwer, 1998
G. Giannatos, S. Andrianopoulos, Logistics: Transportation – Distribution (in Greek)



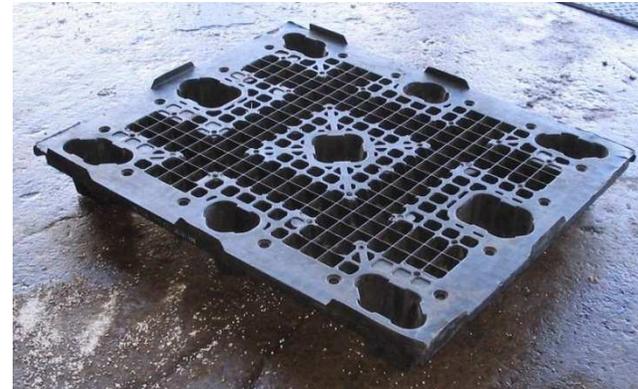
Unit Loads - Pallets

“A pallet is a flat transport structure that supports goods in a stable fashion while being lifted by a forklift, pallet jack, front loader or other jacking device. A pallet is the structural foundation of a unit load which allows handling and storage efficiencies. Goods or shipping containers are often placed on a pallet secured with strapping, stretch wrap or shrink wrap and shipped. While most pallets are wooden, pallets also are made of plastic, metal, and paper.

Pallet users want pallets to easily pass through buildings, stack and fit in racks, forklifts, pallet jacks, automated warehouses, and pack tightly inside intermodal containers and vans.”



The Simple Wooden Pallet



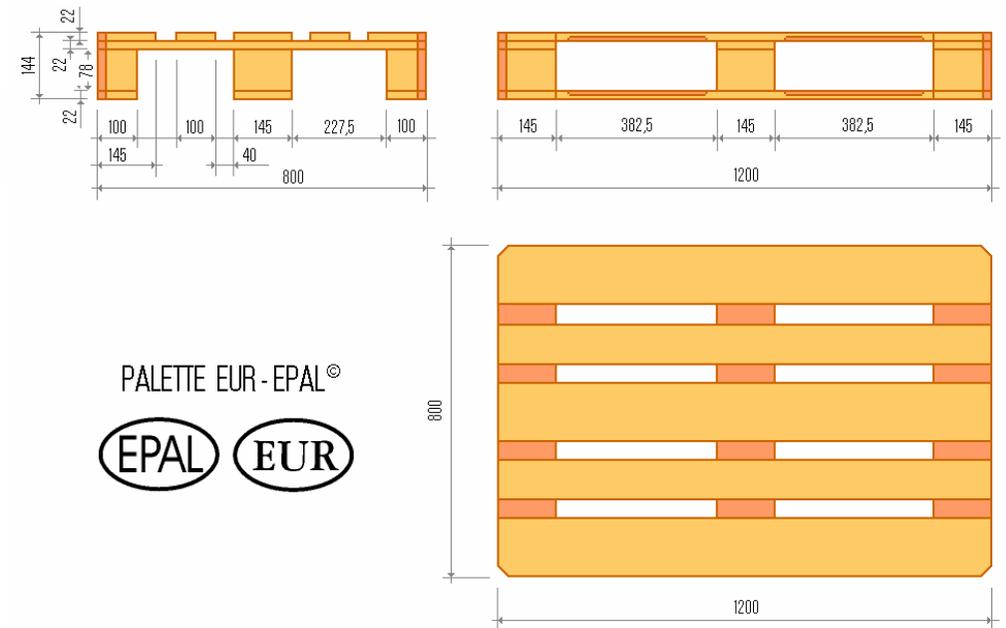
Plastic Pallet that can be lifted from all sides

<http://en.wikipedia.org/wiki/Pallet>

Unit Loads - Standardization of Pallets

There is not a standardized version of sizes, dimensions and characteristics for pallets worldwide. Several organization companies have created different standards (such as ISO, North American, Europe Pallets, etc.).

