
Learning Objectives

For the realization of cross-company supply chains, the informational linking of departments within the company and of cooperating companies is an important means. Furthermore, the internal logistics processes must be supported by adequate information and communications systems. There are strong relationships amongst these systems and the logistics functions. The goal of this chapter is to introduce the many areas of application for identification, information and communications systems, and their potential use in logistics systems. Additionally, the respective effects on logistical performance, quality, and costs will be explained.

Keywords

- Information requirements in logistics and supply chain
- IT standards in business
- Flows of information and their effects
- Electronic Data Interchange (EDI) principle
- Identification systems – barcode and RFID
- Stock management systems
- Planning of transports and runs
- Enterprise Resource Planning (ERP)
- E-logistics

9.1 Electronic Data Transmission

9.1.1 Communication Standards

The complexity of logistical processes and the high number of parties involved require strong efforts for information and communication as well as for controlling and documentation. To control the logistics processes, diverse information with mostly large data volumes are necessary. As an example for a shipment these are: information about the addresses of sender, receiver, shipping company, and carrier; information about the goods like weight, volume, size, special shipping and handling requirements regarding cooling, fragility, preservability etc.; and information about the price, the date of the shipment, and the time of the delivery. Traditionally, this information can be communicated orally or in written form and be attached to the shipment; it can also be sent prior to the shipment by fax.

However, a manual or paper-based process alone is not sufficient anymore for a fast information supply that is ahead of physical events. To realize logistics processes in the best way possible, it is necessary that e.g. information about the delivery of a shipment is available way before the actual delivery for the recipient and other parties like e.g. the carrier. This is made possible by electronic data transmission technology. The same is true for realizing concepts with streamlined process and organizational structures in logistics and in the company as a whole.

For this, the data should be available in standardized formats which allows for all involved parties in the process chain to read and process the data without further transmission, so-called media disruptions. This means a change of transmission medium or data carrier in the information chain, e.g. transferring information from an inventory card (paper) or a delivery note (paper) into an IT system or vice versa. The problem with such media disruptions is the possibility of errors in the process. Conversion in this context means e.g. the harmonization of the data-technological sentence structure (syntax) with respect to the denomination, numerical characteristic, sequence and length of fields in data sets. If media disruptions or conversion processes are avoided during data transmission, information is not only available faster for status requests or for adding controlling commands but the overall transaction costs can be reduced in the process.

Transaction costs are defined as the costs necessary to initiate, coordinate and realize the transfer of goods from the original seller to the consumer.¹

Caused by the requirements of worldwide communication and the necessity to rationalize internal processes, efficient concepts for managing the data intensity and data volume have been developed – also, and especially, in logistics.

This is often called information logistics. It must fulfill the following requirements:

- Avoidance of media disruptions (orally – written – electronic data format)
- Reduction of conversion efforts (intervention-free data transmission)

¹ Cf. Gleißner (2000), p. 21 ff.

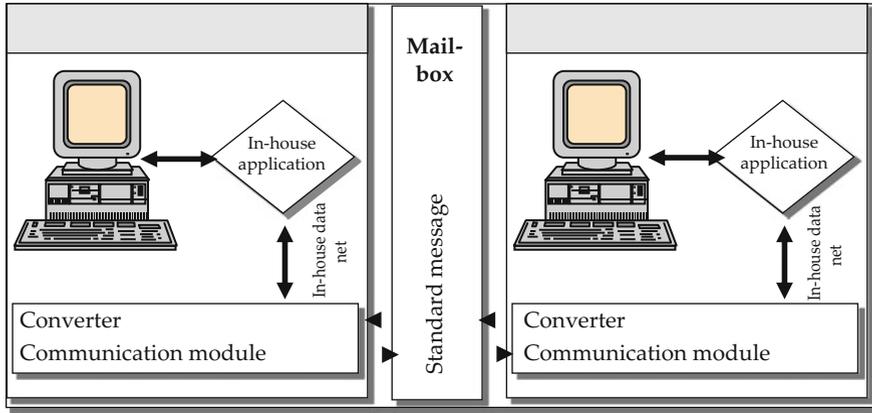


Fig. 9.1 The EDI principle (Cf. GS1 Germany (2006a), p. 5)

- Avoidance of data redundancies
- Data availability before, during, and after the physical logistics process
- Availability of information when needed, with respect to time and demand
- Linking to existing internal information and communications systems as well as interfaces to the Internet
- Trans-company and trans-national communication standards.

Electronic Data Interchange (EDI) is the automated and intervention-free exchange of structured data between business partners according to uniform standards. For this, the data is transmitted from a data processing application of the sender to one of the receiver without personal interferences or modifications (see Fig. 9.1). Structured data transmitted via EDI is characterized by a precise definition of their composition. The information to be exchanged must be determined with respect to the syntax and to the semantics to make possible the communication between the partners. The syntax describes the order of the signs and sign-compositions in a message. The semantics, in this instance, describes the meaning and the content of a sequence of signs.

With this, the preconditions for automatic processing of the exchanged data without further delay are created. From a technical point of view, EDI is a controlled, so-called file transfer between data processing systems.

Different standards are available to create syntax and semantics, i.e. a unified *language* between the communication partners. These standards can generally be divided into open and proprietary standards. Open standards can – with the exception of limitations by the sector or country they are used in – basically be used in every company. Proprietary standards, on the contrary, are only for the data exchange between a company and its business partners.

The advantage of proprietary standards to be tailored exactly to the requirements of the partners, therefore being effective and independent compared with standard

solutions, is neutralized by the disadvantage of their limited possibilities of application. Trade companies are facing special difficulties; they have to be able to work with and adapt to different manufacturers' standards. For this reason, open standards can be considered far more important. They are more and more facilitating the growing information network of all levels of the economy.

The following outlines the most important developments in open EDI standards:

ANSI X.12: Based on standardization efforts begun in the USA in the 1960s, this trans-sector and –function standard was developed from 1978 on, coordinated by the American National Standards Institute ANSI. Today, ANSI X.12 is the most important American EDI protocol standard. It is also available as an EDIFACT subset.²

VDA: Since 1978, there had been recommendations by the German Automobile Industry Association VDA for the data exchange between automobile manufacturers and the supplying industry which have by now been extended by the data exchange with logistics service providers. Developed by a VDA working group, these recommendations are a sector-specific standard. The documentation is available directly from the VDA as the central coordinator. With this, the automotive industry was a pioneer of the systematical development and application of standards for electronic data exchange.

ODETTE: An international sector-specific solution for the automobile industry and their suppliers, ODETTE (Organization for Data Exchange by Tele Transmission in Europe) is a European further development of earlier VDA standards. It has by now been made into an EDIFACT subset as well.

SEDAS: SEDAS (*Standardregelungen einheitlicher Datenaustauschsysteme* – Standard Regulations of Uniform Data Exchange Systems) was developed by a German association for rationalization, GS1.³ It was the first national protocol standard for data exchange in consumer goods trading, including the manufacturers. Orders, invoices, market research data, as well as reference data like product and customer information are to be transmitted using the SEDAS format. However, national sector-specific standards are limitations, so despite its widespread use, SEDAS will successively be replaced by EANCOM®.

EDIFACT: To eliminate basic limitations by national or sector-specific standards, the United Nations' Economic Commission for Europe (UN/ECE) began to

² EDIFACT subsets are sector-specific specifications based on the general framework of EDIFACT.

³ GS1 (formerly CCG) is a German rationalization association in Cologne, provided equally by institutions of trade and industry. The best known regulations created under coordination of GS1 are agreements concerning international numeral systems (e.g. EAN and corresponding barcodes), electronic data exchange as described above (e.g. SEDAS, EANCOM) or, in logistics, multi-way transport systems and pallets. For some time now, activities have been focused on the development of EPC (Electronic Product Code) for use in the field of RFID. Furthermore, GS1 has been supporting ECR (Efficient Consumer Response) and CPFR (Collaborative Planning, Forecasting and Replenishment) concepts.

Table 9.1 EDIFACT message types and their areas of use

Trade/ industry	Inquiry, offer, order change, order confirmation, order, just-in-time delivery, account statement, delivery schedule, despatch advice, partner reference data, price catalogue, invoice
Transport	Note of receipt, booking request, booking confirmation, fixed booking, forwarding and transport message frame, loading list, transport/forwarding order, transport data reporting/status report
Customs	Debit note, expanded credit note, expended payment order, credit note, payment order, payment advice
Banks	Customs duties, customs declaration, customs notice
Insurances	Open account, reinsurance

initiate the EDIFACT (Electronic Data Interchange for Administration, Commerce and Transport) standard in 1987. Widespread by now, this regulation is fit for use in all sectors of the economy and in public administration. Under EDIFACT, 40 sector- and user-specific subsets have developed by now.

All in all, there are around 200 different message types in use today. The most important subset derived from EDIFACT is EANCOM®-2002. An overview across the most important message types can be found in Table 9.1.

In the past, important characteristics of the different EDI standards were their range in the sense of their geographical applicability and the degree of their universality or their sector-specification. The internalization of business relationships, however, led to a loss of importance of standards that had been purely bilateral, national or sector-specific. (e.g. VDA or ODETTE for the German or European automobile industry).

Based on EDIFACT, the International Article Numbering Association (EAN) has conceptualized the so-called EANCOM® communication standard. It is designed for the global electronic information exchange for suppliers (manufacturers), investors (banks), service providers (forwarders), and customers (trade). Some important EANCOM® message types are collected in Fig. 9.2.

EDI has expanded rapidly in the last years. According to data from the European Economic Institute (EWI) there were more than 500,000 users by the year 2000.

At the same time, it can be assumed that EDI is still far from universal presence in day-to-day business and that it will still need some time for this. This is especially surprising with the data processing and transmission technology having reached a high functionality standard, with problems connected to practical EDI application solved or, respectively, solvable.⁴

⁴ Cf. Weid (1995), p. 23.

