
Learning Objectives

Logistical infrastructure is the backbone of logistics systems. Apart from the transport infrastructure, the suprastructure including the logistics locations and real estate as well as the telecommunication infrastructure are becoming increasingly important for logistics. It is the aim of this chapter to illustrate the logistical functions of the various infrastructural facilities. To this end, the numerous complexities and interdependencies of the individual infrastructures will be identified and amalgamated into the logistical infrastructure.

Keywords

- Transport infrastructure
- Infrastructure, superstructure
- Individual properties, logistics parks
- Terminals
- Transshipment facilities
- Freight villages
- Satellite navigation
- Disaster Recovery
- Business Continuity

4.1 Basic Terminology, Types and Functions

A capable *logistical infrastructure* is prerequisite for modern logistics systems in which efficient logistical processes are to be carried out. In general terms, infrastructure means the entirety of sustainable facilities and supply channels that can be used by private households and companies. We distinguish between *economic infrastructure* and *social infrastructure*. Economic infrastructure comprises transport infrastructure, information infrastructure, and (tele)-communication infrastructure.¹ Social infrastructure includes institutions for education, healthcare, culture and security within a state and society. In contrast to this macroeconomic view, the microeconomic dimension of logistical infrastructure refers to the definition of the spatial and technical structural properties and to the dimensioning of a logistics system. This, for example, includes warehouses, means of transport, conveyors, storage and picking technology and facilities as well as the corresponding information and communication systems.² It is therefore in a comprehensive and holistic sense that the concept of logistical infrastructure covers the micro- and macro-economic infrastructure facilities of transport infrastructure, site infrastructure, building infrastructure, and communication infrastructure (real estate).

Transport infrastructure comprises the infrastructure for passenger transport and freight transport. This includes all physical traffic routes such as railroads for trains and city railroads, roads, tunnels, waterways and pipelines including their control systems, and handling facilities. These are also termed linear or networked traffic infrastructure or transport infrastructure. In contrast, *site infrastructure* includes airports, train stations, inland ports and sea ports, which are also referred to as point-shaped traffic or transport infrastructure. Logistical infrastructure in this sense not only comprises traffic facilities but also facilities for transshipment and storage at the site's terminal. These facilities are also termed *suprastructure* (see Fig. 2.5).

The information exchange necessary for logistics processes is made possible by telecommunication and its corresponding infrastructure. Telecommunication infrastructure includes telephone networks, fibre optics networks and their network nodes, satellites with their associated ground stations, and data centers. This is also referred to as web-based or digital infrastructure. As part of all the infrastructure facilities mentioned so far we can also summarize buildings, structures and properties in different shapes and sizes under the term *real estate infrastructure*.

¹ Also Cf. Pfohl (2000), p. 349 et seq., who uses the term macro-logistical infrastructure to cover the infrastructure of goods and information flows, as well as transport policy.

² Cf. Arnold et al. (2008), p. 901.

4.2 Transport Infrastructure and Suprastructure

4.2.1 Transport Routes and Transport Networks

Depending on the respective transport mode, transport infrastructure can be broken down into the national and international networks of air transport, rail transport, inland waterway transport, sea transport, and road transport.³

The EU features a *network of air routes* which comprises more than 450 airports operated by more than 130 airlines. Hub-and-spoke networks have been set up by airlines in order to operate these air routes in the most efficient manner (see Sect. 8.4.2). Within these networks, the busier routes are bundled together by central airports (hubs). Less busy routes start from the spokes and are then joined to the hubs.

The longest *railroad networks* in Western Europe are located in Germany (38,206 km) and France (30,832 km). The quality of railroad networks within Europe differs as to the degree of electrification and the expansion of high-speed train networks. Differing track gages, e.g. in Spain and Russia, necessitate transshipment in cross-border transport. By 2020, Spain will convert its railroad network to the standard European gage.

Inland waterway networks are made up of navigable waterways that serve as a link between inland ports and/or sea ports. Depth and breadth of waterways are defining for their utilization. The longest networks can be found in Finland (7,884 km), Germany (6,636 km), the Netherlands (6,183 km), and France (5,384 km).

Sea transport networks provide routes for either short sea shipping or international ocean shipping. Short sea shipping is carried out on pre-defined offshore routes with good connections to the Hinterland. Sea routes determine the connections on the high seas.