EURO pallet type	Dimensions mm (W x L)	ISO pallet alternative
EUR, EUR 1	800 x 1200	ISO1, same size as EUR
EUR 2	1200 x 1000	ISO2
EUR 3	1000 x 1200	
EUR 6	800 x 600	ISO0, half the size of EUR
	600 x 400	quarter the size of EUR
	400 x 300	one-eighth the size of EUR



(<http://en.wikipedia.org/wiki/Pallet>)



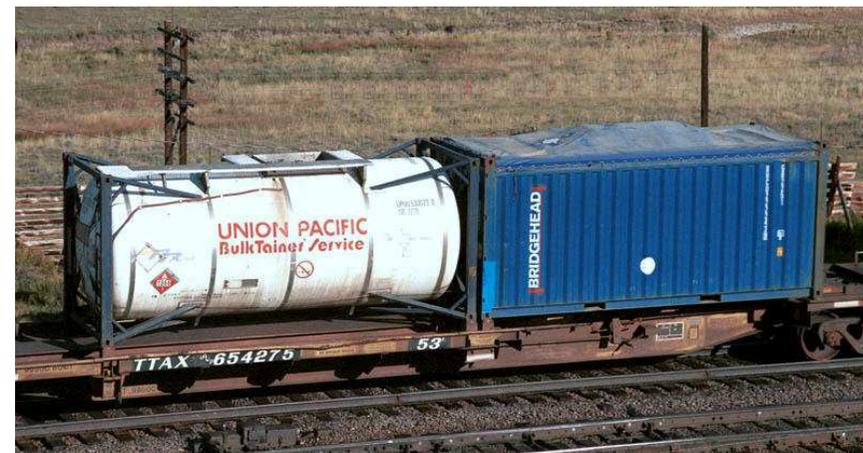
Unit Loads - Containers

“An intermodal container or freight container (commonly shipping container) is a reusable transport and storage unit for moving products and raw materials between locations or countries.

There are approximately seventeen million intermodal containers in the world and a large proportion of the world's long distance freight generated by international trade is transported inside shipping containers.”



A 12.19 m long shipping container.



A railroad car with a 20 ft tank container and a conventional 20 ft container

<http://en.wikipedia.org/wiki/Containers>

Unit Loads - Benefits of Containers

- ❑ Products / Commodities are stacked into the container, which provide maximum security and are not affected by weather conditions
- ❑ Containers are manufactured in order to be able to be transported and loaded directly between different transport modes
- ❑ The standardized characteristics allow the effective stack and loading of them to rail cars, vessels, etc.
- ❑ Different kind of containers are used, based on the transported commodities and their characteristics:
 - ❑ Dry / generic cargo
 - ❑ Liquids
 - ❑ Frozen / Perishable
 - ❑ Bulk Products

Source: S. Papadimitriou, O. Sxinas, Introduction to Logistics (greek), Stamoulis, 2004, Athens



Transport Providers: Introduction

- ❑ Warehousing and Transportation of Products / Commodities consist of one of the core procedures in Business Operations.
- ❑ These procedures can be performed by own resources or by external partners:
 - ❑ Common & Private Carriers (distribution)
 - ❑ Freight Forwarders (distribution & storage)
 - ❑ Third Party Logistics Providers (3PL) (integrated distribution & storage)
- ❑ Each company selects (based on their needs) the types of services to outsource to an external partner.
- ❑ 3PL companies provide an wide variety of services, apart from simple distribution and storage procedures.

Transport Providers: Common Carriers

- ❑ A common carrier is a business that transports people and/ or goods, offers its services to the general public under license or authority provided by a regulatory body.
- ❑ Common carriers typically transport persons or goods according to defined and published routes, time schedules and rate tables upon the approval of regulators.
- ❑ Public airlines, railroads, bus lines, cruise ships, motor carriers (i.e., trucking companies) and other freight companies generally operate as common carriers.
- ❑ In Continental Europe the term is seldom used and has little or no legal implications. Any person who undertakes to transport goods is simply referred to as a carrier.
- ❑ In contrast, private carriers are not licensed to offer a service to the public. Private carriers generally provide transport on an irregular or ad hoc basis for their owners.
- ❑ It should be mentioned that the carrier refers only to the person (legal or physical) that enters into a contract of carriage with the shipper. The carrier does not necessarily have to own or even be in the possession of a means of transport. Unless otherwise agreed upon in the contract, the carrier may use whatever means of transport approved in its operating authority, as long as it is the most favourable from the cargo interests' point of view. The carriers' duty is to get the goods to the agreed destination within the agreed time or within reasonable time.

http://en.wikipedia.org/wiki/Common_carrier



Transport Providers: Freight Forwarders

- ❑ Freight Forwarders are not the classic common carriers
- ❑ Their business is to:
 - ❑ Hire “transport space” from transportation means (carriers, ships, etc.)
 - ❑ Group and integrate loads and shipments
- ❑ The advantages of the existence of freight forwarders and their provided services can be summarized in the following:
 - ❑ They succeed in better transport means’ capacity utilization (due to consolidation of shipments)
 - ❑ Consolidation of shipments and the handling of larger integrated loads/ shipments leads to efficient material handling (loading , unloading, transshipment, etc.)
 - ❑ Due to the consolidation and the transshipment of larger shipments, freight forwarders succeed in lower transport prices with the transport means’ operators, leading to minimized cost in comparison with sending smaller shipments by each shipper.

