8 Logistics Network Planning

Learning Objectives

Designing logistics systems means dealing with complex planning and decision problems. The following chapter will examine details and strategies in logistics planning with a focus on planning logistics networks, warehouse networks, and transport networks.

Besides basic structures and configurations of logistics networks, the reader will be introduced to contemporary concepts of designing transport and storage networks. These are mainly employed in distribution. As logistics networks are increasingly being operated by the logistics service providers, this chapter will highlight aspects of outsourcing, tendering, and selecting transport and logistics service providers.

Keywords

- Planning tasks and details
- Logistical goal conflict
- Logistics networks and structures
- Warehouse network structure
- Transport network structure
- Cross docking
- Capacity planning
- Warehouse layout planning
- Outsourcing

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8.1 Strategic Network Planning

The strategic logistics goals which network planning is trying to reach are improvements of the logistics performance. The goal conflict between market-driven logistics services and minimal logistics costs poses a distinct challenge (see Fig. 8.1).

The image of the product and the resulting customer expectations define which service is in line with the market. The definition of low logistics costs varies from company to company. Minimum costs, however, are always the goal.

For the basic strategic logistics network planning, the synoptic or the incremental planning approach can be employed. The synoptic approach is based on long-term goals; the processes necessary for reaching these goals are comprehensively, gradually, and systematically introduced. The incremental approach, on the other hand, finds solutions to subproblems without explicitly defining goals in advance. This is why the latter strategy is often called a strategy of incoherent steps or muddling through.[1] A general statement about which planning approach is to be employed for the respective problem cannot be made. The synoptic approach stresses a structured working method while the incremental approach provides more room for creativity.

The general method of strategic solution finding – which is also valid for logistics planning processes – is divided into three steps:

- Definition of guidelines
- Strategy formulation
- Strategy implementation

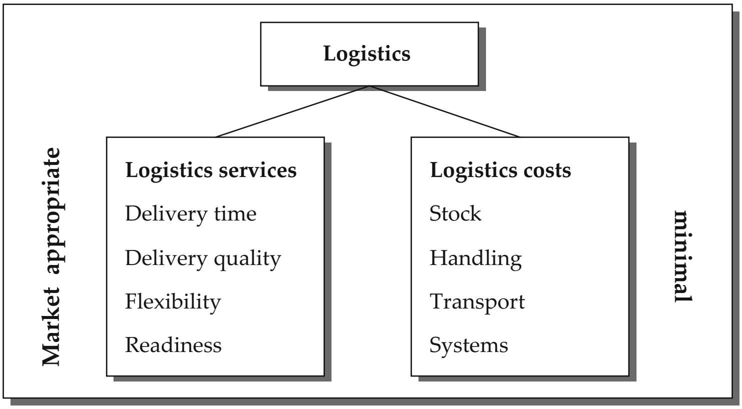

Fig. 8.1 Goal conflict in logistics performance (Cf. Schulte (2009), p. 8 et seq)

[1] Cf. Bea/Haas (2009), p. 221.

Guidelines are based on general company goals and values. They are the starting points for logistical s*trategy formulation* (see Sect. 3.1). The first step is to examine the company environment to find chances and risks, and the company itself for strengths and weak points. The results are used to develop different strategic options from which the preferred logistics strategy is chosen. During the *strategy implementation*, strategic programs are created which help to employ the strategy. The results from implementing the new logistics strategy are compared to the original goals. If the goal and the result deviate from each other, changes to the strategy will be made at the beginning of the decision-making process.

The following will give an overview about common logistics network models and their advantages and disadvantages. They are the basis for strategic planning processes.

8.2 Overview Logistics Networks

8.2.1 Representation of Logistics Networks

The planning task of logistics and supply chain management is to create the preconditions for entering new markets, in order to introduce new or existing products into these markets as successfully as possible. This necessitates the creation and maintenance of a corresponding logistical infrastructure – i.e. logistics networks – for procurement, production, and distribution logistics. The following chapter focuses on the planning of warehouse and transport networks for distribution logistics.

Logistical networks can be represented using a graph-theoretical representation of vertices and edges. Vertices represent the realization of physical processes, e.g. warehousing, handling of goods, or data processing. Edges represent the installations for transport processes, flow of goods, and information transmission. Such a net then consists of sources of goods, e.g. manufacturers' plants, points of sale of merchant intermediaries, and the locations of consumer demand.

A detailed description of logistical nets is possible by further division into relevant levels:[2]

- *Functional level*: Description of tasks for the distribution of goods (warehousing and transport)
- *Process level*: Details about the number of stages in the process (degree of fragmentation of the supply chain)
- *Spatial level*: Localization of the logistical process actualization
- *Institutional level*: Aspects of the organizational realization (creation and tasks of functions and processes)

[2] Cf. Stieglitz (1999), p. 91.

8.2.2 Domains of Decision Making in the Network Design

Domains of decision making in the network design can be divided – according to their time horizon and their contents – into strategic, tactical, and operative aspects. The following planning contents may serve as an example:[3]

- *Strategic (long-term)*
  - Problem of gradation: Gradation/function of the vertices
  - Problem of locations: Location of the vertices
  - Problem of numbers: Number and dimension of the vertices
  - Problem of allocation: Allocation of sources of goods and points of consumer demand to the vertices
- *Tactical (medium-term)*
  - Transport organization
  - Allocation of stock and representation of stock size within the network
  - Definition of the purchase and supply frequencies
  - Definition of the inventory management structure
- *Operative (day-to-day)*
  - Vehicle employment and route planning
  - Definition of the ordered quantities and order times

8.2.3 Structures of Logistics Networks

Regarding the complexity of logistic networks, distinctions can be made between one-step direct nets, two-step indirect nets, multi-step indirect nets and hybrid, and combined nets. Figure 8.2 shows examples from consumer goods logistics with respect to the distribution. These basic structures can also be applied to other fields (see Sect. 12.2).

[3] Cf. Stieglitz (1999), p. 97; Corsten and Gössinger (2007), p. 155 et seq.

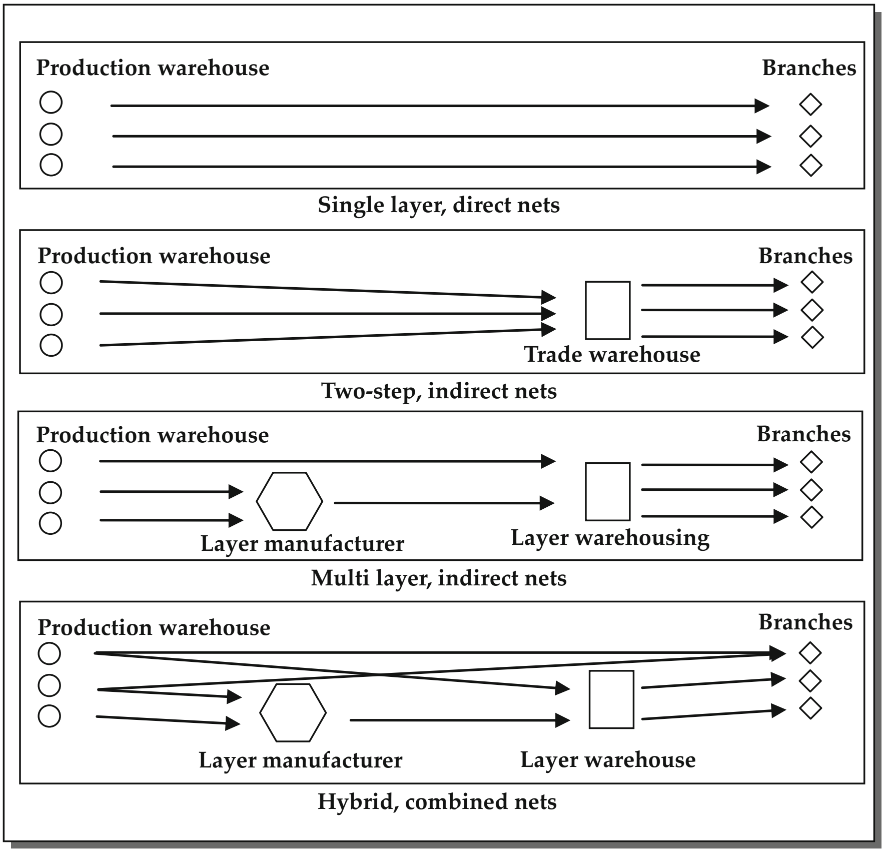

Fig. 8.2 Representation of a network for the flow of goods (Cf. Stieglitz (1999), p. 95)