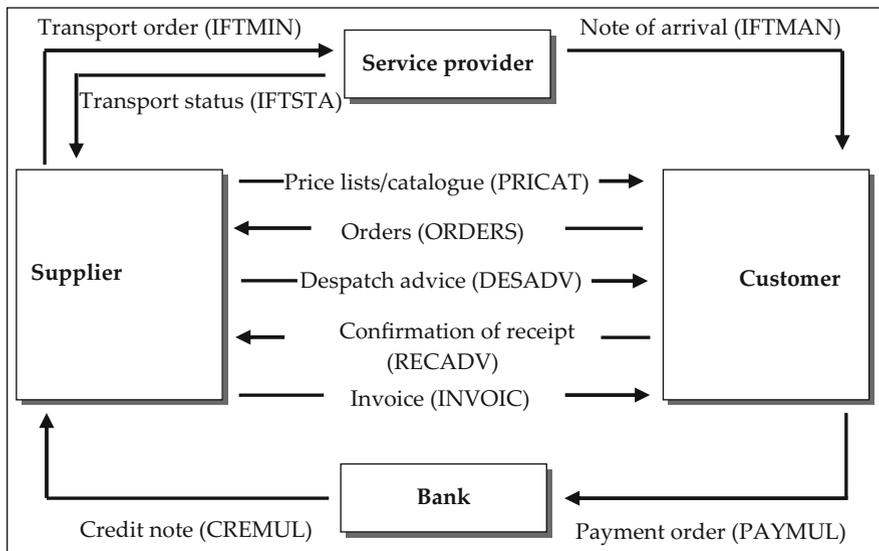


Fig. 9.2 Information flow in logistics with EANCOM® standards
(Cf. GS1 Germany (2006a), p. 7)

The lack of wider expansion of EDI is caused partly by subjective assessment by the management regarding the advantages of its application. Often, costs and other disadvantages like concerns about unauthorized access are reasons against the introduction of EDI. Especially small and medium-sized companies are worried about the costs. For this target group, *web*-EDI solutions have been developed by now. They require only small investments in hard and software and only limited specialized EDI system know-how. With this, it is possible to profit from EDI advantages with a manageable additional manual effort for small data volumes.

Table 9.2 shows and contrasts positive and negative effects of EDI application.⁵ Besides the costs for introduction and operation and the resulting saving potentials, there are indirect costs and saving potentials that are difficult to measure. Furthermore, the arguments against EDI application as well as the operative and strategic advantages in competition resulting from EDI application must be assessed as qualitative factors. Gaining a competitive advantage usually does not result from EDI application alone but from realizing a full strategy like ECR or CFPR that has EDI as an elementary prerequisite.

As a result of the spread of Internet and the available e-commerce solutions (Internet data exchange, e-procurement, Internet market places etc.), the web based XML standard has become very important.

One can assume that EDIFACT and EANCOM® will remain important for electronic data exchange because of their presence and standardization. By

⁵ Cf. Weid (1995), p. 59 et seq.

Table 9.2 Advantages and disadvantages of EDI
(Cf. Weid (1995), p. 129 et seq. and Gleißner (2000), S. 133 et seq)

EDI employment	
Negative effects	Positive effects
Implementation costs	Cost reductions (Staff, equipment and capital commitment costs)
<ul style="list-style-type: none"> ■ Collection of information ■ External EDI consulting costs ■ Coordination with future communication partners ■ Staff training ■ Hard- and software for data processing (computer etc.) and communication (modem etc.) ■ Software adaption/development for existing data processing systems ■ Costs for initial connection to VAN services and systems (ISDN etc.) ■ Pilot or parallel operation in the introduction phase 	<ul style="list-style-type: none"> ■ Handling of documents ■ Recording incoming documents ■ Print and copy costs for outgoing documents ■ Transmission costs (postage, fax) ■ Reduction of the stock with shorter information flow (shorter time for replenishment) ■ Manual sorting, distributing, document storage ■ Correction efforts in case of errors ■ Content comparison of different data formats
Running costs	
<ul style="list-style-type: none"> ■ Software maintenance/development and error elimination ■ License fees to central institutions ■ Software maintenance ■ Connection costs ■ Staff training 	
Other costs	Saving potentials
<ul style="list-style-type: none"> ■ Not exactly quantifiable 	<ul style="list-style-type: none"> ■ Elimination of redundant jobs ■ Simplification of process organization ■ Reduction of the vulnerability to errors ■ Flattening of hierarchies ■ Moving decision-making competence to lower levels ■ Integration and reintegration of processes ■ Higher staff productivity (fewer routine jobs) ■ Higher liquidity because of time advantages between invoicing and receipt of payment; possible lowering of costs of capital
Qualitative disadvantages	Qualitative advantages or potential use
<ul style="list-style-type: none"> ■ Data security hard to realize ■ Documentation of EDI transactions ■ Proof of complete and correct data receipt ■ Unauthorized access (internal/external hackers) ■ Insufficient reference data quality (products, addresses); missing management responsibility ■ Relying of technical DP infrastructure ■ Creation of barriers to entering/leaving a market with IT 	<ul style="list-style-type: none"> ■ Using time potentials by shortening the times for delivery, order processing, and handling ■ Increase in flexibility and efficiency in process organization ■ Increase in employee satisfaction ■ Higher transparency of business processes, improvement of information management ■ Increase in the available reaction time and quality in the logistics chain by earlier and more exact information availability

(continued)

Table 9.2 (Advantages and disadvantages of EDI
(Cf. Weid (1995), p. 129 et seq. and Gleißner (2000), S. 133 et seq) (continued)

<ul style="list-style-type: none"> ■ Resistance against the introduction of innovative technologies and processes ■ Abandonment of person-specific know-how ■ Insecurity about future transmission standards ■ Break even point is not reached in smaller companies because of small data volume or number of transactions ■ Pressure from larger trade partner forces to introduce EDI ■ High introduction costs and a long time until they pay off ■ Missing organizational requirements and willingness ■ Creation of dependences on cooperation partners that are hard to correct ■ Legal problems: <ul style="list-style-type: none"> -Formal requirements for closing of contract -Inclusion of general business terms -Storing requirements for EDI documents 	<ul style="list-style-type: none"> ■ Facilitation of global business activity ■ Basis requirement for realizing ECR strategies ■ General strategic advantages to competition without EDI
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integrating XML, it will in the future be possible to significantly increase the number of companies connected to electronic data exchange.⁶

Table 9.3 shows a comparison of the two data exchange formats.

Table 9.3 Comparison data exchange formats XML and EDIFACT/EANCOM
(GS1 Germany (2009a), p. 75)

XML	EDIFACT / EANCOM
(Meta-) markup language	EDI standard
W3C recommendation since 1998	ISO Norm 1998
Fixed syntax/flexible semantics	Fixed syntax/ fixed semantics
Machine-to-machine communication Human-to-machine communication	Machine-to-machine communication
Flexible data structuring by DTDs or schemes	200 message types at the moment
Flexible data layout with XSL	No specification for data layouts
Few experiences from EDI application	Sophisticated technical equipment necessary

⁶ GS1 Germany (no year).

9.1.2 Identification Standards

Besides standardizing the communication between business partners, standardizing identification systems is also important. This standardization is necessary to connect the information flow to the physical flow of goods. This connection is seen as a labeling of the goods and transport units that can be read by all parties involved in the process chain. The most common identification standards will be explained in the following.

The *Global Location Number* (GLN) makes possible the identification of companies or company departments. This manufacturer number is a part of the EAN number and is assigned centrally by the national standardization organization.

The *Global Trade Item Number* (GTIN) enables the clear and global identification of products, sales and trade units as well as services. The number usually has 13 digits and describes the product and its specifications like color, size, weight, packaging unit etc. It consists of a base number identifying the manufacturer, an individual item number, and one check digit. The GTIN number is the key to access reference data (designation, weight, volume, class of goods etc.) in databases or the price of the article. The manufacturer assigns the item number. Case study 8.1 shows the fundamental data transfer upon scanning a GTIN number as a barcode at the till.

With the space for a 13-digit number not available on small products, there is also a shorter, 8-digit, GTIN number for such cases.

In North America, the 12-digit UPC (Universal Product Code) is used. It is fully compatible with the GTIN number.

Case Study 9.1: Information Flows in Distribution of Goods

At the till in the supermarket, the barcode of the wine bottle is moved across the reading area of the scanner; the GTIN number is read. This unique number is combined with the reference data (designation, weight, trading unit size, class of goods etc.) in the product-lookup (PLU) file. There it is combined with the stored price information. The item is shown in the till and the sales slip is printed out. At the same time, the number is passed on to the database of the supermarket or the trading company and stored there. It is then removed from the local inventory in the inventory control system. Then the data is further processed in the inventory control system of the trading company. After accumulating more sales of the same item, a delivery from the central warehouse of the company is triggered. These inventory changes in the central warehouse can also be aggregated. They are either transferred to orders from the suppliers or passed on as stock information to the manufacturer. The manufacturers or suppliers can then use the information for their own planning process; they may supply new items to the trading company or initiate new rounds of production (see Fig. 9.3).