Extensive *road networks* make a region accessible. Within Europe, Germany (12,363 km), Spain (11,622 km), and France (10,801 km) feature the longest highway network. Germany distinguishes between federal highways (*Bundesfernstraße/Bundesautobahn/Bundesstraße*), state roads (*Landesstraße*), county roads (*Kreisstraße*), and municipal roads (*Gemeindestraße*).

Transport infrastructure is increasingly controlled by the *information and communication infrastructure* of systems that are associated with the respective transport mode. This serves the purpose of improving the transport infrastructure's quality. Examples for inland waterway transport include river information systems (water levels, lock allocation etc.) and automatic identification systems. In sea transport, automatic identification systems are provided in the form of Internet applications and portals.⁴ Numerous telematics systems are available for road traffic transport in order to track vehicles and goods, to monitor rest and driving periods, and to capture data about tolls, traffic congestions and diversions.

³ Cf. Rühl (2008), p. 37 et seq.

⁴ Cf. Biebig et al. (2004), p. 444 et seq.

4.2.2 Airports

Air transport is organized according to the following (sub-) systems⁵:

- Air transport services offered by airlines
- Set-up and operation of air traffic control and control systems
- Set-up and operation of airports (airport services)

Airports fulfill important infrastructural functions. Their main purpose is to provide *infrastructure relevant to air transport*. This mainly includes the provision of runway systems, passenger terminals, and connections to ground transport systems (see Fig. 4.1).⁶ Airports can be subdivided into landside and airside areas as well as air freight buildings.⁷ The terminal is the main *landside* building. In general it consists of two areas separated by border and passport control through which all passengers and flight personnel need to pass preflight. Check-in (ticket collection, seat reservation, luggage check-in, security control) takes place in the front part of the terminal.

Frequently, this part also features shops, restaurants, and exhibition areas (non-aviation area). Waiting areas and accesses to the gates are located behind this part.

The *airside area* of an airport comprises the system of runways which is needed to enable aircraft movements (take-off, landing). Taxiways, maneuvering areas, hangars, and cargo centers also form part of this area.

Depending on the location and distribution area of airports and thus on their position in the hierarchy of central facilities, we can distinguish between *regional* or *national* airports for feeder and distribution services and *international major airports* serving as hubs and transit points. In this context, an airport's significance as a logistics location and its interconnection with the surrounding region are displayed by nearby *airport industrial parks*, *airport terminals* or *airport logistics centers* for air cargo dispatch.⁸ However, rather than necessarily offering air cargo services, logistics service providers in many cases only take advantage of an airport's prominent position within the transport system and of the existence of a highly developed transport infrastructure.

The development of *cargo airports* was brought about by the importance of air cargo and due to the limited service offers of existing airports such as capacity bottlenecks and bans on night flights.⁹ In most cases, the hubs of mail and parcel service providers (integrators) are located at these airports (see Sect. 5.5.2). This, in

⁵ Cf. Koch (2006), p. 93 et seq.

⁶ Cf. Maurer et al. (2003), p. 69.

⁷ Cf. Arnold et al. (2008), p. 770.

⁸ Cf. Ihde (2001), p. 214; Vahrenkamp (2005), p. 301 et seq.

⁹ Cf. Meeder (2003), p. 492.