8.3 Warehouse Networks

8.3.1 Warehouse Network Planning

The locations of network nodes are defined during the process of *location planning*. Changes in the strategic framework conditions are often the reasons for location problems. Possible dimensions of decision-making are:

- Production versus distribution locations
- Static versus dynamic time horizons
- One- versus multi-product strategy

Location factors are divided into quantitative (e.g. transport costs, property prices, staff costs, support measures, taxes) and qualitative factors (e.g. geographical location, condition, infrastructure, possibilities for recruitment, legal aspects). These factors inform location strategies aimed at the creation of capacity: adding capacity

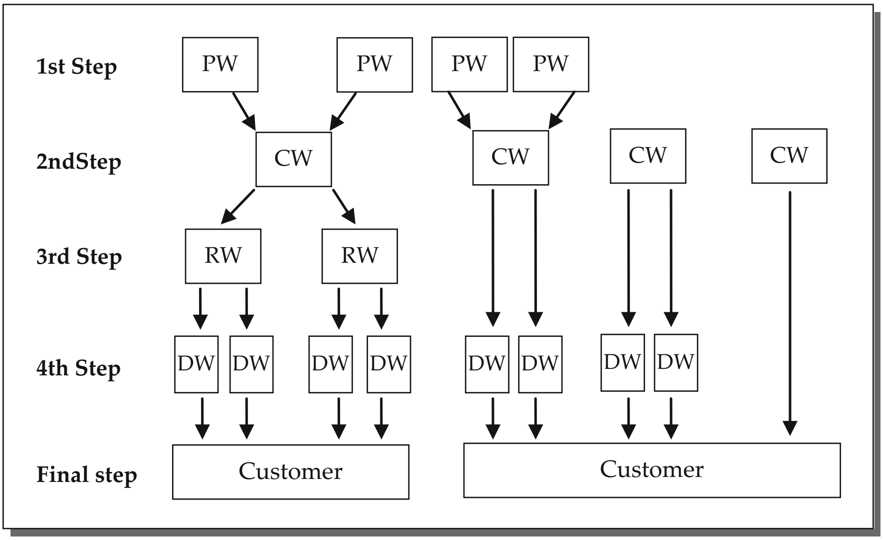

Fig. 8.3 Number and degree of centralization of distribution systems (Cf. Schulte (2009), p. 460)

in new regions or increasing capacity in existing locations; capacities may also be concentrated in existing locations by (partially) shutting down other locations.

For any location, the structure of a warehousing system is analyzed as a vertical one and a horizontal one. The horizontal structure is defined by the number, capacity, and geographical location of the warehousing and handling processes on every warehousing stage; it defines the degree of centralization of a distribution system. The vertical structure of local warehousing and handling processes defines the hierarchy and the number of steps of a warehousing system. Figure 8.3 shows these correlations.

The definitions of the resulting warehousing types are as follows:[4]

- *Production warehouse (PW):* Storing of finished goods from a production site for short-term balancing of stock volume
- *Central warehouse (CW):* Storing of a full product range, supply for lower warehouse levels or, in a centralized structure, for distribution to deliver a customer order
- *Regional warehouse (RW):* Buffer for a specific sales area to relieve earlier or later warehousing stages
- Distribution warehouse (DW): Separation function to compile the ordered quantity in a specific sales area (spot delivery)

8.3.2 Degree of Centralization

With the existing goal conflicts between centralized and decentralized structures, the decision about the *degree of centralization* of a distribution warehouse system is an

[4] Cf. Delfmann (1999), p. 193.

important one. There are two basic advantages to centralized warehouse concepts: First, the possible reduction in the number of connections between the points of delivery and the points of receipt; second, the possibility to considerably reduce the stock, especially the safety stock. Additional, more efficient warehouse technologies, e.g. automated, which are only profitable with a large handling volume, can be employed. This is why for some time there has been a trend to reduce the number of warehousing stages. Centralization and direct supply to companies is more and more taking the place of multi-stage decentralized structures.[5]

Centralization of the warehouse can be achieved by eliminating a full warehouse level or by reducing the number of warehouses on one level. These measures lead to a decrease in the *density of the warehouse network* which means the total volume of goods is stored in fewer warehouses. This, however, creates a higher potential for bundling in delivery to warehouses. The catchment areas of the warehouses – represented e.g. by the average number of branches supplied to by one warehouse – grow. This results in the average *transport distance* growing. On the contrary, the creation of a decentralized regional warehouse system is opted for if the delivery time is the most important factor, i.e. in cases where the supply from a central warehouse to individual regions could only be realized with delivery times or at delivery costs not tolerated by the market.

A concept often practically applied is *selective warehousing*. This is a two-level warehouse structure in which goods with a low prognosis risks, e.g. fast-moving goods, are stored in decentralized regional and spot delivery warehouses that do not carry the full product range. Inventory and B and C articles (slow-moving goods) are centrally stored to economize the stock (see Fig. 8.4).

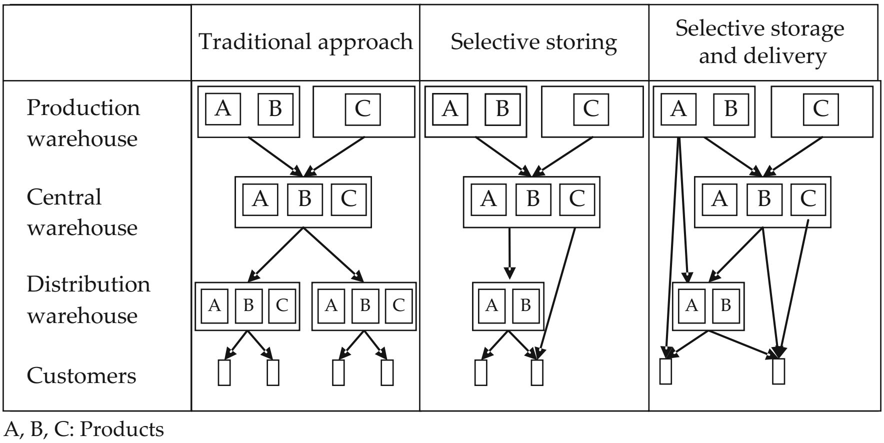

Fig. 8.4 Concept of selective warehousing (Cf. Schulte (2009), p. 460)

[5] Cf. Baumgarten and Thoms (2002), p. 53.

In addition to selective warehousing, further optimization is possible if goods are delivered from the points on which they are stored without touching warehouses on earlier or later stages. This is called selective delivery. Both concepts are often employed in spare parts logistics.

Case Study 8.1: Spare Parts Logistics

The company *Bosch und Siemens Hausgeräte GmbH (BSHG)* manufactures home appliances. It was founded in 1967 as a joint venture between *Robert Bosch GmbH* and *Siemens AG*. The company now has 43 plants in 15 countries in Europe, the USA, Latin America, and Asia.