The *Serial Shipping Container Code* (SSCC) is used to clearly identify shipping units on their way from the sender to the recipient. This makes possible

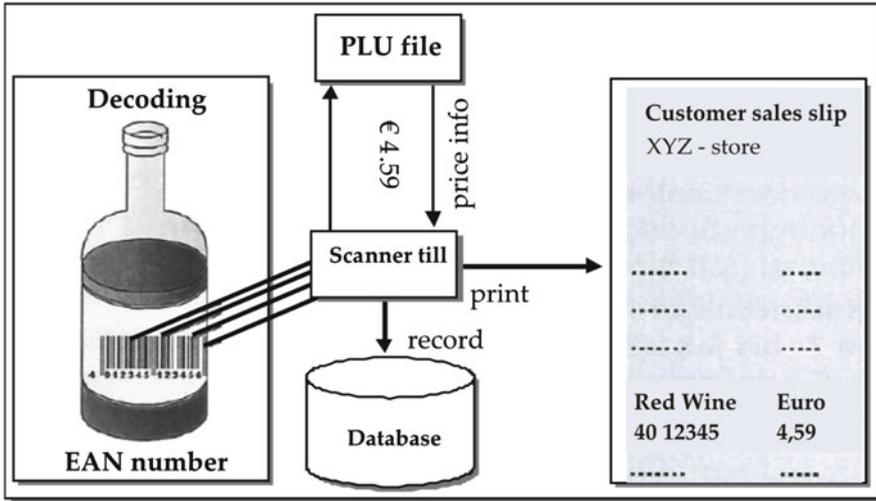


Fig. 9.3 Information flow in the distribution of goods with EANCOM® standards (GSI Germany (2009b), p. 7)

the tracking of a logistical packaging unit or a carrier across the full transport process. Fast location tracking of the transport unit (Tracking & Tracing) is possible. The SSCC can also be used for callbacks and for quality management to check the punctuality of the delivery or for damages to the goods. However, the SSCC is also only a key which grants access to the necessary data of a shipping unit (sender, recipient, forwarder, weight, volume etc.) from connected databases.

The *Global Returnable Asset Identifier (GRAI)* is a special variant. It is used to identify reusable packaging and transport aids (pallets, barrels, boxes etc.). This facilitates the recognition, tracking, and inventory keeping of reusable transport means, the value of which has a considerable weight in logistics processes.

With the introduction of RFID technology, it has become necessary to ensure the international readability of transponder information. To achieve this, the *Electronic Product Code (EPC)* has been developed (see Sect. 9.2).

9.2 Identification Technology

To enable the quick and easy reading and transmission of the described standardized data formats, technically standardized identification systems are required. The goal is to transfer the tasks of recognition and identification from humans to automated technical systems that work with very high or full accuracy. It is necessary to acquire data quickly and accurately to pass on the gathered information, process it with centrally stored data and to continuously generate

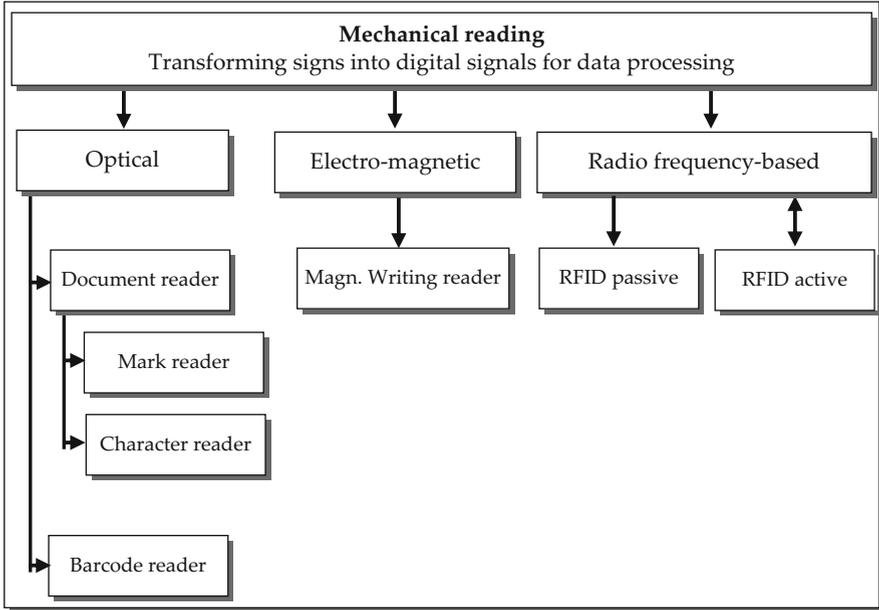


Fig. 9.4 Mechanical reading in automatic data acquisition

controlling information for the logistical process from there. In turn, the processed data should be available for all parties in the logistics chain in as little time as possible. Besides the quick availability of controlling information, automatic data acquisition has the advantage of rendering manual work like the recording of shipment and status information on paper lists unnecessary, thus making it possible to reduce staff costs.

There is a multitude of technical possibilities for the recording of goods today (see Fig. 9.4). The easiest way is to identify the item by measuring its weight or volume. Using information carriers is technically more challenging. Possibilities include the mechanic recording using contacts attached to the item, and the reading of magnetic stripes or opto-electronic information carriers like character, barcode or QR-code scanning. The most advanced recording method is the communication with electronic or electro-magnetic data carriers in the form of fixed or program-mable electronic memory chips like RFID.

Besides mark readers, the easiest way for automatic identification in logistics is optical character reading (OCR) with the so-called OCR code (see Fig. 9.5). Reading devices are able to read labels attached to the items with a corresponding

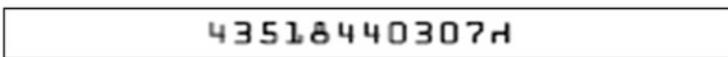


Fig. 9.5 Characters for optical recognition

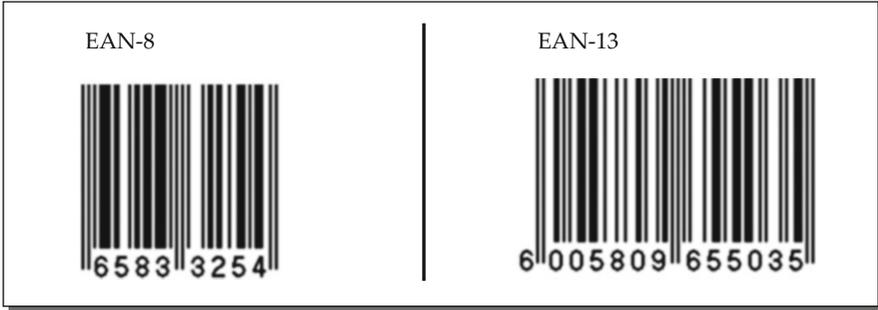


Fig. 9.6 EAN barcodes for individual items

combination of numbers. However, the data volume transferrable with this method is limited.

Using a *barcode*, the data volume and the reading rate can be increased. The barcode consists of a combination of vertical bars that can have different lengths, depending on the standardized data format. The barcode is read by infrared reading devices (scanners or cameras) to record the width of the bars and the distance between them. By using more scanners that are mounted in different positions, barcodes can be also read when they are uneven, attached to the sides or are only attached loosely (luggage on flights). To increase the reading rate, a blank area must surround the barcode. At the end of the combination of bars, there is a check number. To make the information readable for humans as well, they are often printed beneath the barcode in standard characters.

Today, the barcode in its different variants is the most common and the most standardized auto-identification technology in use.

For product identification, mostly the EAN-8 or the EAN-13 barcodes are used (see Fig. 9.6).

With its larger information volume, the EAN-128 barcode is mostly used in logistical areas such as material flow in production, in warehouse processes as well as for delivery control and shipment tracking in the distribution process. Furthermore, it is important for the tracing of batches or the expiry date in chemical, pharmaceutical, and food industries.

In contrast to the shorter product codes EAN-8 or –13, the EAN-128 contains the SSCC and the EAN as well as different additional characteristics that facilitate the reading and prevent misreading (see Fig. 9.7). A two- to three-digit application identifier before the actual number defines the information stored in the following character sequence. This prevents confusion and makes possible complex data processing processes on the downstream databases.

The EAN-128 code is often used with SSCC content for logistical transport processes (see Fig. 9.8).

Besides the one-dimensional barcode described above, more and more two-dimensional barcodes are used. For these so called QR-codes, information can additionally be generated from the horizontal arrangement of lines, dots and areas

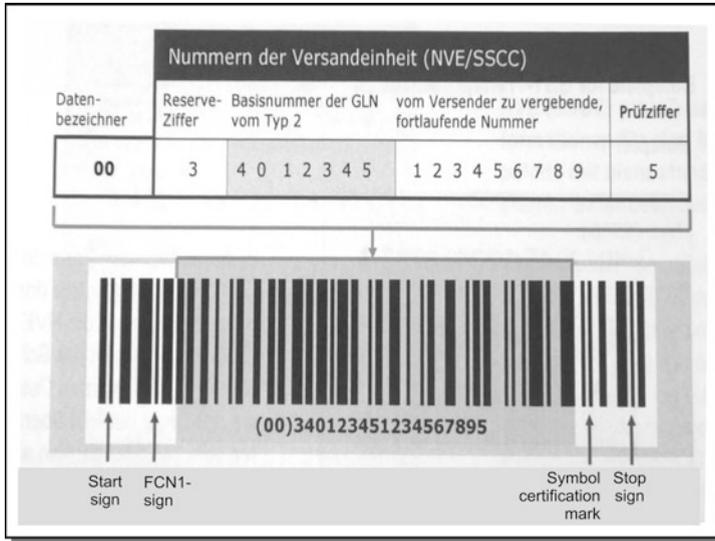


Fig. 9.7 EAN-128 as SSCC (Cf. GS1 Germany (2009a), p. 27)



Fig. 9.8 EAN-128 transport label – concrete example of SSCC (Cf. GS1 Germany (2009a), p. 25)

as well as from their distances to each other. They are more and more used in the fields of postage and address information, online tickets (see Fig. 9.9) and a wide utilization range with mobile devices like smart phones.



Fig. 9.9 2-D codes for postage and train tickets

Table 9.4 Advantages and disadvantages of barcodes

Advantages	Disadvantages
Small costs per unit/label	Sensitive against dirt, moisture, mechanical impact
Standardized reading units in use	Reading only possible visually
Standard widely used in logistics	Limited data volume
	No data addition possible in the process

The barcode is still the most common standard solution for identifying an object in the logistics chain. Its advantages and disadvantages are shown in Table 9.4.

RFID technology, which has been technically available for a long time already, used for military friend-foe identification and later for anti-theft devices in shops, will become more widespread in logistics as well. The most important argument for this is its significant performance increase compared to the barcode.

Its principal functioning is shown in Fig. 9.10.