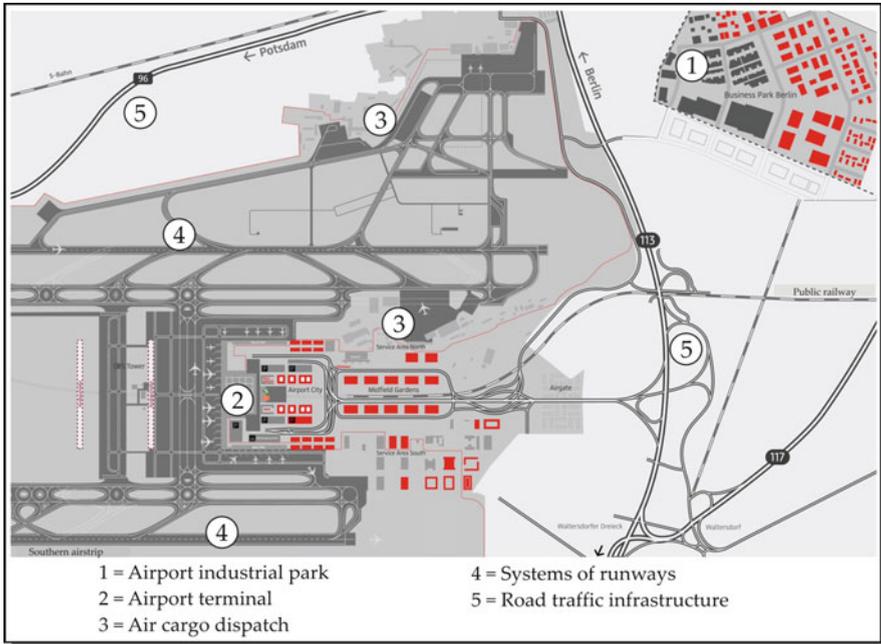


Fig. 4.1 Schematic outline of Berlin's airport 'Willy Brandt' (Berliner Flughäfen 2011, p. 10)

turn, directly affects the set-up of the airport's infrastructure. The service portfolio of an airport and thus that of an airport operator is of direct relevance for logistics. The most relevant factors are:

- Guaranteed 24 h operations in all weather conditions
- Minimal ground times for air cargo
- Existence of suitable cargo facilities with sufficient space for consolidation and deconsolidation of cargo and for intermediate storage
- Capacities for direct transshipment of passengers, luggage, and cargo

4.2.3 Sea Ports and Inland Ports

Sea ports or inland ports are infrastructure facilities consisting of berths for seagoing and/or inland vessels. They serve as an interface between land and sea transport and fulfill the functions of transshipment and storage as well as pre-carriage and on-carriage of goods. *Inland ports* are used for transshipment by inland vessels, coasters, and smaller sea vessels. *Sea ports* are used for feeder transport by sea vessels or inland vessels. They can be located at the sea and along canals and rivers. Inland ports are located along rivers, canals, and at inland lakes.¹⁰

¹⁰ Cf. Ihde (1991), p. 99.

With regard to a port's infrastructure, we generally distinguish between the infrastructure and the suprastructure. *Infrastructure* comprises immovable port facilities such as docks, shipping channels, track systems, and quays. *Suprastructure*, in turn, includes movable and immovable facilities such as crane systems, warehouses, and industrial trucks. Also included in this superstructure are information and communication systems which illustrate the interdependencies between the individual forms of logistical infrastructure.

Port infrastructure is largely dependent on the development of the ports and on the functions they fulfil. In the wake of the industrialization, the development of the railway and due to globalization, ports have become a *gateway* to the Hinterland.¹¹ Hinterland is a term for those inland territories behind a port which maintain an exchange of goods with the port.¹² The *infrastructural connections to the Hinterland* through pipelines, railways, waterways, roads, and by air are of great importance for the economic development of the Hinterland.¹³ The demand for incoming and outgoing seaward (mass) transports and improved transport connections in the Hinterland lead to increased ship sizes, the construction of deeper approaches to ports as well as to the installation of railway sidings and depots for docks and quays. This also exemplifies the interdependencies between different logistical infrastructures. Major factors in the development of ports are the fact that increasingly bigger ships are built as well as the containerization of transport flows (see Sects. 5.3.4 and 5.4.2). Both these developments call for an increased industrialization of transshipment in ports, which, in turn, poses significant challenges for a port's infrastructure and suprastructure.

4.2.4 Rail Stations and Railroad Systems

Rail stations are generally defined as railroad systems with at least one switch, providing a starting and ending point for trains and allowing them to swerve or turn.¹⁴ *Rail infrastructure* includes all railroad systems, properties, buildings and other facilities necessary to perform or secure passenger or cargo transport by rail. An overview of elements relevant to rail infrastructure is given in Fig. 4.2.

Depots serve to load and unload rail cars and wagons. Facilities for loading and unloading may come in the simple form of transshipment areas between freight cars and road vehicles. These areas can be located beside or in between the rails. There

¹¹ Cf. Nuhn (2005), p. 110.

¹² Cf. Biebig et al. (2004), p. 290 et seq.

¹³ Cf. Pfohl (2000), p. 352.

¹⁴ Cf. Berndt (2001) p. 82 et seq.