The basic requirement of fast troubleshooting is an effective spare parts logistics. It directly becomes a part of customer experience. Therefore it is also temporarily much more coupled to the time of the resale. This insight has inspired the slogan *The first product is sold by the sales department; all further products are sold by the service*. In 2000, the project Total Customer Logistics was started. The individual steps were gradually implemented by 2005. The foremost goal was an increase in customer satisfaction while reducing the costs at the same time. The logistics concept that was created will be shortly introduced.

The global spare parts logistics network is based on the global manufacturing networks of the product areas. Globally, there are seven *central warehouses* on four continents. To prevent uneconomical small transport activities, intercontinental moving of goods is consolidated on the central warehouse level. The flows of goods are clearly defined. The BSHG plants deliver goods only to the central warehouse assigned to them. One central warehouse is assigned to the subsidiaries in every country. The BSHG's largest *central spare parts warehouse* is located in Fürth, Southern Germany. With the introduction of direct delivery from a central warehouse, it was possible to shut down eight *regional warehouses* in seven European countries and 55 *customer service warehouses* in Germany and Austria (see Fig. 8.5).

By now, 800 customer service technicians in Germany, Austria, Belgium, and the Netherlands receive spare parts overnight directly from the Fürth central warehouse. Orders from German technicians are taken every day until 3 p.m. After the order-related commissioning, the parts are handed to the transport company in reusable boxes for delivery by 7 a.m. the next day – directly to the technician's vehicle or to another point previously agreed on. Parts not needed on the previous day are returned. Secondary processes like sorting, disposing, and new packaging are integrated. Prior to each order, a clear statement is made which spare part is needed. For this, the stock lists and exploded drawings are available on the brand homepages, besides a number of general information.

The size of the appliance which is to be repaired determines the logistics strategy: *repair at the customer's* or *repair in a workshop*. In Europe, more than 2,000 company technicians are responsible for repairing stoves, washing machines, dish washers, and cooling devices directly in households. Small appliances, on the other hand, are repaired in central repair workshops to use the economies of scale of centralization.

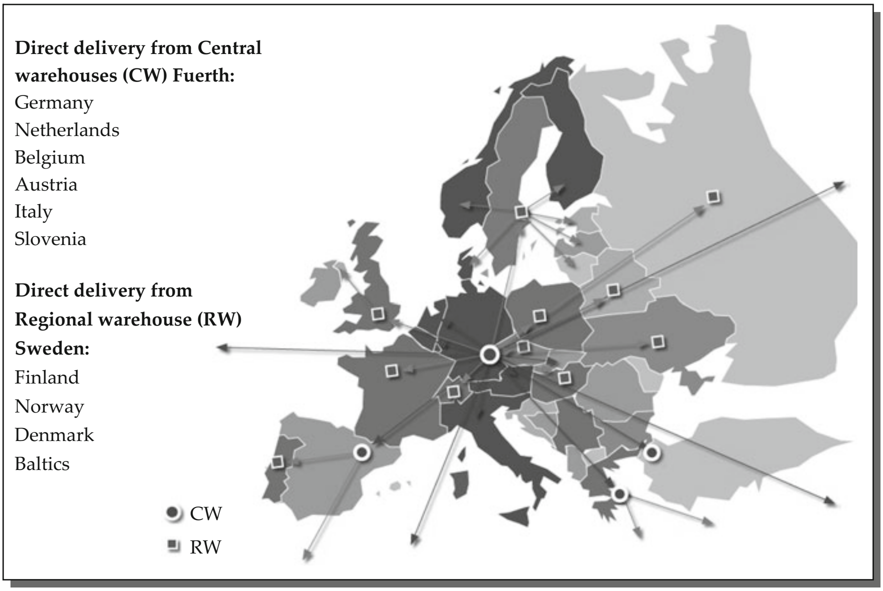

Fig. 8.5 Logistics network BSHG (BSH GmbH (2005))

With this concept, including its effects on the repair and core business, customer satisfaction could be measurably increased during the last 5 years. Further market share in the core business could be won and the costs for spare parts logistics could be lowered by 26 %.

8.3.3 Capacity Planning

The configuration of the warehouse network substantially influences the required floor space, the spatial and staff capacities, as well as the layout of a warehouse location. Furthermore, the technical equipment on storage, handling, and sorting installations and the resulting process organizations must be considered.

The *capacities* can be divided into qualitative and quantitative aspects. The qualitative achievement potential of a warehouse location must be in line with the respective customer and order requirements regarding flexibility and productivity. Quantitative capacity dimensioning defines which capacities are actually available for a given period of time. It has to consider the current order volume – e.g. represented by the number of storage places, the number of orders within a given period of time, and the chronological demand history – with respect to the possible monthly, weekly, daily, or shift performance.

Anticipatory capacity planning must also take in account that the spatial and handling potentials as well as the staff capacity of a warehouse location must cover different workload volumes. Expected dimensions, ranges, and times of demand fluctuations must be part of the planning. Most of all when planning commissioning capacities, solutions which are balanced between the danger of too limited capacities – especially during (seasonal) peaks – and the problem of too small workloads must be found. Staff adjustments to demand fluctuations are possible with flexible work time models using working time accounts (e.g. for a full year) and by employing part time and temporary staff. However, possible negative effects on commissioning quality, productivity, and reliability must be considered.

The defined processes necessary to realize the desired result are planned in *process organization.* The necessary qualitative capacities are largely defined based on the class and degree of automation of the equipment as well as the corresponding qualification requirements of the staff. It must be noted that a possibly desirable high degree of automation, described as the relation between equipment performance and staff performance, is considerably influenced by the types of storage and commissioning tasks, the homogeneity of the goods, as well as the degree of palletization of the packaging. This has effects on the quantitative capacity characteristics like possible order processing times and performance features that are, in turn, to be considered for the qualitative capacity planning.

8.3.4 Layout Planning

Besides the projected number of orders or the number of goods to be stored, *layout planning* demands a rough idea of the flow of goods which is influenced, among others, by the warehouse technology that is employed and by the spatial arrangement of the equipment. Layout planning can be divided into basic and fine layout planning. In basic planning, the property and building layout is planned based on the local circumstances. Besides the dimensioning of the full floor space requirement, the structuring of the floor space for the warehouse and for the yard (e.g. parking, waiting, and maneuvering spaces for vehicles and load carriers) must be planned. Furthermore, enlargement options of the location must be taken into account. Steps in the *building layout* planning are: the definition of the number and the arrangement of gates and ramps; space and room requirements for discharging, conveying, storing, commissioning, temporary storing; providing and other functional areas; the spatial arrangement and the shape of the building which represents the fine layout planning. (see Sect. 4.2.6).

With respect to the floor space capacity of the mentioned functional areas, the *technical equipment* of the storing, sorting, and commissioning areas (shelves, packaging machines, palletizers, lifting trucks, stackers) must be specified, as well as the *staff capacities* according to their numbers and necessary qualifications. The focus of the quantitative dimensioning of e.g. the commissioning capacities would be planning the staff requirements and deployment. Based on the expected volume of orders – as seen from the number of orders, number of order items, and number of pieces per order item within a given period – the number and working times of the staff, determined by the number and length of the shifts, is defined.

8.4 Transport Networks

8.4.1 Transport Network Planning

For logistics networks, the planning of the *transport networks* must occur analogue to the planning of the warehouse structures. Tasks of transport comprise supplying goods to plants, warehouses, and selling places as well as the disposal of materials and goods which are no longer needed. The transport services necessary for this are realized in transport nets. Transport nets consist of vertices, joined together by edges. *Vertices* of transport nets are sources, selling, and handling points. The first and the second point are locations where transport objects enter or leave this transport net; loading and discharging processes take place here. *Edges* connect vertices by transporting. The appearance of the edges is partly determined externally, e.g. by the traffic route. Two relations lie on one edge. One relation is a source-shopping point relationship (sender-receiver).