So-called transponders⁷ are attached to the goods, load carries, or containers. They consist of a microchip that stores the information, an antenna for sending and receiving, and housing. The housing may be a box or just consist of film, which is a special advantage for product identification for consumer goods. They are so flat

⁷ Transponder is a combination of ‘transmit’ and ‘respond’.

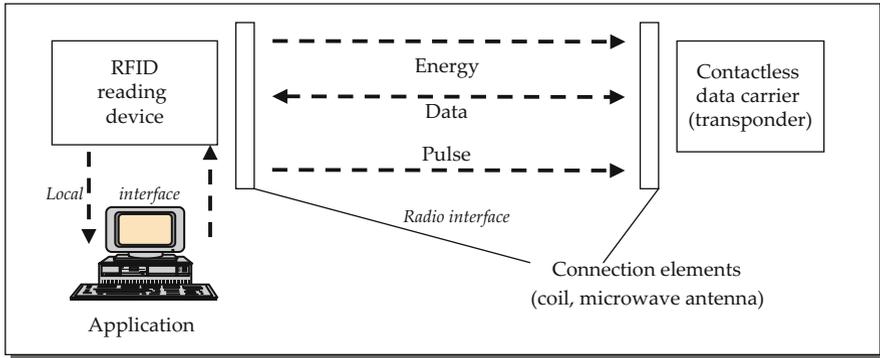


Fig. 9.10 Logic of the RFID data flow

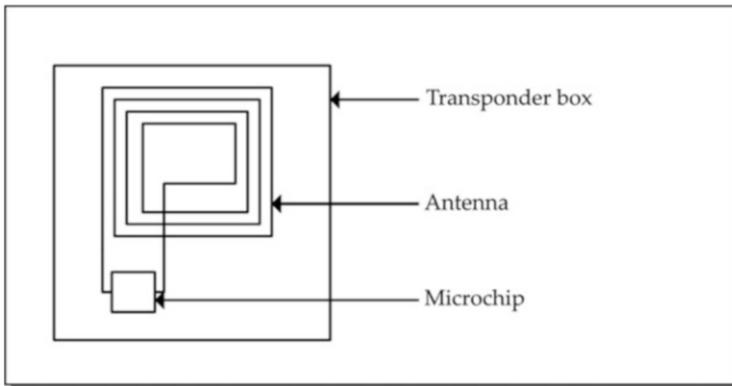


Fig. 9.11 Transponder (smart label) (Cf. GS1 Germany (2003), p. 13)

that they can be attached to the items as stickers (so-called smart labels; see Fig. 9.11).

With respect to the energy supply, transponders are divided into active and passive transponders. The active writing/reading device initiates the transmission or reading of the information on the transponder. Active systems use the energy from an integrated battery for controlling processes of the microchip and for independently sending information. Passive systems, on the other hand, receive their energy by induction – they drain energy from the (electro-) magnetic frequency field. The capacity of an RFID transponder can reach up to 64 KB. There are also models where the data can be complemented during the use or deleted afterwards to make room for new information.

The advantages and disadvantages of RFID technology are shown in Table 9.5.

Basically, there are two methods to store data on an RFID transponder. The first method is to directly store all relevant data of one article or a logistical unit on the transponder. This is a decentralized approach to data storing and, through this

Table 9.5 Advantages and disadvantages of RFID technology

Advantages	Disadvantages
Reusable	Sometimes high prices for transponders
Readable without direct visual contact and across large distances to the transponder (label or tag)	Potential disturbance of receipt or sending by metallic environment
High data volume storable	Higher data volume means more difficult control because of data protection
Writable with data during the logistics process	Uncontrolled operation criticized by data protection specialists
Relatively immune to dirt	Danger of data loss if exclusively stored externally on transponder
Wide range of data (e.g. temperature in the cool chain)	Processing of high data volumes necessary in downstream applications
Automation of processes	Complex technology
Localization of objects also within the warehouse	

independence from downstream databases, shortens the time for transmission and decision-making, creating an advantage. However, it requires high storing capacity of the transponder and bears a high risk for data loss.

The second method is to use the EAN numbering system, the same as for barcodes. To use the higher performance of the transponder compared to the barcode, the EAN codes can be integrated in the so-called *Electronic Product Code (EPC)*. In this area, EPCglobal – an initiative of the national standardization organizations – is working on defining an international EPD standard. Furthermore, a special EPCglobalTM server network is planned to organize the global information exchange of EPC numbers and corresponding reference and transaction data via the Internet.

9.3 Stock Management and Warehouse Control

9.3.1 Classification of IT in the Fields of Inventory and Warehousing

Due to their complexity, stock management and warehouse control are not imaginable without IT systems anymore. In the different areas, various operative application systems work together. They are generally divided into the four system levels that control the logistical process. The first and highest level is the *ERP system*. The stock management, the economic assessment of the inventory situation, the purchase controlling, and the initiating of reorders as well as the recording and management of customer orders take place here.

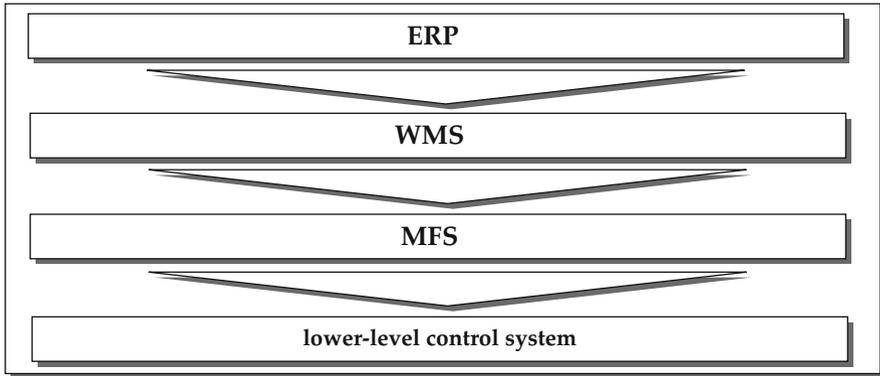


Fig. 9.12 Network of IT systems in the warehouse

The second level is the *warehouse management system (WMS)*. Its tasks are local stock management, the storage area management and assignment as well as the stocktaking and replenishment planning.

The *material flow system (MFS)* is the third level. It controls the internal transports, orders of goods coming into and going out of the warehouse as well as the individual procedures for replenishment, picking, and stocktaking.

The fourth, lowest and purely operative level is the *lower-level control system* by programmable logic control unit (PLC). Their elements control the handling technology and data transmission systems as well as peripheral devices like printers for receipts and barcodes.⁸ The network of IT systems used in or bordering the warehouse is shown in Fig. 9.12.

9.3.2 ERP Systems

From the point of sale, the controlling and planning tasks of logistics processes are handled by so-called *Enterprise Resource Planning (ERP)* systems. Mainly in the trade sector, ERP systems considerably improve the information base for prognosis procedures with an item-based sales data recording and stock management in downstream, operative units. The sales forecast of a stock-managing point (warehouse) is not exclusively based on the own sales or delivery data anymore but can work with data from the demanding points (branches).

In detail, those are:

- Sold volume with respect to time and space
- Recording of inventory data
- Recording of goods leaving and entering
- Calculation of stock range and
- Assessment of delivery potential and presence of items

⁸ Cf. Arnold et al. (2008), p. 4 ff.

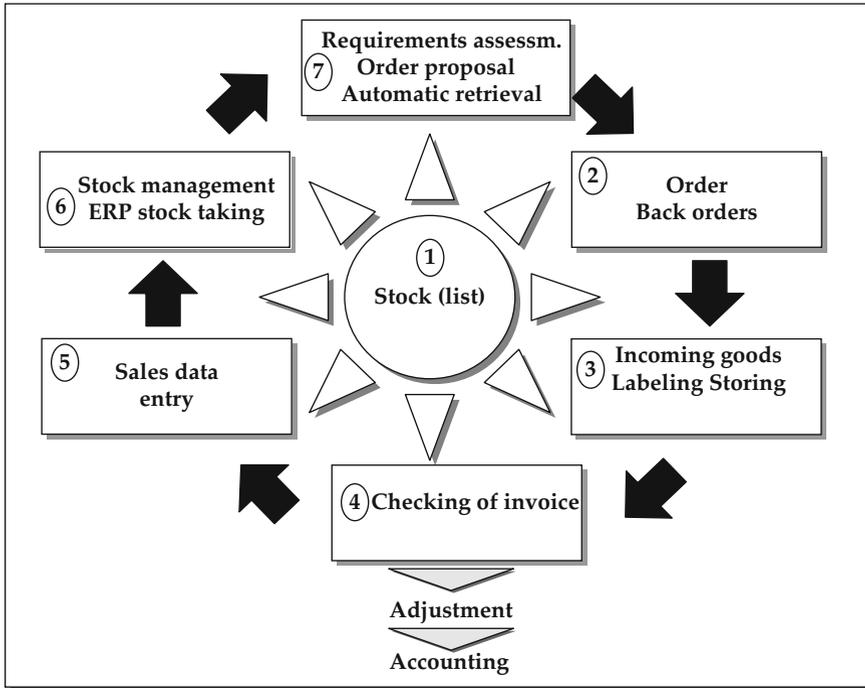


Fig. 9.13 Cycle of a closed ERP system (Cf. Hertel et al. (2005), p. 225)

The ERP system is based on the process logic shown in Fig. 9.13.

More exact information about stock, movement of goods, and current sales forecasts can reduce the level of uncertainty. Traditionally, this is achieved by storing goods, thus investing capital. The forecasts are the more exact the more they are based on the sales data of the end customers in the value chain. Prognosis methods can include many different influences, e.g. trends, seasonal factors, calendar-related factors, or marketing activities.

The utilization and exchange of information in ERP systems depend on the depth, i.e. the level of detail, of information that enters the system. The level of detail is divided into time-related (data from days, weeks, months), item-related (items and the item groups), and location-related (branch or site level of the locations). The information process is furthermore determined by the degree of automation of the data exchange and of the information exchange. From this, in turn, come the timeliness and quality of the information as well as the costs of the communication infrastructure.