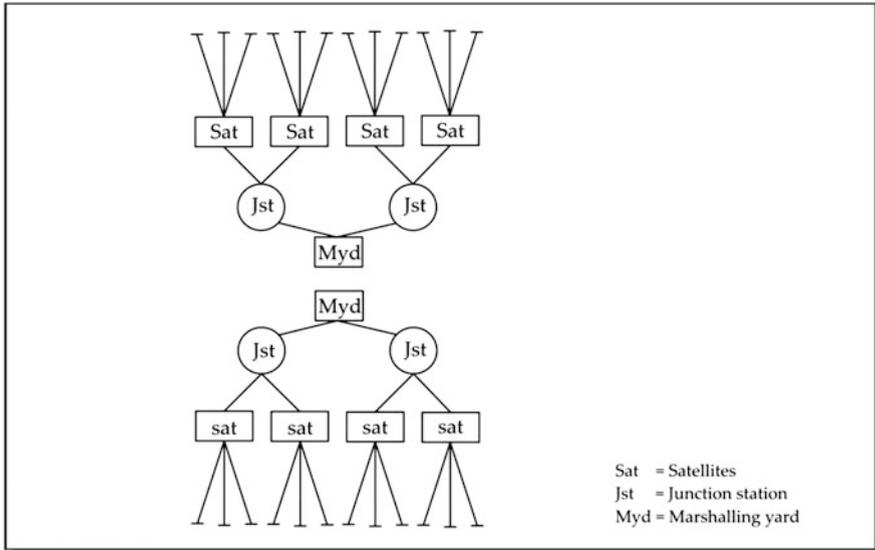


Fig. 4.2 Rail infrastructure (Cf. Berndt 2001, p. 44)

are different ways in which transshipment can be carried out. For example, ramps, cranes, or tipping devices for bulk goods may be utilized.¹⁵

Train units are formed or decoupled at *marshalling yards*. At these yards, a large number of freight cars can be decoupled from incoming trains within a short time in order to form new freight trains.

Rail sidings also form a part of railroad systems. They provide access to the rail freight network and serve for the loading and unloading of rail cars. In most cases, they are located on the premises of the sending or receiving company. Rail sidings enable companies to transport rail cars directly from the sender to the receiver, thereby avoiding time-consuming and costly transshipment procedures.

4.2.5 Terminals and Transshipment Facilities

Transshipment terminals (transshipment points) are (external) sites at which transshipment activities take place. These activities include the loading and unloading of means of transport, sorting of goods, storage of goods, and release of goods from the warehouse (see Sect. 6.5.2).¹⁶ Transshipment terminals exist for all means of transport and can also be seen as a hub where different transport modes converge.

¹⁵ Cf. Berndt (2001), p. 94 et seq.

¹⁶ Cf. Boysen (2008), p. 1286.

Air cargo terminals are transshipment points in air freight transport between ground-based modes of transport (rail/road) and airplanes.¹⁷ The facilities and equipment for transshipment of air cargo are in the air cargo centers of major airports (see Sect. 4.2.2). The structural layout of a terminal is influenced by the following kinds of transshipment activities¹⁸:

- Export: receipt of cargo landside and loading onto an airplane
- Import: airside receipt of cargo from an airplane and loading onto a truck
- Transfer or transit: receipt of cargo from an airplane and transfer onto another airplane

Sea port terminals or inland port terminals are furnished with facilities and equipment needed for the loading and unloading of sea vessels and inland vessels. They also feature areas for storage and distribution of goods. Depending on the type of goods being transshipped and their corresponding mode of transport, various *kinds of terminal* can be distinguished¹⁹:

- Terminals for liquid goods (petroleum products or chemicals) or bulk goods (ore, coal, crop, fertilizers)
- Terminals for general cargo (machines, technical equipment)
- Container terminals
- RoRo Terminals

Handling at these terminals can be carried out using cranes and container gantry cranes, by sucking and pumping the goods into storage areas, tanks, and silos or through direct transshipment. Which one of these handling techniques is utilized depends on the type of goods being transshipped, on the type of on-carriage, and on the available transport connections.

The infrastructural facilities of bulk good terminals may comprise buildings and halls (quay sheds) or open-air storage areas. The loading and unloading of bulk goods – such as coal and ore – is carried out by means of conveyor belts, through free fall in feeding pipes, or by crane. The unloading of a ship at the port of destination can be effected by using the ship's own devices such as conveyor belts or cranes. Liquid goods such as oil are transshipped in special oil terminals. These are equipped with special transshipment devices as, for example, pumps on land for loading and unloading, platforms with loading arms, tanks for intermediate storage, and pipelines.