The task of *transport network planning* is to design the process organization of the transport of goods between the sources and the selling points. The goal is to create a net with the most effective transport connections between the individual points by using the given infrastructure. Transport net planning defines whether the edge is realized by regular or irregular transport intervals. Regular transport intervals are scheduled based on demand projections and framework contracts. Irregular transport intervals are planned based on existing transport orders (see Chap. 5). Table 8.1 gives an overview of the basic elements of transport nets.

Table 8.1 Basic elements of transport nets (Adapted from Janz (2003), p. 21)

	Vertices	**Edges**
Function	■ Source, selling point ■ Handling point (type)	■ Short distance ■ Long distance
Institution	■ Transport contractor ■ Sub contractor ■ Cooperation partner	■ Transport contractor ■ Sub contractor ■ Cooperation partner
Characteristics	■ Road accessibility ■ Loading and discharging areas ■ Floor space ■ Staff ■ Tools ■ Handling technology ■ Warehouse equipment	■ Traffic infrastructure ■ Number and types of vehicles ■ Employed vehicles ■ Geographical characteristics ■ Distances ■ Altitude differences
Organization/ processes	■ Sorting processes	■ Regular transport intervals ■ Irregular transport intervals

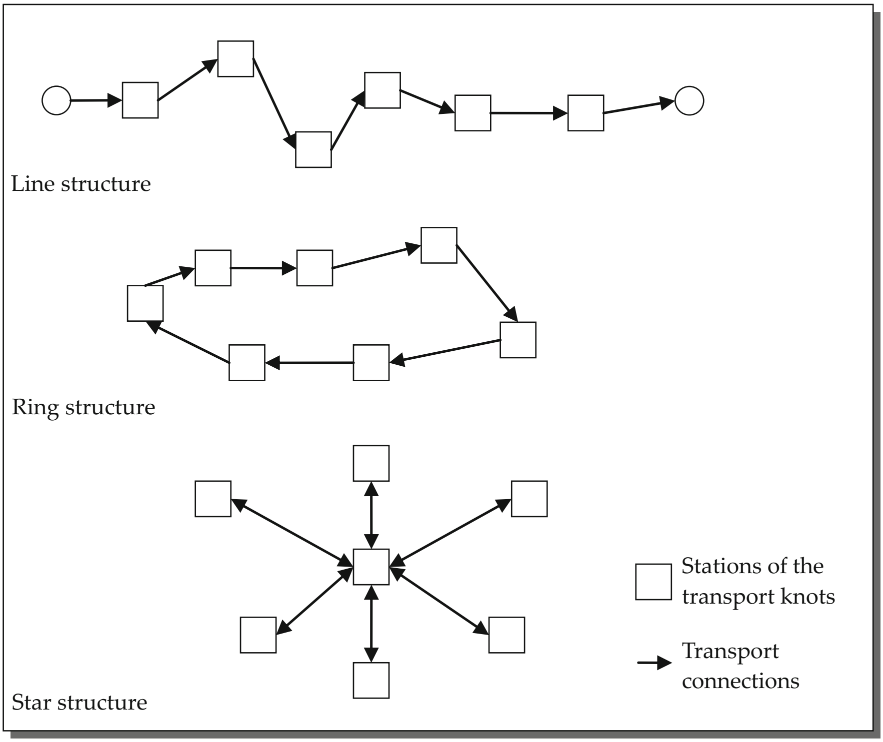

Fig. 8.6 Forms of net structures (Cf. Gudehus (2010), p. 778)

8.4.2 Transport Network Configurations

Configurations of transport nets can be divided into one- or multi-stage forms of line, ring or star structures; see Fig. 8.6.

Consecutively arranged vertices and edges characterize line structures. In this structure, transports have a high number of empty runs. Those tend to be prevented with ring traffic. The average vehicle utilization is increased and the cycling of the means of transport is optimized. From these basic network structures, further forms can be derived which are employed mainly in practical transporting: grids, hub and spoke nets, and hybrid net structures (mixed forms).

In *grids nets,* all shipping and receiving depots are connected by direct traffic (complete network). There is a direct exchanging of goods. There is no need for an additional exchange of goods. The individual depots have a collecting and a dispatching function as well as a sorting and providing function for the main run. The number of relations in such a direct transport net increases squarely with the number of depots (see Fig. 8.7).[6]

[6] Cf. Vahrenkamp (2007), p. 262.

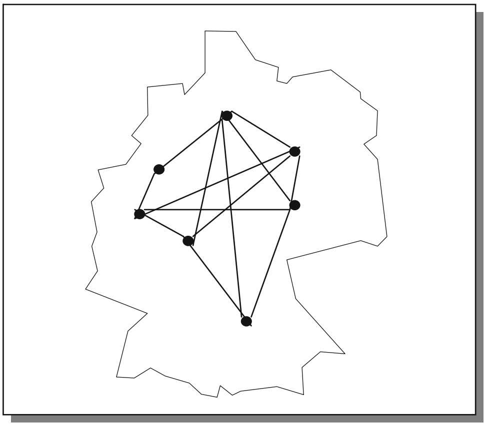

Fig. 8.7 Net configuration: grid

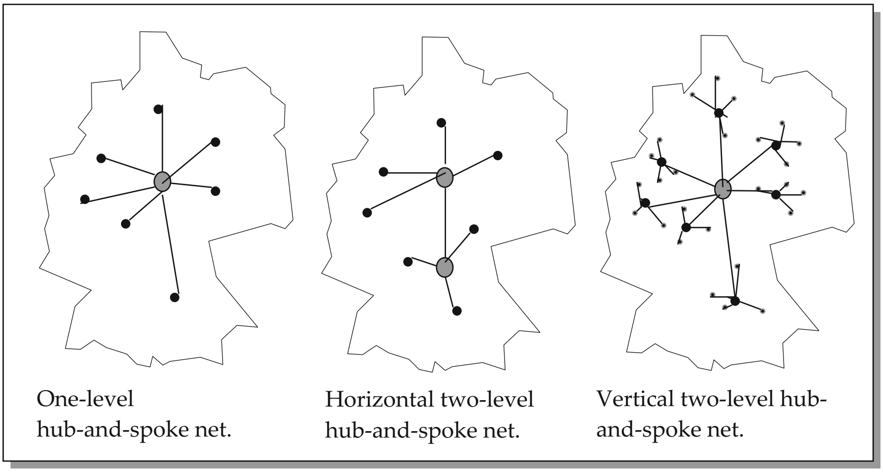

Fig. 8.8 Net configuration: hub-and-spoke

Hub-and-spoke nets are characterized by the traffic between the dispatching and the receiving depot being channeled to and from a central handling depot (hub). There are no direct ways between two depots, i.e. all transports are made via the hub(s) (see Fig. 8.8).

Functions of depots are sorting, consolidating, and forwarding. They are distributed across the area that is to be supplied; they have a regional collecting and delivering function. The number of relations for a hub is exactly twice as high as the number of depots.

The number of connections for hub-and-spoke traffic is calculated as follows:

$$\text{n connections}\,(\text{n} = \text{number of depots}).$$

For exclusive point-to-point traffic in grids, the number of connections is calculated as follows:

$$(n-1)+(n-2)+\ldots+1 \text{ connections or : } [n^{*}(n-1)]/2.$$

Case Study 8.2: Hub and Depot Planning

A logistics service provider is planning a distribution network in a new location. The focus is on the reduction of connections because of a calculation showing that many small flows of goods and many ramp contacts are pushing costs. Ten depots are needed to cover the area.

Calculate the number of connections for a hub-and-spoke system and the point-to-point traffic.

With the result, what do you recommend and what must be considered when comparing the costs?