With respect to the forms of ERP systems, four basic variants can be described, as shown in the following Fig. 9.14.

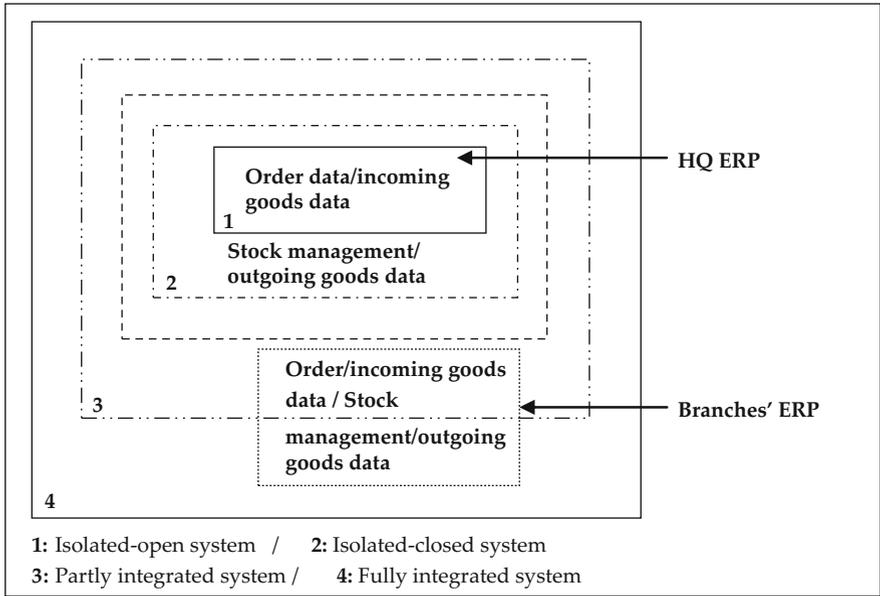


Fig. 9.14 Forms of ERP systems in trading companies (Cf. Hertel et al. (2005), p. 227)

As seen in the figure, in *isolated-open ERP systems*, only the order data or the data sets of the centralized incoming goods are recorded. Conclusions about realized sales and revenues can therefore only be made indirectly and after a delay. In *isolated-closed ERP systems*, not only incoming goods and order data is recorded but also the data from the centralized incoming goods of the branches. However, this is not connected to the order and stock data of the branches. *Partly integrated ERP systems* link central ERP systems to the order and incoming goods data of the decentralized branches system. *Fully integrated ERP systems* take this further. They also record information about the incoming goods and issue of goods that are connected via the individual systems. With this approach, information about the real stock and sales situation in the branches can be transmitted within the centralized system.⁹

9.3.3 Warehouse Management Systems

Systems for comprehensive warehouse controlling and stock management are called *Warehouse Management Systems (WMS)*. Their main tasks are recording goods received, assignment and management of storing areas, control of the relocating and picking processes, reorganization of the storing area occupancy,

⁹ Cf. Hertel et al. (2005), p. 227.

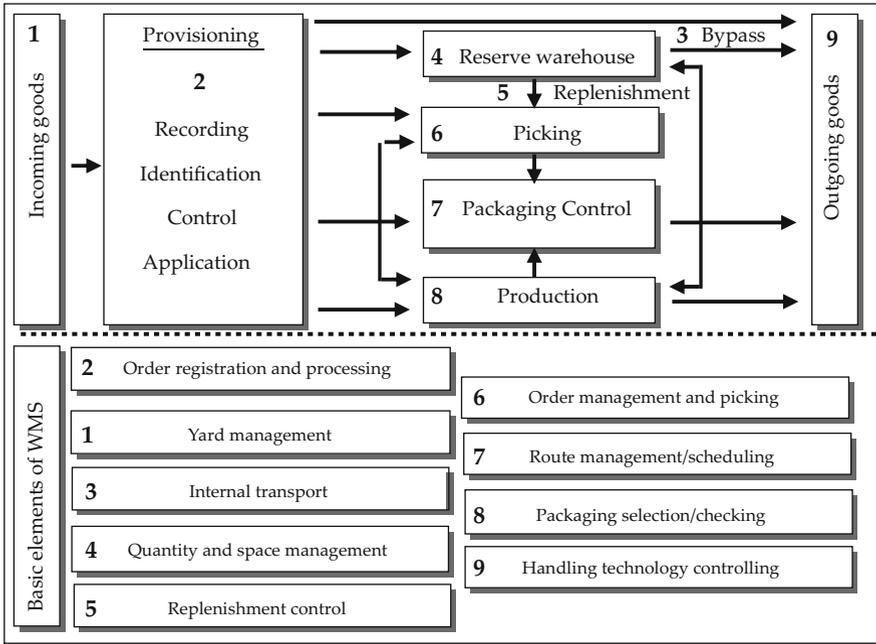


Fig. 9.15 Process-oriented view on warehouse management systems
(Cf. Bode and Preuß (2004), p. 325)

replenishment control, recording outgoing goods, and stocktaking. The warehouse processes and the corresponding functionalities of a WMS are shown in Fig. 9.15. The allocation is made with the help of the corresponding numbers in the picture.

9.3.4 Material Flow Systems and Lower-Level Control Systems

Systems for material flow control provide for the smooth material flow in the warehouse. This includes the controlling of the storing, assigning of storing space, picking and replenishment controlling with respect to priority and/or efficiency. In this context, efficiency means short ways for storing and moving out, high storage space utilization, and short access times.

The *controls* or *lower-level control systems* (PLC – Programmable Logic Controller) are the *intelligent* units directly responsible for controlling the individual conveying systems in the warehouse. The lower-level control systems trigger the starting or stopping of the continuous handling systems, automated stacker cranes etc. and also initiate e.g. the dropping of goods from sorters on their destination. They are programmed based on a predefined set of rules (syntax) and are triggered by the material flow system. The connection between the WMS, the material flow control and the PLC is shown in Fig. 9.16.

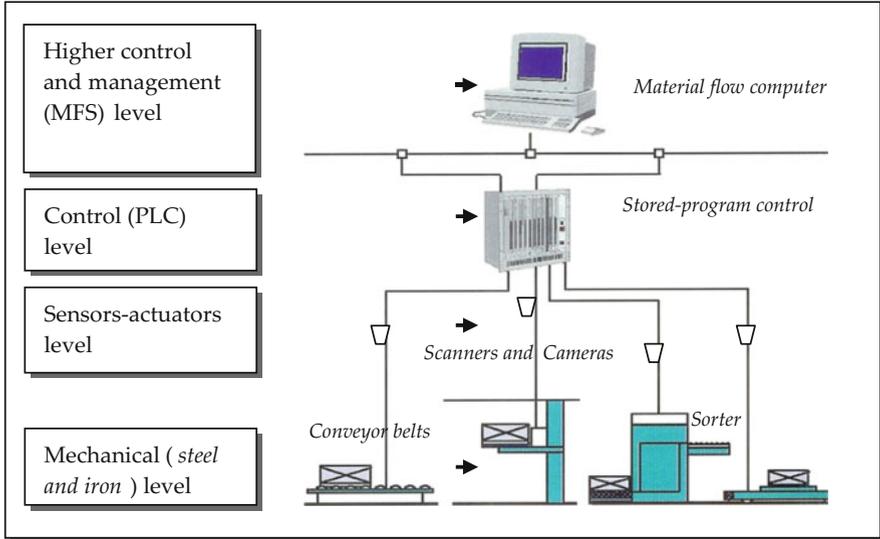


Fig. 9.16 IT structure in the warehouse (Cf. Caninenberg (2004), p. 34)

9.4 Transport Planning and Controlling

Transport systems can be divided into internal (within the company) and external transport systems (company to company or to consumer).

Internal transport systems are usually parts of production planning and control systems or of warehouse management systems, a detailed description of which shall not be given here.

Planning systems for external transports calculate the most favorable combination of means of transport and their utilization, using the best route and sequence of loading and unloading locations. One main task is to consolidate part loads on longer routes to achieve maximum utilization of the means of transport. Further tasks include the controlling of complete loads to optimize the routes and to avoid empty runs or include back loads in the planning (see Chap. 7). In road transport of goods, these planning systems are mostly used for complete, part load or groupage service.

Route planning or scheduling systems are IT applications that support transport fleet managers to efficiently plan routes for delivering or picking up goods. A number of customers, the demands and locations of which are known, are to receive a defined good from one deposit with a number of vehicles with certain capacities. The system gives suggestions about how the routes should be made in order to minimize total transport costs while adhering to certain secondary conditions (e.g. capacity and time restrictions).

The determinants of route planning are collected in Table 9.6.

Table 9.6 Determinants of route planning and scheduling

Distance determination	<ul style="list-style-type: none"> ■ Digital network method
Travel time calculation	<ul style="list-style-type: none"> ■ Digital road network ■ Average speed ■ Speed depending on the distance ■ Speed depending on the streets ■ Weather factors ■ Traffic/road works
Loading/unloading/ waiting times	<ul style="list-style-type: none"> ■ Minimum standing time per customer (paper processing, maneuvering time) ■ Time depending on the quantity ■ Time depending on the customer
Other restrictions	<ul style="list-style-type: none"> ■ Driving and resting period regulations ■ Regulations about working times for drivers and loading/unloading staff ■ Different types of vehicles with different maximum loads; equipment necessary for delivery, e.g. hydraulic ramp, forklift) ■ Empties/back loads ■ Uncalculated waiting times at customer sites ■ Driving ban on holidays, due to weather and in inner cities

Tactical route planning is concerned with standard or framework tours that take place at certain times (daily, weekly) and have a more or less defined order or deliver to a defined area.

Operative route planning means to create a daily planned route based on the current order situation or on framework routes that have already been defined. Such systems are linked to commercial systems of order management or ERP systems or are part of them.

The advantages from using computer-based route planning systems are collected in Table 9.7.