General cargo with different measurements and properties are loaded and unloaded at *general cargo terminals*. Since this is usually very costly due to the high number of staff members required, powerful transshipment facilities such as gantry cranes and truck cranes are frequently used.

¹⁷ Cf. Arnold et al. (2008), p. 766 et seq.

¹⁸ Cf. Mensen (2007), p. 304.

¹⁹ Cf. Brinkmann (2005), p. 137 et seq.

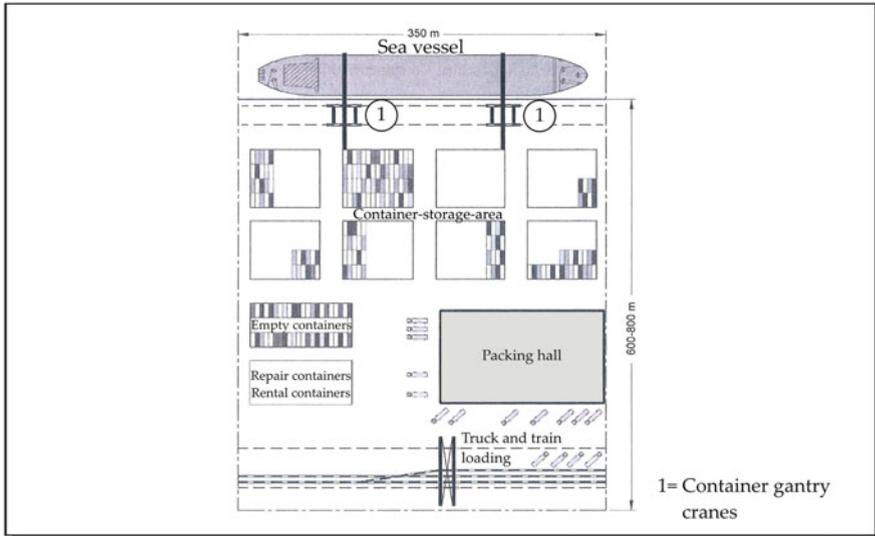


Fig. 4.3 Layout of a container terminal (Brinkmann 2005, p. 239)

A *container terminal*, in contrast, enables the efficient transshipment of goods into containers. The design of a container terminal needs to take into account ship sizes, the types of containers to be dispatched (open-top container, cooling container, hazardous material container, empty containers etc.), container sizes (40, 20, 10 ft.) as well as container capacities (see Sect. 5.4.2) (see Fig. 4.3).

RoRo (Roll-on/Roll-off)-terminals are needed for transport with RoRo ships. This technique was developed for ferry transport, in which ships are loaded through gates and ramps at the stern, side or bow of the ship. Automotive trailers, chassis, large-sized pallets, train cars and containers or vehicles carrying them load the ship by rolling onto it. RoRo-terminals are suitable for smaller ports without landside transshipment facilities but with connections to the road and railroad network.

Terminals in railroad transport are above all transshipment points of combined railroad transport in the form of transshipment terminals and container terminals. They can be small areas for loading and unloading or large transshipment stations. The most important infrastructural elements of these terminals are road infrastructure for road vehicles (driveways for entrance and exit, parking lanes, loading lanes, traffic lanes), railroad infrastructure in the form of siding tracks which connect trains to the main rail network and storage areas.²⁰

The following case study illustrates a rail terminal in the form of a railport of *Deutsche Bahn*.

²⁰ Cf. Berndt (2001), p. 118.

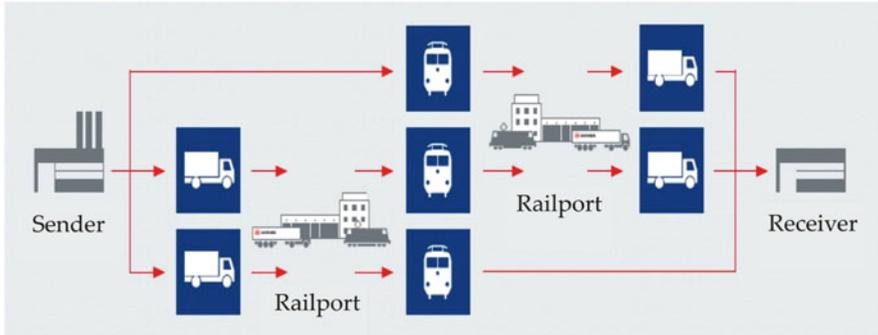


Fig. 4.4 Schematic layout of a door-to-door logistics chain (DB Schenker Rail GmbH 2011)

Case Study 4.1: Railport

A *railport or rail cargo logistics center* is a multifunctional logistics location with direct rail link in order to connect several transport modes. Due to its dominant position within the transport system, this is usually road transport with connections to the highway network and direct access to the distribution network in the catchment area. It is also possible and reasonable to provide connections to inland waterways, airports, and pipeline networks.