Source: G. Giannatos, S. Andrianopoulos, Logistics: Transportation – Distribution (in Greek)



Transport Providers: Third Party Logistics (3PL) Providers

- ❑ Recent trends in logistics and business operations have led to the 3PL providers.
- ❑ A 3PL firm provides outsourced services to companies for part, or sometimes all of their supply chain management function.
- ❑ Typically specialize in integrated operation, warehousing and transportation services that can be scaled and customized to customer's needs based on market conditions and the demands and delivery service requirements for their products and materials.

Source: http://en.wikipedia.org/wiki/Third-party_logistics



Transport Providers: Third Party Logistics (3PL) Providers

- ❑ The usual operations 3PLs provide are related to Warehousing and Transportation (W&T) Services :

Services Provided	Description
Exclusive W&T	<ul style="list-style-type: none"> ❑ One single customer (shipper), ❑ All transportation related procedures are provided from the 3PL ❑ Offer Warehouses, Transportation Fleet & Distribution Centers
Multiple W&T	<ul style="list-style-type: none"> ❑ Multiple customers (shippers) ❑ Warehousing and Transportation Costs / Expenses are shared (leading to cost benefits for all participants)
Specialized W&T	<ul style="list-style-type: none"> ❑ Services such as Warehousing and Transportation of frozed goods or works of Arts.
Peripheral Multi-Customer W&T	<ul style="list-style-type: none"> ❑ Multiple customers are served, for many different product types that do not require specialized services (i.e. companies from distant places or islands)
National Multi-Customer W&T	<ul style="list-style-type: none"> ❑ Same as above ❑ Usually uses larger Warehousing facilities and serves transportation from depot to depot (intra-company distribution)
Transit	<ul style="list-style-type: none"> ❑ Offers only collection, distribution and picking / sorting services

Source: Rushton, A., Croucker P., Baker P.,The handbook of logistics & distribution management, 3th Edition



Third Party Logistics (3PL) Providers

- Apart from the usual operations (warehousing, collection, distribution, picking, fleet management, etc.) 3PLs also undertake other operations that are related to the transport of goods.

Other Services Provided	Description
Assembly Services	<ul style="list-style-type: none"> □ PC manufacturers sent the components (monitors, hard drives, etc) of computers to 3PL companies, where the final assembly (and software installation) is taking place and forwarded to the final destination.
Packing & Repacking	<ul style="list-style-type: none"> □ 3PL companies undertake the packing operations of several products to be transported. □ Additionally, repacking operations (such as containerization, pallets or blister-packing) are performed
Reverse Logistics & Packing Materials Returns	<ul style="list-style-type: none"> □ Due to legislations, packing some packing materials may have to be returned in order to be re-used □ Containers may have to be returned to their starting locations (empty or loaded) □ Damaged or malfunctioned products should be returned to the shipper.
Time-Related Services	<ul style="list-style-type: none"> □ The major 3PL providers support the JIT (just-in-time) operations of major manufacturers by supplying accurately and in the proper volumes (based on production schedules) raw materials or spare parts (i.e. TOYOTA)

Source: Rushton, A., Croucker P., Baker P., The handbook of logistics & distribution management, 3rd Edition



Advantages of 3PL Services

	Description
Cost / Expenses	<ul style="list-style-type: none"> <input type="checkbox"/> Investments to Facilities (warehouses, transshipment centers) or equipment (vehicles, material handling) are not required. <input type="checkbox"/> Costs / expenses are known in advance in detail and based on the transported volumes and distances (usually based on contractual agreements) <input type="checkbox"/> Economies of Scale: It is cheaper for small manufacturers and shippers in contrast to maintain own facilities and fleets. <input type="checkbox"/> It is easier to change the operational logistics model, in order to succeed in more efficient logistics services, than re-engineer the company's own logistics services (if there are already fixed facilities and resources)
Organization	<ul style="list-style-type: none"> <input type="checkbox"/> Companies (shippers) can focus to their core business operations (sales, marketing, etc.) <input type="checkbox"/> Can gain immediate access to intelligent IT & Telematics infrastructure (without the additional cost of investment)
Physical	<ul style="list-style-type: none"> <input type="checkbox"/> Offers great flexibility in market penetration (due to the wide distribution network of a 3PL company) <input type="checkbox"/> 3PL companies offer a wide variety of vehicles that can undertake commodities with specialized characteristics and even use multiple-compartment vehicles that can transport different products simultaneously (i.e. frozen goods with simple product compartments in a vehicle)