Transport fleet management systems are used for transport fleet controlling. Basically, they consist of an on-board (computer) unit (OBU) installed in the vehicle and central analysis software. The on-board units record the process data accumulating during employment and subsequently transmit it to the analysis system. The latter contains basic data about the vehicles (purchase costs, amortization, insurance premiums, service life etc.). The on-board unit record consumption and situation data (fuel consumption, mileage, tire condition, motor strain, GPS location data, street navigation etc.). This data serves to compile statistics about the

Table 9.7 Potential advantages of route planning

Potential advantages of trip planning	
For executives/management	<ul style="list-style-type: none"> ■ Rationalizing potential between three and five per cent of the transport costs ■ Transparency across the full transport process ■ Competent information for tactical and strategic decisions
For transport fleet managers	<ul style="list-style-type: none"> ■ Competent scheduling in the available time ■ Transparency across the full transport process ■ Reduction of administrative efforts ■ Facilitation of the process ■ Systematization of the planning process ■ Reduction of risks during holidays or absence due to illness
For drivers	<ul style="list-style-type: none"> ■ Same workloads for all drivers ■ Better adherence to delivery times ■ More information about orders and trips
For customers	<ul style="list-style-type: none"> ■ Better delivery service by increasing the order time ■ Better compliance with delivery restrictions

vehicle utilization and strain, indication for vehicle use (e.g. fuel-saving driving, temperature of cooling or freezing systems), repair intervals, the ideal time of use, and source-based cost information for individual transport activities, including the deduction of road tolls. Transport fleet management systems are offered by vehicle manufacturers, technical testing companies, and independent software vendors.

So-called *Fleet Monitoring Systems* support transport fleet management. These systems establish a connection between the driver and the fleet management (headquarters) via mobile communication. This connection can be used to send the current position as well as changes to the status (driving, waiting for unloading, unloading completed) from the vehicle. The fleet manager can assign new orders to the most favorable vehicle based on this information; the job can be directly assigned via mobile communication. The on-board units for road tolls in use today generally feature the components necessary for fleet monitoring: GPS locating with digital net as well as mobile communication with the GSM net.

Tracking & tracing systems make possible the more or less complete tracking of transported goods and vehicles and, at the same time, ensure later traceability. Information about the current location of a shipment are important for interventions in the transporting process or for initiating counter-measures like a substitute delivery in case of delay, loss, or changes to the location of receipt. Transparency of the status during the transport process is also an important quality factor for

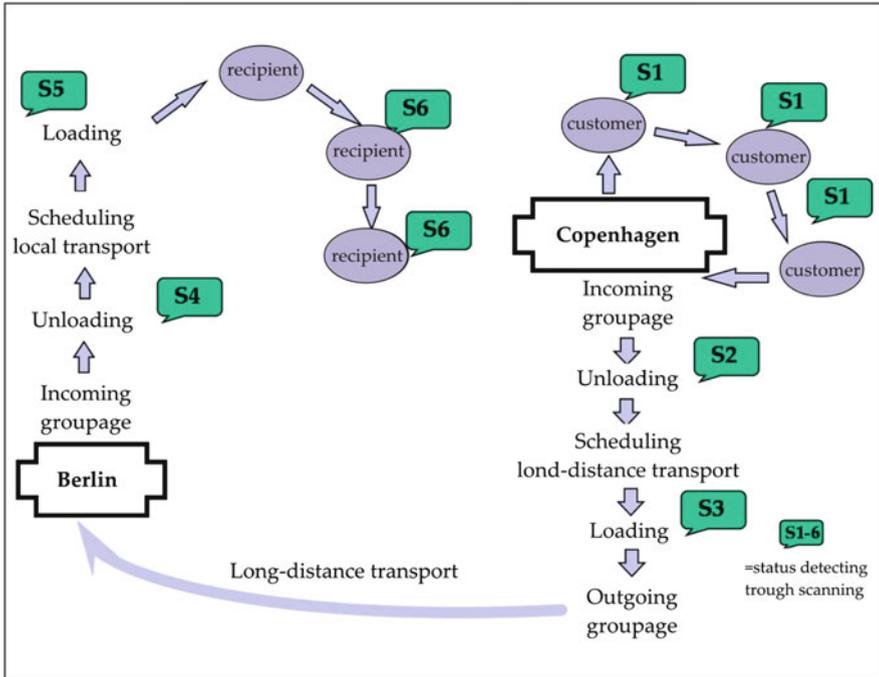


Fig. 9.17 The principle of tracking & tracing systems

logistical services. Furthermore, legal regulations about the traceability of foods or the cold chain can be adhered to. Data inputs in tracking & tracing systems are made by acquisition on certain key points, e.g. when leaving the warehouse, when handling the goods at the cross-docking point, when entering the receiving warehouse, and on delivery to the customer. Tracking & tracing systems are often used for tracking valuable or dangerous goods and in the field of express and parcel delivery. Furthermore, continuous satellite-based locating and tracking is possible; it is used e.g. for trucks, trains, or containers.

Figure 9.17 shows the changes to the status of a shipment during the transport process. Usually every status is documented by scanning and can be stored in the tracking system with the corresponding date and time.

9.5 Strategic and Operative Planning Systems

9.5.1 Site and Network Planning

Software systems are available for almost all planning processes introduced in Chap. 8. *Systems for site optimization* or *distribution network planning* give results based on mathematical or heuristic methods that can be transferred to draft

decisions after a qualitative assessment. The quality of the results from IT applications largely depends on the possibilities to include parameters and influencing factors. The bases of such systems are always mass data in the form of individual business events (number of shipments, locations of dispatch and receipt, size, volume etc.) from which *ideal* warehouse locations or distribution networks can be calculated after different iteration processes under the same conditions. These optimization systems support management decisions; but with *soft* and non-quantifiable decision factors always having to be taken into account as well; they cannot replace them.

9.5.2 E-procurement

On the operative level, the Internet has been responsible for considerable changes to the purchasing process; this is described by the term e-procurement. The data exchange between suppliers and buyers had been realized via EDI. The Internet, however, has made possible unlimited and easy contact. All business processes take place electronically, ideally without documents. Decentralized ordering of goods by the buyer who also overviews the process is possible. All of this takes place on a virtual market place which is used as a transaction platform that ensures the information supply between sellers and buyers and supports the initiation and, where possible, the realization of transactions. Market places can be divided into horizontal – i.e. for trans-sector products and services, e.g. for energy and office material – and vertical, sector specific – e.g. for the automobile or healthcare sector – trading places. Solution concepts are mostly simple B2B approaches (market place or catalog solutions). Catalog solutions are favorable for standardized products with little complexity. The Internet ensures a high market transparency. Low prices or at least low price volatility and a regular demand are assumed. Sometimes, configuration via catalog systems is possible.¹⁰ There is a certain price level where price comparison or explicit tendering is better. Such tendering processes assume a buyer market situation. The goal is to get the best acquisition price. The specific requirements are tendered. After the pre-selection of suppliers, the process is reduced to pure price negotiations. One problem is the taking into account of unequal suppliers or quality. During the tendering, the price development is downward. The best price at a certain point is shown to all suppliers who can see potential for improvements from this.

The admission to these B2B platforms is defined by selection criteria like sector specialization, market share, neutrality, transparency, and information services.

A further step towards integration is setting up a B2B desktop-purchasing system which makes possible the automatic execution of many internal processes with numerous market places and, if possible, all suppliers. The goal is to shape all workflows within the company as well as to include the solution in existing

¹⁰ Cf. Stieglitz (2003), p. 266 ff.

ERP/SCM software. Such systems enable companies to unbundle the processes. The preparation of offers and the completing of order forms are no longer necessary. If the payment is made with a purchasing card or a credit note, the same is true for invoice checking, manual receipt of payment, or receipt archiving.

Beyond the purchasing sector, the term *e-logistics* has been established for the strategic planning and realization of logistics systems for Internet-based business. The operative and administrative controlling of logistics processes for supply to end customers in Internet trade, cargo pools for setting up and bundling transport space, but also pure information logistics services can be subsumed under the term e-logistics. In this context, information logistics means the information supply and the management of information flows to realize business processes.¹¹

9.5.3 Enterprise Resource Planning

Based on Material Requirements Planning (MRP I) systems, systems for sequential material requirements and capacity planning, called Manufacturing Resource Planning (MRP II), developed mainly in production areas. A further development was Production Planning Systems (PPS). Following an integrated approach, *Enterprise Resource Planning (ERP)* systems go beyond production and make possible the supervision of all company resources. The functionalities of ERP systems primarily have an operative character. However, they also supply data for strategic planning decisions. Using these transaction-oriented ERP systems, company resources like raw materials, finished goods, staff, and financial means are connected to achieve the company goal; and efficient suggestions are made for the process and dimensioning of transactions. Following guidelines by the management and initiated by the order habits of the customers, ERP software solutions manage and control all business processes of a company in the commercial sense.

An ERP system can include the function areas sales, order processing, purchasing, materials management and logistics, finance and controlling, human resources, quality management and, finally, production. It is crucial that the data storage and the process handling in an ERP solution takes place cross-functionally. ERP systems specifically adapted for logistics connect, manage, control, and monitor the logistical sub-processes from the order handling to the delivery or even to the invoicing and monitoring of the receipt of money. WMS and ERP systems can be independent software packages, e.g. in grown IT structures in a company. However, they should be closely connected to each other. In case of purchasing new equipment in this area, it is sensible to opt for an integrated WSM/ERP solution.

¹¹ Cf. Straube (2004), p. 69 ff.

9.5.4 Supply Chain Planning

Leaving the organizational parts of an individual company that maps the different business processes – maybe across several sites – with ERP, Supply Chain Management (SCM) is the bordering field. SCM systems work on three different levels:

- Supply Chain Design (SCD)
- Supply Chain Planning (SCP)
- Supply Chain Execution (SCE)

The aim of SCM systems is to design, plan, and control the flow of materials and the cross-company processes during the complete logistical chain, from raw materials and production, to trade and, eventually, to the customer. Doing so, a multitude of connections between interfaces with different characters takes place (see Fig. 9.16). Like ERP systems, SCM systems tend to have an operative character.