Deutsche Bahn AG and its transport and logistics department *DB Schenker* pursue the idea of offering their customers an integrated door-to-door service by making use of these multifunctional and multimodal rail logistics centers throughout Europe (see Fig. 4.4). The development of this concept was triggered by the idea of more deeply integrating the railroad system in order to unlock new logistics potential. This also helps decongest the road infrastructure and thus decreases the ecological impact by using eco-friendly modes of transport. Railports are mostly built in the vicinity of already existing freight depots or cargo terminals.

Railports offer the possibility of transshipping and storing many different types of goods:

- Units of combined cargo traffic (e.g. container, swap bodies, trailers)
- Cranable large-sized goods (e.g. steel products, pipes, wood, machines)
- General cargo (e.g. palletized goods, paper rolls, furniture)
- Bulk goods (e.g. clay, fertilizers, scrap metal, building materials)

However, the services offered at railports go much beyond the mere storage and transshipment of goods. Goods also need to be prepared for on-carriage and distribution throughout the region. This involves services such as picking, inventory management, quality checks, clearing, and delivery or collection of the goods to the region or from the region.

An ideal railport usually features the following components:

- Traffic routes of the different transport modes
- Areas dedicated to the operation of transshipment devices (e.g. gantry cranes, truck cranes, forklift trucks)
- Open areas for handling and storage
- Sheltered or indoor areas to carry out logistics services

Transshipment and storage activities can thus be adapted to requirements of the specific types of goods. Open areas, warehouses, and transshipment halls usually have direct rail and road access.

Depending on the size and number of terminals, the most common transshipment techniques involve cranes (bridge cranes, gantry cranes) and forklift trucks (frontload trucks, sideload trucks, telescopic handlers).

Cross-docking terminals as another type of transshipment terminals in which consignments are directly transshipped between incoming and outgoing trucks without intermediate storage. They are mostly long buildings with numerous gates. They are mainly utilized in consumer goods logistics (retail chains), by mail and parcel service providers (hub-and-spoke systems), by transport companies and carriers (general cargo networks) and in the automobile industry (OEMs, suppliers) (see Sects. 5.5, 7.4, 8.4.3).²¹ Different technical devices may be used, depending on industry and function. These include ground conveyors (vehicles), material flow technology, and sorting technology (conveyor belts, chain conveyors, sorting robots) (see case study 6.3).

4.2.6 Logistics Real Estate, Logistics Parks, and Freight Villages

Logistics real estate can be described as a building with appropriate infrastructure and technology built on a suitable property for the purpose of performing transshipment, storage, and all services associated with it (picking, packing, quality checks, (sub) assembly).²² Therefore, a number of different types and categories of logistics real estate can be distinguished. On the one hand, there are *individual properties* including warehouses, transshipment halls, distribution centers, and logistics service centers.²³ On the other hand, there are *real estate parks* comprising several buildings and sites, which can serve as logistics parks, industrial parks, or freight villages.²⁴

Warehouses may be used as central warehouses, regional warehouses, production warehouses, or distribution warehouses. Their purpose is the storage of goods, and they serve as a link between procurement and distribution. The way they are

²¹ Cf. Boysen and Tiedemann (2010), p. 54.

²² Cf. Börner-Kleindienst (2006), p. 453; Nehm et al. (2009), p. 24.

²³ Cf. Börner-Kleindienst (2006), p. 454.

²⁴ Cf. Nehm and Schryver (2007), p. 233 et seq.

equipped is dependent on the range of functions they fulfil and on the logistics processes to be carried out on the property (see Sect. 8.3). In most cases, warehouses offer good delivery capabilities for a speedy transshipment of goods.

Transshipment halls serve to distribute goods that arrive through long-distance and short-distance transport. Since goods are stored for only a short time and because the throughput rate is accordingly high, transshipment halls feature a small height and depth but many gates for usually double-sided delivery. The gates need to be designed in a way which enables the loading and unloading of large trucks, utility vans, as well as station wagons.