Hub-and-spoke systems realize bundling advantages. By transporting shipments with different destinations when feeding into the hub or shipment from different sources when delivering from the hub, vehicles can be utilized better (economies of density) or larger vehicles can be employed (economies of size). At the same time, the sorting efforts in the depots (spokes) are reduced because the shipments must be *sorted* to one relation only, the hub. Thanks to the consolidation by the hub, larger quantities may be transported as an unsorted complete shipment from a customer directly to the hub. Without the hub-and-spoke concept, transports on routes with little traffic could only be offered with a high time bundling (see Fig. 8.9).

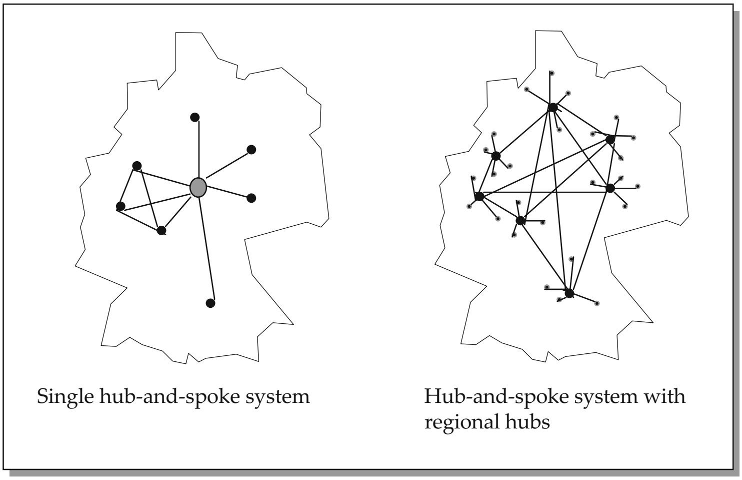

Fig. 8.9 Combinations of grid and hub-and-spoke nets

Indirect routes and additional handling processes are disadvantages of hub-and-spoke systems. Decision criteria for implementing a hub-and-spoke system are the volume of goods to be transported within the net, the time reserves available for the consolidation steps, and the costs necessary for installing consolidation stations.

Besides pure grid and hub-and-spoke systems, there are a number of *combinations of these two configurations*. In such a net, relations with little traffic are supplied via a hub; relations with a high traffic level are supplied directly. Additional options are *single hub-and-spoke systems* and *hub-and-spoke systems with regional hubs*.[7]

Case Study 8.3: Distribution Nets

Sites where goods are stored, handled, or compiled according to customer or order requirements are called distribution centers. From experience, different forms of distribution centers have developed. With respect to their functions, they are divided into regional and trans-regional distribution centers. A 2006 study by a logistics initiative from the German state of North Rhine-Westphalia shows different modes of use for such distribution nets in different forms in this state.

Regional distribution centers are mostly pure delivery sites operated by retailers for supplying goods to their branches. On average, e.g. the regional logistics centers operated by the retailer *Aldi Sued* supply consumer goods to 50 branches in a region. An Aldi Sued distribution center has an average size of 2.5 ha and an average property size of around 20 ha. In one center, 150–180 people are employed. The investment volume for every site is 40 million Euros. A different example for regional distribution centers is the food warehouse in Oberhausen, Germany, operated by the company *Lekkerland* which, among other activities, supplies convenience goods to gas stations. On a 10 ha property, a center in one configuration stage has been built. It has a floor space of 1.8 ha and employs 500 people.

Trans-regional distribution centers are, among others, used for central storing and delivering goods to regional distribution centers. In Europe-wide distribution structures, trans-regional centers also have the function of national distribution. Such centers are mostly located in peripheral regions with important trans-regional traffic connections (interchanges, terminals for intermodal transport) and strategically planned near markets and production sites. The distribution center operated by the drug store chain *dm Drogeriemarkt* in Meckenheim near Cologne is an example of a trans-regional distribution center. The goods are supplied by the manufacturers, stored, and compiled for the branches as needed. The distribution center has a size of 2 ha on a property of 6.5 ha. Around 50 million Euros have been invested, and 500 jobs are planned. Besides the center in Meckenheim, dm owns four more in Germany. An example

[7] Cf. Arnold et al. (2008), p. 784 et seq.

for the distribution using only one national distribution center is the e-commerce company *QVC*. On a 6 ha property, the company invested 100 million Euros in Hueckelhoven, Germany. About 1,000 employees work there.

Besides regional and trans-regional distribution centers, more and more *European distribution centers (EDC)* are built as a byproduct of market expansion. One advantage is that the goods can be stored in one location, regardless of their origin. Orders can be compiled fast and efficiently and delivered to large European customers. The distribution center operated by *3M* in Juechen is an example of an EDC. Besides Germany, 3M products are delivered to the Netherlands, Denmark, Sweden, Norway, Finland, Poland, and Russia from there. The European distribution center is 4.2 ha and a total investment volume of more than 50 million Euros. At the moment, 200 people are employed by the center. Another example of an EDC is the site operated by the cosmetics manufacturer *Shiseido Co, Ltd*. in the Duisburg harbor. The flows of goods from the production sites are bundled there and distributed across Europe to around 6,000 trade partners. The distribution center which is located on a 4 ha property is not operated by Shiseido itself but by the logistics service provider *GEODIS*. As contract logistics service providers, more and more specialized companies operate full distribution sites of customers from industry and trade; as a part of industry logistics concept, they may also build distribution centers for their customers (see Chap. 12). An example is the logistics provider *Fiege*, which is building a 4.2 ha logistics center for the tire manufacturers Bridgestone/Firestone and Yokohama in Dortmund. Another example is the outsourcing of production logistics of the confectionery producer to the logistics service provider *tts Global Logistics*, which in the meantime has been taken over by the Fiege Group. Since then, the logistics have been handled in a 3 ha central warehouse in the logistics park Cologne-Eifeltor with around 90 employees.[8]

8.4.3 Transport Consolidation

Another design variable of transport nets is *transport consolidation,* which has to be a part of the planning. Consolidation is the combination of shipments by more than one loading and/or receiving points during collection and/or distribution runs. Such a route-related consolidation follows the consignment and/or consignee acceptance[9] approach, as shown in Fig. 8.10.

[8] Cf. NRW Landesinitiative Logistik 2006, p. 48 ff.

[9] Cf. Ihde (2001), p. 225 ff.

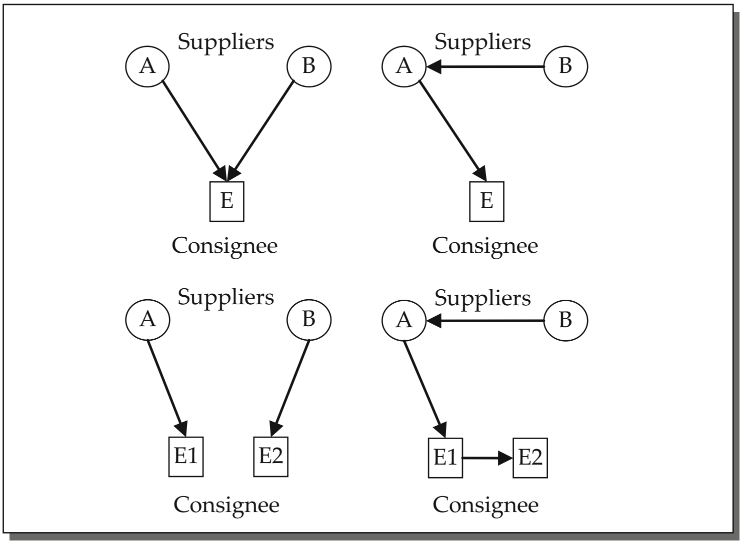

Fig. 8.10 Load and consignee acquisition (Cf. Ihde (2001), p. 226)

Consolidation can also be achieved by including a handling point without stock (transit point): Shipments are regrouped according to relation and receiver. Effects of consolidation are, among others:

- Creation of polynomial transport chains
- More effort compared to direct delivery
- Additional handling processes
- Growing scheduling efforts for the flows of goods to be consolidated
- Better utilization of the means of transport because of a higher relation-related quantity
- Creation of constant connections in cases of long-term trading relations

In procurement and distribution logistics of the consumer goods industry, numerous *consolidation concepts* are employed.[10] Table 8.2 gives an overview about the most important ones.