The main task of *Supply Chain Design* is the designing of logistics networks and the valuing of the necessary investments.

In the field of *Supply Chain Planning*, IT systems realize consumption or requirements planning, stock planning, transport planning etc. in the logistics chain and calculate them for coming periods. Such calculations and plans for logistical capacities derived from them are realized by specialist *Advanced Planning and Scheduling Systems (APS)*.

Supply Chain Execution (SCE) systems use IT functionalities to support the operative realization in the fields of order processing, production, warehousing, and transport.

The connections between Supply Chain Design, Supply Chain Planning and Supply Chain Execution are shown in Fig. 9.18.

Case Study 9.2: Enterprise Resource Planning for Supply Chain Processes

This case study describes the implementation and the employment of an ERP system at a warehousing services provider. Because of the detailed description, topics from the other chapters come up as well. This can be seen as proof of the wide-reaching character of IT systems for logistical tasks.

1. The Company

Aarau storehouses plc, in Switzerland, offers logistics services as well as integrated logistics solutions for nationally and internationally (cross-borders) active clients. Besides classic logistics services like transporting, warehousing, and handling, services like stock management, quality control, packing, labeling, and customizing are offered. The company realizes crucial parts of their clients' logistics processes.

These offers are connected with certain requirements:

- Universal business processes, across company borders between industry, logistics and trade

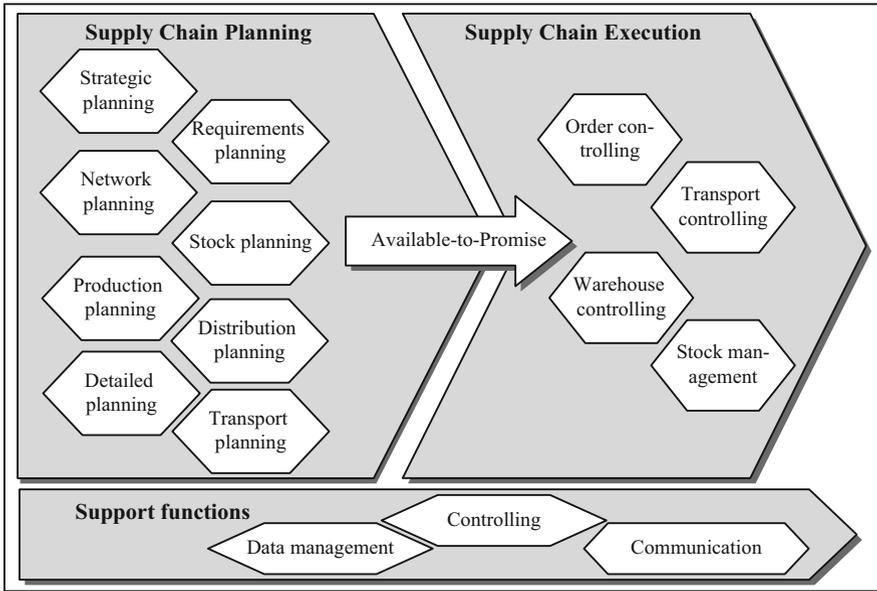


Fig. 9.18 Task model SCM systems (Cf. Kuhn and Hellingrath (2002), p. 13)

- Quick, batch-oriented handling of the goods, e.g. according to expiry date or quality criteria
- Flexible and reliable realization of customer requirements like picking and packing

In these areas, Aarau storehouses specializes in logistical challenges in the field of food, beverages, and tobacco. Customers in this field include Masterfoods, Nestlé, Royal Canin, Gustav Gerig and Ricola. For Masterfoods, Aarau storehouses supply goods to retailers (partly using distribution centers) and bulk buyers everywhere in Switzerland. This includes delivering full pallets as well as displays according to customer demands. Furthermore, customers in the non-food sector include Elcotherm, Swatch, Vespa, Piaggio, FORS Liebherr, Sibir, Titan, and Electrolux. Based on decades of experience in the fields of warehousing, customizing, and distribution of foods, the company vision is to offer individually tailored logistics services that fit into the existing logistics processes to customers active nationally and internationally. The company presentation says:

Aarau storehouses is a modern logistics service provider focusing on food logistics with complete services and wide know-how. Our goal is to build long-term relationships with our partners as their logistics service provider.

2. The Sector: Significance of Information Technology and E-Business

Information technology (IT) and the electronic exchange of data between business partners play a central role in logistics. IT is used for different purposes. Besides normal business processes, these are especially the increase of efficiency for individual processes, the provision of prerequisites for new function and the process integration with clients.

As a contract-based service provider, Aarau storehouses is especially interested in offering their clients high additional value. This includes transparency, e.g. by the access to current stock data and *permanent stock-taking*, a very high level of flexibility and planning security as well as a smooth integration of the IT system with that of the clients.

3. The Integration Project

3.1 Starting Situation and Reason for the Project

The reason for starting the project was the wish of a client to be able to do a complete tracing of goods based on batches. The background for this was a recently introduced regulation to ensure the traceability of batch-based quality information (EU regulation 178/2002, General Food Law). This means that a continuous flow on information must be ensured for the supplier of the primary products to the producer and the trading. Logistics must therefore be able to record the batch information from the producer and deliver them, across all following procedures to the places where they are eventually for sale.

3.2 Implementation Partner (Supplier of Business Software)

The *GUS group* offers business applications (ERP solutions) focusing on the so-called life science industries (pharmaceutical, chemical, food) as well as complete solutions for distance trade and logistics systems. It develops, distributes, and implements complete solutions for ERP, quality management, e-commerce, and logistics.

3.3 Business Partners

Masterfoods is active worldwide as a producer of sweets, snacks, and food brands as well as for products for pets. Retailers (directly or via distribution centers) and large customers are supplied to in Switzerland.

4. Specification of the Integration

Aarau storehouses deliver food producer's full product ranges to retailers and large customers in Switzerland. This case study takes the customer *Masterfoods* as an example for these services. The logistics outsourcing includes the tasks order management, stock management, batch tracing, picking and customizing as well as transport (see Fig. 9.19).

For these processes, Aarau storehouses is fully integrated into the communication processes between the producer and the client. Integral communication elements like stock information, orders, activity data (necessary because of the production of displays for special offers) as well as despatch advices are distributed to the partners using an information hub, made possible by the integrated logistics solution at Aarau storehouses.

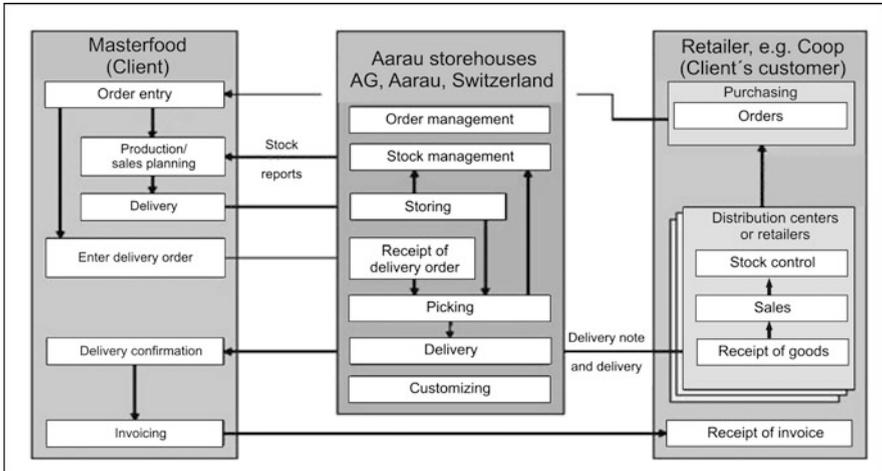


Fig. 9.19 Integration of Masterfoods and retailing

- Based on the sales planning between Masterfoods and the retailer, Aarau storehouses daily receives shipping order information from the Masterfoods headquarters.
- From this, Aarau storehouses creates the picking and delivery jobs for internal logistics and distribution in Switzerland.
- Based on the delivery data, the retailers receive dispatch advices.
- Masterfoods receives regularly updated stock information (permanent stock-taking).
- Uncalculated waiting times at customer locations:

Based on the stock data and the sales planning, Masterfoods generates production orders in their own sites and delivers to Aarau storehouses.

Aarau storehouses stores a stock from few days to 3 months, depending on the product. Usually, the products are delivered within 24–48 h after an order requiring high delivery precision and quality.

The quality orientation made possible by the integrated logistics and IT concept is aimed most of all at the batch traceability required in the food, beverage and tobacco sector. As a result, Masterfoods can see which product was delivered to which customer with the batch number of a product. This also makes possible the quick and targeted realization of possible product recalls.

4.1 View Process

Aarau storehouses divides the logistical process into receipt of goods/storing, order management, picking, and customizing. Customizing includes services like creating product display with a defined mixture of goods. Additionally, quality management accompanying the process and batch tracing takes place. The task, jointly completed by Masterfoods and Aarau storehouses, secures a high level of delivery precision. It has to be noted that the stock management

works according to FeFo: first expire, first out. The respective product with the nearest expiry date is delivered first; the date of receipt is not taken into account. This strict monitoring of batches and expiry dates ensures that no product that is due too early will get into the client's sales channel. The basic processes can be individually adapted or expanded for each customer to fit into their own logistics processes. The following describes the processes order management and picking, as they have been adapted for Masterfoods.