Compared to warehouses and transshipment halls, *distribution centers* are significantly larger and have a greater number of loading gates. In addition, they are frequently equipped with (automated) storage and picking systems. The type and quantity of goods and commodities to be handled have a significant bearing on the size and capacities of a distribution center. The spectrum of goods ranges from all kinds of consumer goods (food, necessities, brown goods, white goods) to various industrial goods. Perishable and temperature-sensitive products, for example, require facilities for low-temperature storage which, in turn, raises certain challenges for the property (layout, accesses, insulation). Machines and facilities require an especially stable ground as well as special lifting and transport devices (cranes) (see Sect. 6.6).

Logistics service centers have the purpose of concentrating several suppliers, warehousing companies, and transport companies in one place so that production can take place nearby (e.g. just-in-time delivery). To this end, goods from different sources need to be consolidated and processed in, for instance, production-logistics centers (light industrial).

A *logistics park* is an area where several logistics properties are concentrated in close proximity. The individual properties may differ with regard to their type and size as well as to their tenancy and ownership relations. The main purpose of a logistics park is the realization of synergies through the common use of infrastructural facilities such as gas stations, forklift truck fleets, workshops, offices etc. The administration and maintenance of the infrastructural facilities is at the responsibility of the park owner. Since these parks are usually managed as an integrated whole, it is safe to say that they are cheaper to maintain than an individual property. Logistics parks may also be designed in an industry-specific way and according to required logistical concepts. For this reason, there are numerous concepts for logistics parks, which are also termed supplier parks. These are especially prevalent in the automobile industry (see Sect. 7.4.3).²⁵

Due to the high accumulation of logistics real estate, freight villages can be seen as an extended form of logistics parks. Freight parks, however, serve purposes related to transport and traffic policy and to the supply and disposal of goods in specific regions (see Sect. 8.4.4).

²⁵ Cf. Becker (2006), p. 41.

Table 4.1 Location and object requirements of logistics real estate (Cf. Muncke et al. 2008, p. 202)

Location requirements	Object requirements
<p><i>Macro location</i></p> <ul style="list-style-type: none"> ■ Active promotion of economy and investment ■ Relationship between economy and government / administration (investment climate, according to the time required to obtain permits and the amount of regulations) ■ Low tax burden ■ Availability of workforce ■ Good living standards for executive staff 	<ul style="list-style-type: none"> ■ Property on ground level with good potential for expansion, property completely fenced in ■ 45-60 % of property built-over or ready to be built on (preferably 5 ha or larger) ■ 5-10% allocated office space ■ Single-floor warehouse with at least 10,000 m² ■ Warehouse height 10-12 m; distance between pillars > 12.5 m ■ Ground bearing capacity > 5,000 kg/m²
<p><i>Micro location</i></p> <ul style="list-style-type: none"> ■ Commercial and logistical use secured by planning and building law. ■ 24h accessibility via the national road network (at a distance of max. 1-3 km) ■ Proximity to airports (max. 1hr driving time) ■ Technological infrastructure is available and expandable ■ Possibility of carrying out compensatory measures ■ Supply with retail and services close-by 	<ul style="list-style-type: none"> ■ Ceiling sprinkler system; gas heating ■ Great number of ramps and one gate on ground level per section (at least one ramp for each 1.000 m² of warehouse); double-sided delivery for transshipment warehouses ■ Maneuvering space and yard space of at least 35m depth; sufficient parking spaces for cars, trucks and semi-trailers ■ Flexible utilization which ensure multi-functionality and adaptability; possibility to form sub-divisions, high alternative use capacity

Regardless of the individual category and the actual design of logistics real estate, specific requirements for locations and objects are increasingly becoming apparent. These requirements are listed in Table 4.1.

4.3 Information Infrastructure and Communication Infrastructure

4.3.1 Telecommunication Infrastructure

Along with transport infrastructure, an efficient information and communication infrastructure is vital for the development of logistics concepts and for the performance of logistics processes. This infrastructure is to a great extent based on

telecommunication infrastructure and can be set up using different networks (land-line, mobile telephony, radio network, microwave radio relay), depending on the services offered (GSM, UMTS) and on the data transfer.²⁶ There is, however, a tendency towards the development of a uniform network infrastructure through which all services can be offered and utilized. This network infrastructure is based on the Internet Protocol (IP) which replaces the circuit-switched networks with a packet-switched network infrastructure.