The *multi-pick concept* says that the ordered quantities of a retailer and its branch for a defined replacement period are collected during a defined tour of manufacturers and sent bundled to the trading warehouse (see Fig. 8.11).

This requires giving the collecting and delivering job to one logistics service provider. Effects are the increase of the average utilization of means of transport and of the discharged quantity per delivery.

The *by-pass concept* includes picking up shipments that are already commissioned for the branch at the manufacturer site. The goods are not stored

[10] Cf. Stieglitz (1999), p. 150 ff.

Table 8.2 Consolidation concepts
(Cf. Stieglitz (1999), p. 150)

Point of acceptance \ Location of the branch-related commissioning	Transit point	Manufacturer/supplier
Trade warehouse	*Multi-pick concept*	*By-pass concept*
Branch	*Cross docking*	*Direct store delivery*

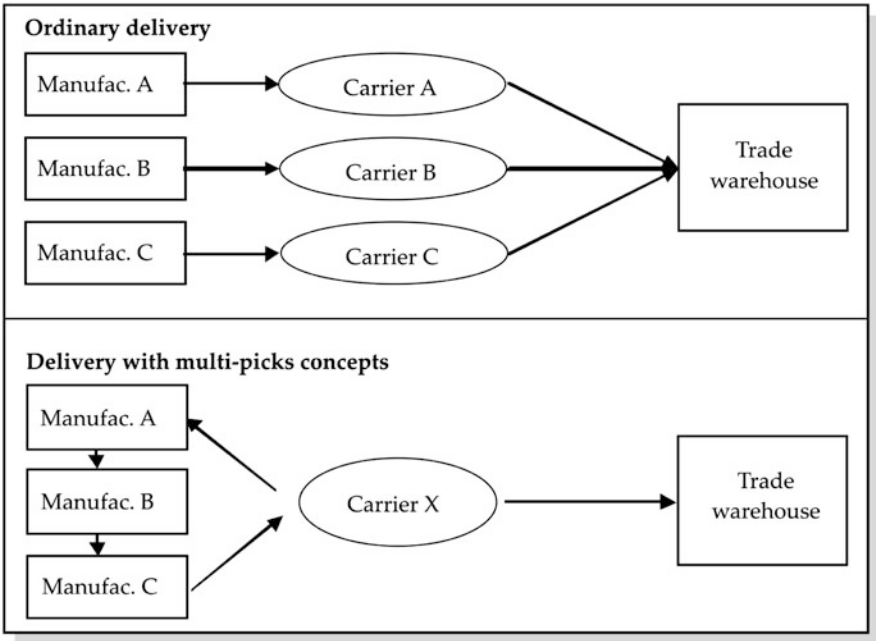

Fig. 8.11 Ordinary delivery versus delivery with multi-pick concepts
(Cf. Stieglitz (1999), p. 150)

but passed through. During this process, an order joining takes place with branch shipments from the warehouse of the retailer. With the branch orders being divided into order parts (warehouse and manufacturer), not only the provision of the shipment from the trade warehouse must be realized in the order cycle but also the branch commissioning by the manufacturers. Advantages are the reduction of handling efforts as the loading and discharging processes in the warehouse are no longer necessary.

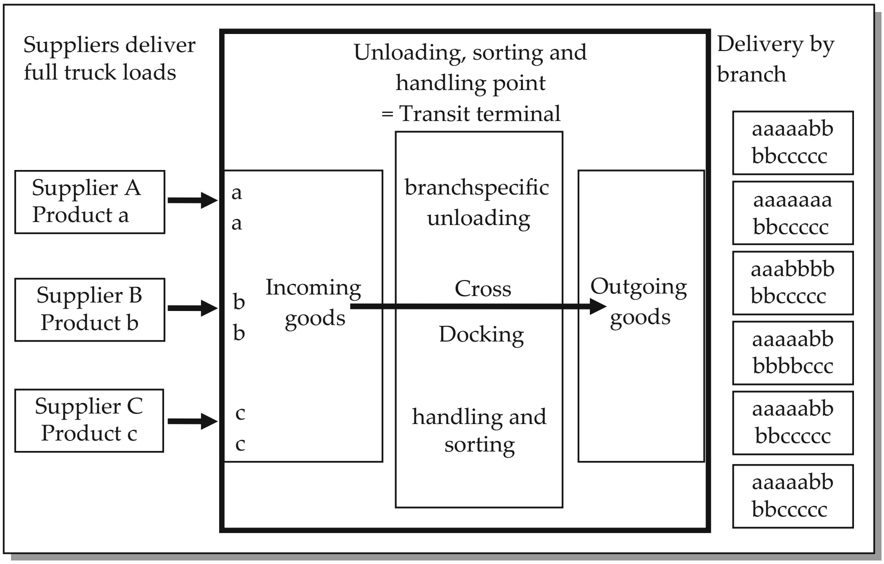

Fig. 8.12 The cross-docking principle (Cf. Kotzab (1997), p. 159)

The *cross-docking* and *merge-in-transit concepts* are closely related to the reduction of warehouse levels.

For cross docking, the handling process means that goods are cross-exchanged (cross) between delivering trucks from different carriers that dock to the goods receipt of the transit terminal at the same time (docking) and empty delivery vehicles which are ready for loading in the goods outwards. The basic requirement for this concept is advance information, in order to control the operation factors; i.e. there must be a clear coordination regarding minimum and maximum order volumes with the suppliers. High reliability is required here, with no stock buffer planned between the manufacturer and the branch. The cross-docking platform must be able to handle a high volume in little time. Some effects are a clear reduction in the order lead time, from the placement of the order to the goods arriving at the branch, a reduction in stock in the branch, the increase of the goods handled, and the storing and take-out processes no longer being necessary (see Fig. 8.12).

With respect to its steps, cross docking (CD) can be divided into:

- 1-step CD: The manufacturer commissions for the branch in advance; then the shipments of more suppliers are joined in the cross-stocking point for the delivery to single branches without manipulation to each shipment (e.g. pallet) itself.
- 2-step CD: The manufacturer sends pallets by sort that are recompiled at the cross docking point for final shipments to single branches.

The *merge-in-transit* concept must be seen in the context of production sites located all over the world which makes it more and more necessary to join products from a customer order not in a warehouse but to merge the individual items in handling terminals (in transit) to complete orders before the actual delivery.

The *direct-store delivery* concept makes it possible to compile the goods for a branch already at the manufacturer. The latter must make the commissioning efforts. Depending on the size of the shipment (vehicle utilization) combined runs can be made directly to the branch or compiled in a transit point after handling of the shipments with respect to the relation to define delivery runs.

The basic possibilities for using consolidation potentials usually depend on the terms of delivery agreed on by the supplier and the customer. They are important instruments, especially in international movement of goods. The interpretation of standard contract terms is defined in the International Commercial Terms (INCOTERMS), which regulate the obligations of buyer and seller regarding costs and risks. The terms EX Works (EXW), Free On Board (FOB), Cost, Insurance, Freight (CIF), and Delivered Duty Paid (DDP)[11] are common. With this, the terms of delivery determine acquisition price.

The following will examine the choice between DDP and EXW more closely.