4.2 Order Management and Picking

- Three times every day (5:00 a.m., 10:30 a.m., 4:30 p.m.), shipment order data is sent from Masterfoods to the ERP system of Aarau storehouses, using a leased line.
- If the goods are in stock, the order is passed on to picking and transport pre-planning. Otherwise, an out-of-stock message is generated and sent to Masterfoods.
- In pre-planning, the orders are assigned to a delivery zone. Detailed route planning takes place after this in the transport department.
- The dispatch message is automatically sent by EDI or fax to the retailer.
- The processes shipping orders and reported stock data is reported to Masterfoods with each daily closing.
- Picking and handling of reorders.
- From the order data from Masterfoods, picking orders are generated and realized in a two-shift system.
- Sorted to optimize routes, the picking orders are transmitted via radio data transmission to the picking machines. The ERP system, in dialogue with the radio terminal, automatically confirms the orders and gives the remaining quantity to update the stock information.
- If a minimum stock quantity is not met in the picking warehouse, a relocating order from the main warehouse (according to FeFo) is automatically sent to the displays of the forklift drivers.
- Every physical movement (storing, replenishment, outgoing) is monitored within the warehouse area by the ERP system. This guarantees complete control over the flow of goods and the expiry dates.
- Every picking order is completed with the automatic printing of a pallet label (EAN 128) at a printer in the area.

4.3 The Application

The described business processes and the corresponding cross-company communication largely rely on the adapted, batch-oriented ERP system *GUS ERP CHARISMA* as the central logistics system. The system performs the following tasks:

- Keeping of customer data, order data, stock lists as well as stock information, batch information and performance data
- Automatically transforming incoming orders to picking or customizing orders and controlling the picking

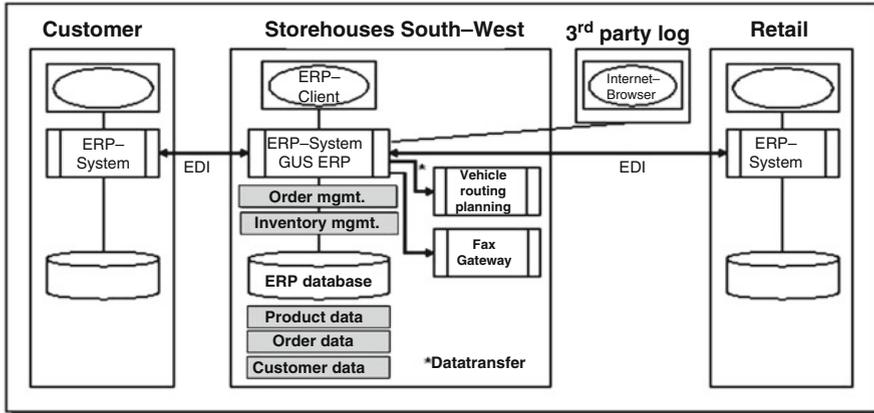


Fig. 9.20 Application overview

- Updating the stock numbers after every moving in or out of items (continuous stock taking)
- Regularly reporting stock information to the client
- Sending dispatch messages to the retailers via EDI or fax.

Additionally, Aarau storehouses gives the delivering forwarders the possibility to reserve a time window for their delivery on an IT platform accessible via the Internet. This considerably facilitates the planning for Aarau storehouses and for the forwarders.

4.4 Software

GUS ERP CHARISMA is configured standard software for logistics management, adapted to the need of the customers. Lagerhaeuser Aarau uses the version developed for the iSeries platform. This version requires additional programming for the adjustment of processes necessary for every customer. However, CHARISMA can be used besides GUS-OS ERP for Life Sciences, the GUS Group's newly developed open business software. This allows for a workflow-based process adaption or expansion without changes to the program code (see Fig. 9.20).

4.5 Pallet Identification

The clear identification of pallets and the management of additional information about the pallets are necessary for the batch tracing and a precise stock and quality management. This information is exchanged electronically between Masterfoods, Aarau storehouses and the retailers. Additionally, it is attached as EAN 128 labels to the pallets for shipment identification. EAN 128 labels encode the EAN 13 codes of the products on the pallet, additional information like batch number and expiry date as well as the Serial Shipping Container Code (SSCC) for identifying the pallet itself. Designing the codes and EAN 128 labels, it had to be taken into account that especially the large customers in retailing

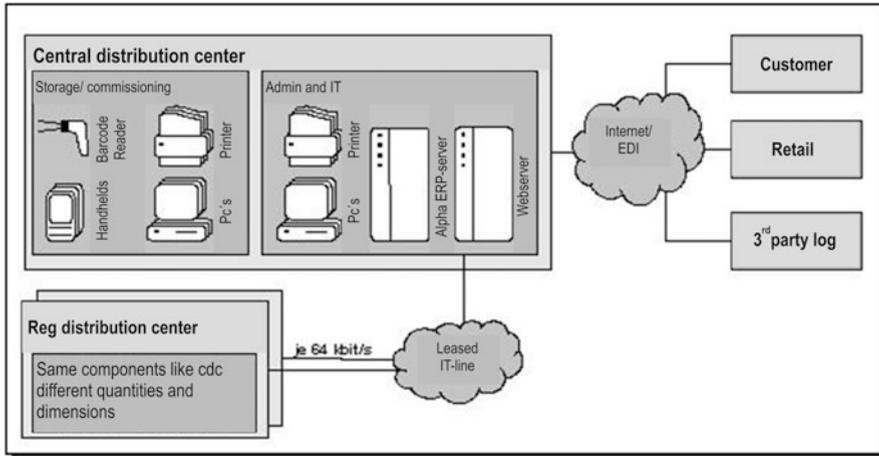


Fig. 9.21 System overview

have, respectively, own requirements for the code structure within the relatively open standard.

4.6 Reference Data

It is essential for the realization of batch tracing and a precise stock management that even parts of pallets can be clearly identified. This requires information about the layout of pallets (reference data) to know e.g. how many layers a pallet has and how many units (boxes) are stacked per layer. This data is generally provided to Aarau storehouses. However, the incoming goods do not always correspond to the expected formats. In such cases, the goods are standardized during the checking of incoming goods. This makes possible the realization of processes according to the requirements in the following logistics chain.

4.7 The Technology

The ERP system at Aarau storehouses is operated at the Schafisheim site on an IBM iSeries AS/400 system. Due to the starting situation, a centralized solution with access via Internet or VPN was chosen. GUS ERP Charisma can be fully operated via Internet access. Additionally, various password-protected areas are available (see Fig. 9.21).

The security of EDP applications and the availability of data and information is a top priority for Aarau storehouses. To achieve this, all relevant data is mirrored on the central system in the Aarau storehouses company headquarters in Lausanne, in the central distribution center in Spreitenbach as well in the regional warehouse in Schafisheim. Communication with customers and retailers takes place by Internet and EDI, in some cases still via fax.

5. Evaluation

Upon introduction of the system, some adaptations had to be made to the processes, mostly in picking. A higher discipline is required for recording

remaining quantities and handling sub-quantities. Despite this, the process adaptation could be realized smoothly. The requirements set by Masterfoods could be met.

The realized integrated logistics concept means an increase in efficiency, more transparency, and cost reduction for Masterfoods:

- Storing space Masterfoods needs does only have to hold the preliminary products and the connected interim spaces
- Delivery to retailers is realized from a central location, despite the goods coming from different sites
- Processing time in the warehouse can be significantly reduced
- Direct transfer of order data prevents mistakes
- Error rate was reduced to few per mils
- Delivery reliability was increased
- Batch traceability was completely realized; EU regulation 178/2002 is constantly met
- Average weight per order was significantly increased, reducing the transport costs
- Permanent stock taking renders the expensive yearly process partly unnecessary
- Logistics costs can be analyzed based on transactions down to the level of the delivery note. With this, the client has a tool for detailed cost analysis of their sales channels

6. Success Factors

The most important success factor is for the logistics service provider to record and map the customer requirements as precisely as possible. This means that the business model of the service provider must be designed in a way that it can flexibly take over sub-processes from different clients' logistics and create synergy effects despite the differences. Aarau storehouses has designed their business processes and ERP system in a way that it can be connected to or even integrated in the process and system architecture of their clients.

The key to this is an information system that automates, records, and controls the individual processes. With every sector, every client and even every client's customer introducing requirements to the complete system, there is not just one correct process for the food industry but there are many. And these variants create the differentiation potentials of the clients.

The competence of Aarau storehouses is, on the one hand, to include the diversity but, on the other hand, to make it into standardized and, in the sense of a defined quality, unified sub-processes. The business software is a central component for this; the diversity can only be mapped if the data model is correspondingly expandable and if the processes can be mapped flexibly.

Review Questions

1. What is information logistics?
2. Explain the term 'communication standard'.
3. Describe the EDI principle.
4. Outline the informational connections in ERP systems.
5. What are the differences between open and closed ERP systems?
6. What are the central functions of a warehouse management system?
7. State the difference between the fleet monitoring- and tracing & tracking systems and route planning.
8. What is the difference between enterprise resource planning and supply chain planning?
9. What is the number of the shipping unit?
10. What are the advantages of transponders?

Additional Literature

- Arnold, D., Kuhn, A., Isermann, H., & Tempelmeier, H. (2008). *Handbuch Logistik*. Heidelberg: Springer-Verlag.
- Franke, W., & Dangelmaier, W. (Ed.). (2006). *RFID – Leitfaden für die Logistik*. Wiesbaden: Gabler.
- Kopfer, H., & Bierwirth, C. (Ed.). (1999). *Logistik Management: Intelligente I + K Technologien*. Berlin/Heidelberg: Springer.
- Scheer, A. W. (Ed.). (2008). *Rechnungswesen und EDV*. Heidelberg: Springer.
- Schütte, R., Vering, O., & Wiese, J. (2000). *Erfolgreiche Geschäftsprozesse durch standardisierte Warenwirtschaftssysteme*. Heidelberg/Berlin: Springer.
- Stadtler, H., & Kilger, C. (2007). *Supply chain management and advanced planning*. Berlin: Springer.
- Straube, F. (2004). *E-Logistics – Ganzheitliches Logistikmanagement*. Berlin: Springer.
- ten Hompel, M., & Schmidt, T. (2009). *Warehouse management*. Berlin: Springer.
- ten Hompel, M., et al. (2004). *Software in der Logistik 2004*. München: Huss-Vlg.
- Wildemann, H. (2002). *Distributionslogistik*. München: TCW.