Telecommunication networks can exhibit different structures (network typology) which utilize various types of hardware and access methods for data connection and transmission. These, in turn, determine the rate of transmission, the data throughput, and data security concepts. Thus, local networks (LANs – Local Area Networks) consist of several computers and external devices (printers, scanner etc.) which are interconnected in one building. Internet access is given via a router. In contrast to LANs, WANs (Wide Area Networks) cover a large geographical area. Commercial WANs are designed for maximum capacity utilization and consist of circuit-switched connections, point-to-point connections, packet-switched connections, and Virtual Private Networks (VPN). In order to support these services and to achieve high transmission speeds, optical transmission media (fiberglass) are used more and more frequently for broadband infrastructure.²⁷

All these hardware and software installations are usually hosted in IT rooms, server rooms, or in data centers which display a specific infrastructure. The infrastructure of data centers includes the provision of rooms, energy supply, air conditioning, and object security.²⁸

The development of IT and computer technologies does not only substantially influence the kind of services rendered in data centers – it also affects the property and room layout. Data centers are a specific type of real estate which are also termed collocation centers, IT centers, IT hotels, server hotels, telehouses, and so forth.²⁹

We can also see an increase in the number of data center parks in which companies rent cages, several rooms, or entire buildings which are then equipped or (re-) constructed according to the customer's specifications. These types of solutions offer the advantage of redundant provisioning of building infrastructure as well as the possibility to provide office space with emergency workplaces. These workplaces can be utilized in emergency situations (disaster recovery, business continuity) in order to continue business without interruption, which is also becoming increasingly important in a logistical context.

²⁶ Cf. Heiserich et al. (2011), p. 361 et seq.

²⁷ Regarding this technology Cf. Keller (2011), p. 141 et seq.

²⁸ Cf. Rittweger and Roszbach (2006), p. 239.

²⁹ Cf. Seitz (2004), p. 29.

4.3.2 Satellite Systems and Satellite Navigation

World-wide telecommunication is to a great extent based on satellite systems. This technology makes it possible to set up a comprehensive infrastructure that offers services with high data transmission rates. A logistical example of this is the ERMTS (European Railway Transport Management System), which offers several projects and services in the area of railroad information systems, as for example the international GSM-R-network (Global System for Mobile Communication Railways). This network is a platform for commercial railroad radio systems.³⁰

Apart from the support of telecommunication services, satellites also offer *satellite navigation* as one of their core functions. This method enables the determination of an object's position. Using suitable technologies and programs, modern satellite navigation makes it possible to determine the coordinates of locations based on their distances to at least three satellites. The construction of the European satellite system *Galileo*, due to be operational by 2013, is of paramount significance for the commercial use of satellite systems. Galileo will be a system of the European Union which adds to the already existing state-owned US satellite system GPS (Global Positioning System) and to the Russian system Glonass (Globalnaja Nawigazionnaja Sputnikowaja Sistema). The system will comprise 30 satellites. Galileo will make it possible to offer different services which vary in regard to accuracy, number of signals, and reliability of service.

Commercial satellite navigation services are especially suitable for logistics and can be used for the navigation of continental transport, telematics platforms, for locating purposes in aviation and shipping, and as research platforms for transport and logistics systems.³¹ The additional availability of these applications in comparison to existing systems is mainly due to the system's high accuracy and its world-wide availability. Central to these applications is the localization and tracking of goods which are transported in a multi-modal manner. This requires constant location of the respective carriers and of the goods transported, and all parties involved in the supply chain need to be able to continuously obtain information across all transport modes and independent of their location (location information).³²

³⁰ Cf. Berndt (2001), p. 122.

³¹ Cf. Schenk et al. (2011), p. 573 et seq.

³² Cf. Clausen and Inninger (2009), p. 43 et seq.; Elsenbach (2006), p. 445.

Review Questions

1. What does logistical infrastructure mean?
2. What is the difference between superstructure and transport infrastructure?
3. What is the significance of information and communication infrastructure for logistics systems?
4. Name the infrastructure facilities of an airport that are relevant for air cargo transport.
5. Name the most important factors that need to be considered when setting up a container terminal at a sea port.
6. Describe the functions of a marshalling yard.
7. Differentiate between different types of logistics real estate.
8. What are the most important location and object requirements for logistics real estate?
9. In what way are logistics parks different from freight villages?
10. What is the significance of telecommunication infrastructure for logistics?

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