In case of *DDP*, the suppliers bear the costs and corresponding duties, e.g. for delivery time and condition. Sometimes they will assume further duties like e.g. the discharging of the goods. The buyer will assume the risk at the point of receipt, i.e. the seller is responsible for complete and punctual delivery.

In case of *ex works*, the buyer bears the transport costs and takes responsibility for delivering the goods to their destination. The supplier does not need an own distribution structure. The buyer must organize the planning and controlling of the collection and delivery at the points of receipt and order a logistics service provider. Changes in the terms of delivery from DDP to EXW are becoming more and more common. Basic requirement for changing to EXW is the bundling of volume from individual or cooperating manufacturers.

With the freight costs a part of the pricing for DDP, it must be ensured that the correct freight cost is calculated for EXW. The changes in the terms-of-delivery strategy influence the distribution of the system leadership for goods movements. This may result in strong conflicts of interests between the supplier and the buyer (see Sect. 3.3.2), which is especially true for the cooperative division of the savings resulting from the consolidation.

Case Study 8.4: Net Design of METRO Group Logistics

MGL METRO Group Logistics is the logistics service provider for all companies of the METRO Group. As logistical service and competence center, METRO Group Logistics controls the flows of goods of the METRO Group sales brands. With founding of METRO Group Logistics in 1995 and the implementation and further development of the innovative concept of procurement logistics, the METRO Group was able to strongly increase efficiency. The core points of this concept will be briefly examined in the following.

[11] Cf. Pfohl (2000), p. 189 et seq.

The network structure was changed to a mix of relation loading, direct loading, and classic goods transport. The cross-docking terminals are located in a way that there are always handling points close to branches and suppliers. The disadvantages of ordinary cross-docking structures which often feature some less central terminals for the complete branch supply, causing unnecessarily long ways, are no problem. Each one of the three distribution systems is employed efficiently. The relation loading to terminals near the branch is suitable for suppliers with a large share in the product range; their trucks can cover longer distances without handling. Secondly, direct delivery from cross-docking terminals close to the manufacturer to large branches is suitable as soon as the trucks are fully utilized. Thirdly, in all cases in between, i.e. for all ways between suppliers with smaller quantities and branches with a smaller daily requirement, the system provides for a transport with two interruptions. For this, the collected shipments from different suppliers in source regions are consolidated into main run relations. In the destination regions, goods from different suppliers and source regions are delivered to different branches, which can be described as classic transport of goods. The network structure can be seen in Fig. 8.13.

By using many possible vertices in the source or destination regions, the METRO Group Logistics system uses the advantage of shorter distances, which prevents many unnecessarily long transports. The large number of cross-docking terminals would be, were they owned by METRO Group, uneconomic. The logical – but until then uncommon – consequence was using the existing nets of established service providers.

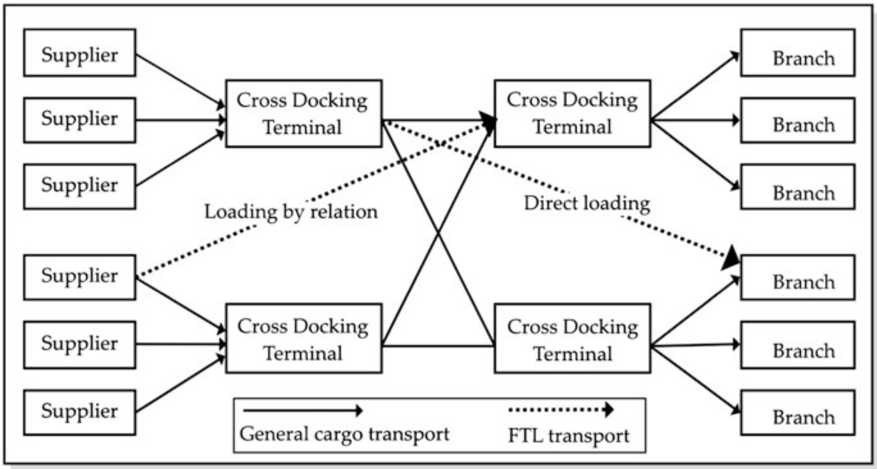

Fig. 8.13 Cross-docking variants in the METRO Group Logistics system (MGL METRO Group Logistics 2002)

The controlling and coordination of the METRO Group procurement logistics system is accompanied by a change in the system leadership in the supply chain from the supplier to the retailer.

However, METRO Group does not always demand the control over logistics. The supply chain partner with the structurally most favorable qualifications – i.e. long-term – should bear the logistics efforts or find a logistics service provider. To ensure this rule is obeyed, METRO Group expects being paid for logistics services exactly the sum of the process costs taken off the suppliers by the METRO Group service (cost equivalent).

In case of system leadership change, the following advantages and disadvantages for METRO Group can be named: The suppliers do not have to plan runs and concentrate on the core business, the manufacturing of products. However, they are forced to exactly meet the production deadlines defined by METRO Group.

The main advantage for METRO Group is the reduction of ramp contacts in the branches because the trucks are better utilized and more precisely timed. Though production fluctuations from the suppliers now have a stronger effect on the whole transport organization.

The procurement logistics system introduced has by now been implemented in many countries where METRO Group does business. It has, however, always been adapted to the country-specific economic-geographical and logistical characteristics. Besides procurement logistics, METRO Group Logistics offers further services regarding sales brands and product ranges as well as cross-border services.

8.4.4 Transport Logistics Concepts

Numerous transport logistics concepts have developed from the different structures of transport nets. In this context, the freight village and city logistics will be introduced.

Freight villages are transport logistics vertices on which logistics service providers are present. At least carriers (road/rail/waterway/airport-multi modality), an interchange in the form of handling points for short and long distance runs (trans-regionality), as well as diverse logistics service providers and other pre- or post-transport service providers (multifunctionality) should be parts of a freight village. Aims are transport-logistical advantages to realize rationalization potentials, e.g. by bundling transports and by shared use of information and communication systems as well as databases. Ecological goals are also possible, e.g. the prevention of high traffic volume by transport bundling and preventing empty runs. Furthermore, it is an advantage for regional economic policy, e.g. securing jobs, supporting small and medium-sized businesses, and a balanced spatial structure.

Location requirements for freight village are, among others:[12]

- Position within the region
- Frequency/main direction of goods suitable for freight villages
- Space requirements of 60–200 ha
- Infrastructural connection/features
- Highway connection
- Main train line
- Inland waterway connection (optional)
- Terminal for combined transport
- Train terminal for combined transport
- Shipping port

The service providers in the freight village should at least offer the functions inspection of goods, storing, order handling, commissioning, confectioning, mounting, packing, route planning, disposition of transports, and shipment tracking.

Despite the advantages, there are large difficulties in establishing freight villages. Although around 40 freight villages were planned in the 1990s in Germany, only a few have actually been realized (e.g. Bremen).[13] The reasons for this are:

- Carriers/forwarders/service providers are not willing to move after investing in a larger site
- Carriers fear modal split changes from road to rail
- Large space requirements make it difficult to find a suitable property
- Required road connections lead to high infrastructure costs
- Communities, railway and freight village operators experience financing restrictions

City logistics concepts try to solve the problems that come up with delivering to and collecting from inner city areas.[14] The city development is characterized by a strong imbalance of the traffic flow, i.e. a usually much larger flow of goods into the city than from it. The storage spaces in business have been reduced to a minimum what, in turn, necessitates daily deliveries, or even more. The structure of inner city traffic is mainly characterized by carrier and road freight transport as well as by cars and utility vehicles for quick delivery. Pedestrian zones and determined delivery times additionally restrict deliveries. The times during which retailers accept deliveries are highly restrictive which leads to unproductive waiting times of the vehicles. Increasing packaging disposal raises the need for transports in urban areas.