Source: Rushton, A., Croucker P., Baker P., The handbook of logistics & distribution management, 3rd Edition



Disadvantages of 3PL Services

- ❑ Apart from the advantages of utilizing a 3PL provider for some of the operational procedures of a company there are also some disadvantages that should be taken under consideration when selecting a 3PL provider or when deciding to adapt a logistics strategy based on 3PL services:
 - ❑ Using 3PL providers may lead to lose control of the distribution and storage procedures of the products (Usually it is managed through contractual agreements and Key Performance Indicators-KPIs)
 - ❑ 3PL providers have a physical advantage in comparison to the shippers (“since they own all related facilities, equipments, systems) and the shipper may start to depend on specific 3PL providers
 - ❑ Shippers cannot gain expertise and experience in distribution and storage operations and processes (and it becomes difficult to re-adapt a non-3PL distribution and storage model)
 - ❑ Service provision issues may arise: (1) the company’s sales and deliveries to customers may not be aligned and in-time and (2) there is no direct contact with customers.
 - ❑ Trust issues may arise: 3PL companies that serve different competitive shippers

Source: Rushton, A., Croucker P., Baker P., The handbook of logistics & distribution management, 3rd Edition



Issues in Transport Management

- ❑ Transport Managers / Dispatchers are facing operational issues daily regarding the organization of the transportation network, the management of the fleet and the management of shipments
- ❑ Some of the problems that should be confronted either in the planning phase of a transportation network or during daily operations are summarized below:
 - ❑ Mode Selection
 - ❑ Route Selection
 - ❑ Fleet Sizing
 - ❑ Vehicle Scheduling
 - ❑ Shipment Consolidation

Source: Kasilingam R.G., Logistics And Transportation, Kluwer, 1998



Issues in Transport Management

Mode Selection	<input type="checkbox"/> Which transport mode to select and how to combine them (intermodal) in order to achieve lower transport costs and better customer satisfaction ?
Route Selection	<input type="checkbox"/> Route selection determines: <ul style="list-style-type: none"> <input type="checkbox"/> The sequence of customers to visit <input type="checkbox"/> The shortest path to follow in order to minimize travel costs and times. <input type="checkbox"/> Vehicles may return to starting location or not, multiple origins / destinations may exist, intermediate may exist or not.
Fleet Sizing	<input type="checkbox"/> Fleet sizing deals with the trade offs between fleet size and customer needs satisfaction. <input type="checkbox"/> The larger the fleet, response time to demands increases but vehicles utilization decreases. In contrast a limited number of vehicles may not be able to cope with the total demand. <input type="checkbox"/> Homogeneous or heterogeneous, fleets exist, with different capacities and different capabilities and characteristics.

Source: Kasilingam R.G., Logistics And Transportation, Kluwer, 1998



Issues in Transport Management

Vehicle Scheduling

- ❑ Vehicle Scheduling deals with time-related options / decisions in routing problems.
- ❑ Main decisions to be answered are what time to send shipments, how many vehicles and when to dispatch them , when to serve customers with specific time-windows, etc.

Shipment Consolidation

- ❑ Answers to questions regarding when, where and how to group shipments with same or similar characteristics (i.e. can be loaded to the same vehicle) in order to achieve in minimized transport costs.
- ❑ Shipments can be grouped by time (serve similar customers in same day), inventory (increase order sizes and achieve order discounts) or hub-resource (use an intermediate station - warehouse in order to consolidate shipments and use larger vehicles to their final destinations)

Source: Kasilingam R.G., Logistics And Transportation, Kluwer, 1998



Transport Operations Costs

Various cost factors have to be taken under consideration in order to generate the cost associated with Transport Operations. Costs are related to routes, terminals, vehicles, personnel.

- Cost can be separated in Capital and Operating and costs
- Capital costs** include:
 - Facilities cost** (investment in route, terminals, distribution centers)
 - Equipment cost** (vehicles, containers)
- Operating costs** include:
 - Maintenance costs** (facilities, equipment),
 - Transport cost** (fuel, tolls)
 - Personnel costs** (drivers and admin salaries, overtimes)

Source: Kasilingam R.G., Logistics And Transportation, Kluwer, 1998