To solve these problems, numerous city logistics have been developed and partly realized in some cities. The central approach is the partial relief of the inner areas from transport traffic by bundling the delivery and collection runs and by reducing

[12] Cf. Aberle (2009), p. 560 ff.

[13] Cf. Berg (2003), p. 418.

[14] Cf. Vahrenkamp (2005), p. 413 et seq.

the number of daily runs to the inner city. The utilization of the remaining runs is therefore increased and the inner city congestion intensity is reduced. Further considerations are the use of public transport (trains and subways) for inner-city transport of goods and the realization of city terminals for carriers, directly located on the edge of the city.

8.5 Outsourcing, Tendering and Placing of Transport and Logistics Services

Cost effects are the most common argument for logistics outsourcing. Costs are reduced by optimizing – after the logistics service provider has reached a high average utilization, e.g. sinking costs per item with a growing transport volume or economies of scale in warehousing. High fixed costs caused by capacities targeted towards high peak loads can be made variable by outsourcing. Labor costs can be reduced by sector arbitrage, e.g. because of more favorable wage agreements for service providers. Furthermore, the reduction of opportunity costs should be realized so that companies can concentrate on their core business and not on logistics. In the latter case, it is possible to calculate a lost profit in the form of opportunity costs.

Besides positive effects on costs, *performance increases* can also be a part of logistics outsourcing.[15] These result from the increase in efficiency by specialization because of the service provider's know-how and the employment of possibly more advanced technology. However, higher degrees of outsourcing do not automatically lead to more success but rely on *planning* and *realization*. The process of successful outsourcing of logistics services can be divided into six phases:[16]

1. Creation of a full company logistics concept
2. Definition and quantification of the required services
3. Developing and adopting the placing policy
4. Realization of the tendering
5. Evaluation of the offers
6. Assessment of the services and costs

In the full company logistics conception, the nature and the quantity of the required services, the logistics structures, and the limits of the own logistics networks have to be defined. Rules have to be implemented in the form of benchmarks e.g. for transport costs, costs and prices of internal logistics services, estimated investments and operating costs for logistics centers. For the *definition and quantification of the service requirements,* the required service quantities, rules for the realization of the services and payments related to the areas in which the service was realized, must be defined. The goals of the outsourcing must be defined with the *developing and adopting of a placement policy*. The core competences of

[15] Cf. Wildemann (2007), p. 134 et seq.

[16] Cf. Gudehus (2010), p. 987.

the logistics services must be defined and, subsequently, which services must still be realized internally. Furthermore, the limits of the outsourcing must be defined.

The *realization of the tendering* should consist of the following: A short description of the service requirements, a table with the required service quantities, a price table to be filled by the service provider, and the general purchasing conditions for logistics services. Tendering documents for warehouse and system services should include the following:[17]

- Specification of the required functions and services
- Definition and identification of clear process and service chains
- Definition of service and quality requirements
- Statement about the required service quantity
- Requirements for information and communications systems
- Performance recording and payment

The *assessment of the offers* can be made according to formal, functional, and commercial criteria:

- Formal criteria are, among others:
  - Quality of the offer (Completeness, presentation)
  - Price tables completely filled
  - Offer documents signed
- Functional criteria rate e.g. the
  - Concept solution: The offered solution fulfills all functions and requirements
  - Functionality: Method of the realization (technology, equipment etc.), capa bility of the IT competence
  - Service realization: Availability of sufficient capacities or resources, qualifications and experience of the staff
  - Relevant and suitable references

Commercial criteria help to rate the following:

- Prices for the different services, including reference objects, fixed costs, vari able cost rates etc.
- Yearly costs resulting from the planned quantities and services costs
- Payment modalities like payment deadlines and escalator clauses
- Liability/warranty: Regulating the amount and the length of the warranty agreements and defining the liability sum and the penalty for faulty services

For performance recording and payment, agreements must be made about the planning period and the payment periods as well as quality deficits and penalties. In detail, this means agreements about the utilization risk, e.g. by fixed payments, agreements about price adjustments (escalator clauses) and regulations about

[17] Cf. Gudehus (2010), p. 1005 et seq.

discounts in the form of logistics discounts (reference values, e.g. full packaging units, full pallets with one kind of article, long lead times) and quantity discounts (depending on the number of loading units, transports etc.). The tendering is completed by including *performance measurement* by performance monitoring using fault statistics, customer complaints and quality reports as well as an active outsourcing controlling to monitor the services offered and the price development on the market for logistics services (see Chap. 10).

Besides the planning and realization, the ability and willingness for cooperation between the outsourcing company and the logistics service provider are becoming more and more important as a *success factor*. This may become visible in open communication, mutual trust, and collaborative planning.[18]

Case Study 8.5: Distribution Warehouse Structure Planning

The goal of this case study is to apply the information from Chaps. 6, 7, and 8 to a simplified planning task.

The basic questions for a network planner are the following:

- How many warehouses?
- In which locations?
- What types of warehouses?
- With which capacities?

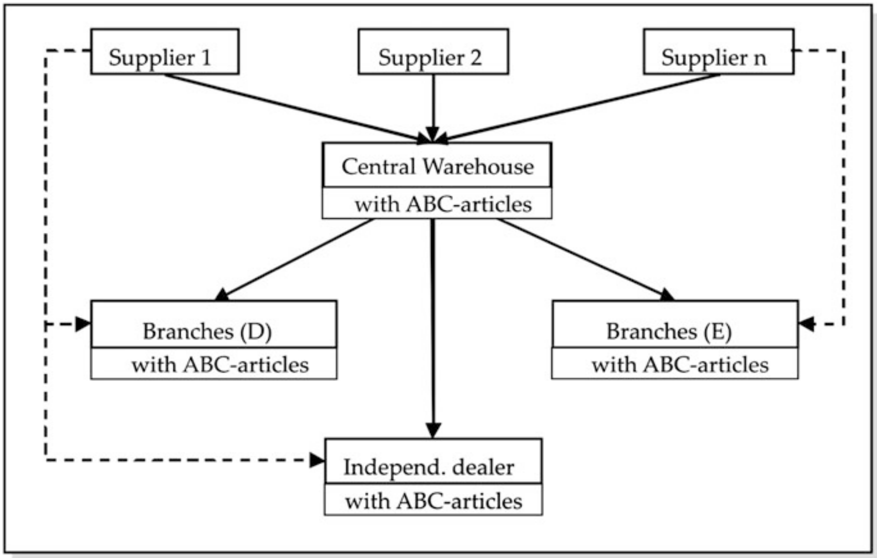

Fig. 8.14 Existing distribution structure

[18] Cf. Bretzke (2007), p. 176 et seq.

- Which production sites deliver to which warehouses?
- Which customers are supplied to by which warehouses?
- Which means of transport are employed?
- Which product quantities are produced in which production sites?

The answering of these questions is aimed at one basic goal: To ensure a delivery service which is in line with the market and, at the same time, by minimum logistics costs.

A furniture store chain is reviewing its existing distribution structure. At the moment, 143 suppliers deliver their goods to the central warehouse. The central warehouse near Kassel, Germany, carries the full product range (A-, B-, and C-class items); the same is true for the branches and the connected independent dealers. Direct delivery to the German (D) branches is realized by four suppliers and with around 30 products. Direct delivery in Spain (E) is realized by four suppliers, with around 520 products (see Fig. 8.14).

Now you are asked to outline alternative network structures!

Review Questions

1. What is a logistics net and what structures may it have?
2. What is meant by *degree of centralization*?
3. Give concepts of transport consolidation.
4. What transport-logistical concepts do you know?
5. Explain cross docking.
6. What forms of distribution sites do you know?
7. Describe changes in the terms of delivery?
8. Name advantages of hub-and-spoke nets?
9. Design a net for the flow of goods for the food consumer goods sector.
10. What are important factors in the capacity planning of a distribution center?

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