

Chapter 2

Transportation Services in the Consumer Goods Industry

Transportation has been a major component enabling trade for centuries. The physical movement of goods has historically been the basis for economic wealth and political power for states as well as for private enterprises. Consumer goods have always had a great share of total transportation demand. Fruit, coffee, tea, cocoa, tobacco or rice are distributed from their growing areas all across the globe and have gained high acceptance in areas where they are not native, due to efficient transportation (Garnett 2003). Still, never before have consumer goods moved across such long distances and in such vast quantities from their origins to their destinations as they do today. Trade and transportation have been closely linked all throughout the history of both sectors. Some of the biggest European consumer goods manufacturers have evolved from a trading background.

Today, efficient transportation is accepted as a prerequisite for specialization. Furthermore, it allows production and consumption of goods to occur in different locations. Managing the material flows from raw materials and across different and geographically distributed production stages to the customer is the key task of supply chain management, of which transportation is one key process (Chen and Paulraj 2004).

This chapter delivers an overview of the transportation and consumer goods markets in a supply chain management context. It is therefore structured as follows: First, an overview of transportation processes is presented that will position transportation in the context of supply chain management and logistics. Afterwards, an introduction to transportation concepts as well as a short overview on transportation planning follows. In the second subsection the focus is put on supply chain processes in the consumer goods industry. Third, external influences on transportation and consumer goods markets are analyzed toward their impact on the underlying study scope.

2.1 Transportation Services

Transportation processes are a significant contributor to every supply chain, and in many industrial sectors they are held responsible for the majority of the supply chain costs (Ballou 2007). Yet, in an industrial environment transportation is often regarded as a necessary evil. Transportation is perceived as a non-value-adding process (Simons et al. 2004). Since transportation effort is best to be eliminated completely, this view may have contributed to the increasing popularity of outsourcing decisions among supply chain managers in industry and retail in recent years.

As the title of this subsection indicates, transportation is to be regarded as a service and is, in contrast to goods, not “storable” (Blauwens et al. 2008). This implies the necessity of demand for transportation to be synchronized with the capacity thereof. Unused transportation capacity of one period cannot be stored for deployment in a future period. It could be compared to the supply of electricity that shows a similar service behavior. And, as with electricity, trading of transportation services is easiest if these services are standardized according to certain parameters.

In this subsection transportation services are characterized as a key process within supply chain management and logistics. Furthermore, different types of transportation services are described and the markets for outsourced transportation services are specified. In addition, a short introduction to transportation planning tasks within the environment of supply chain planning activities is given.

2.1.1 *Transportation in a Supply Chain Context*

In order to understand the significance of transportation in consumer goods supply chains, a general definition and differentiation of the terms “transportation,” “supply chain management” and “logistics” is given. The term “management” as used in “transportation management” is understood to encompass the tasks of planning, control and execution.

Supply Chain Management

Supply chain management (SCM) has in past years evolved to be a competition relevant competence for many companies. The concept comprises a large number of areas such as production planning, inventory management, material control and many more. The Council of Supply Chain Management Professionals defines SCM as follows (Ballou 2007):

Supply Chain Management encompasses the planning and management of all activities involved in sourcing and procurement, conversion, and all Logistics Management activities. Importantly, it also includes coordination and collaboration with channel partners, which can be suppliers, intermediaries, third party service providers, and customers. In essence, Supply Chain Management integrates supply and demand management within and across companies.

The integrative aspect of supply chain management is highlighted in many contributions by focusing on decision making processes that include conflicting objectives. Examples are the trade-off between transportation costs and inventory costs and the optimization of transportation frequencies (Ballou 2007), or the trade-off between material costs and transportation costs, often referred to as total costs of ownerships and in retail closely linked to the term “factory gate pricing” (Thonemann et al. 2005; McKinnon and Ge 2006).

From an academic perspective supply chain management comprises disciplines such as management, industrial engineering, logistics, operations research and business computing (Günther 2005). This integrated aspect is stressed by Stadtler (2008b) defining supply chain management “as the task of integrating organizational units along a supply chain and coordinating material, information and financial flows in order to fulfill (ultimate) customer demands with the aim of improving competitiveness of a supply chain as a whole.”

While the integrative aspect of supply chain management is widely accepted, the growing complexity of the approach has resulted in two strong trends:

- *Standardization*: In order to control the growing complexity accompanied by the integration efforts, process standardization has been identified as a key concept to reduce process lead times and guarantee high process quality (Mayer 2007).
- *Extensive deployment of IT*: IT systems can relieve the process stakeholders and especially the decision takers from repetitive tasks in information gathering through immediate access to large amounts of relevant data, thereby increasing transparency and in turn decision quality (Stadtler 2008b; Thonemann et al. 2004).

In accordance with the above mentioned definitions Fleischmann (2008a) states that it is “the integrated view of transport, production and inventory holding processes [that] is characteristic of the modern SCM concept.” This statement already hints at the strong influence of logistics within supply chain management. And it admits transportation to be a key component alongside production and warehousing. This view is supported by Ballou (2007) claiming transportation to be responsible for the major share of logistics costs, and according to Rider (2003) amounting to 3–7% of total sales.

The preceding paragraphs have shown the integration aspects of supply chain management on the one hand and the measures that are taken to control the resulting complexity on the other hand. The management of a supply chain requires the balancing between complexity and simplification by standardization. This may be eased by focusing on the key components of supply chain management.

Logistics

Of the many aspects to logistics processes, the two commonly mentioned elements are transportation and storage. While transportation can be characterized as a function for bridging in the dimensions of space, storage can be understood as a function for bridging time (Fleischmann 2008b). These two functions may be viewed as the core processes that are surrounded by many supporting processes and activities that usually find consideration in the term logistics.

According to Ballou (2007), the Council of Supply Chain Management Professionals defines logistics management as “part of SCM that plans, implements, and controls the efficient forward and reverse flow and storage of goods, services, and related information between the point of origin and point of consumption in order to meet customer requirements.”

Tempelmeier (2008) states the approach connected with the term “supply chain management” is as integrated as the generally acknowledged term of logistics. In this text a position following Großpietsch (2003) is taken, maintaining that whereas logistics constitutes a central part of supply chain management, it is, however, not a synonym thereof (see also Fig. 2.1).

Transportation

According to Chopra and Meindl (2007) transportation can be defined as follows: “Transportation refers to the movement of a product from one location to another as it makes its way from the beginning of a supply chain to the customer’s hands.” Fleischmann (2008b) puts it directly into a logistical context and states transportation to be the means of bridging the dimensions for objects. These so-called objects may be people, information or physical products—the last of which shall be referred to in the rest of this text.

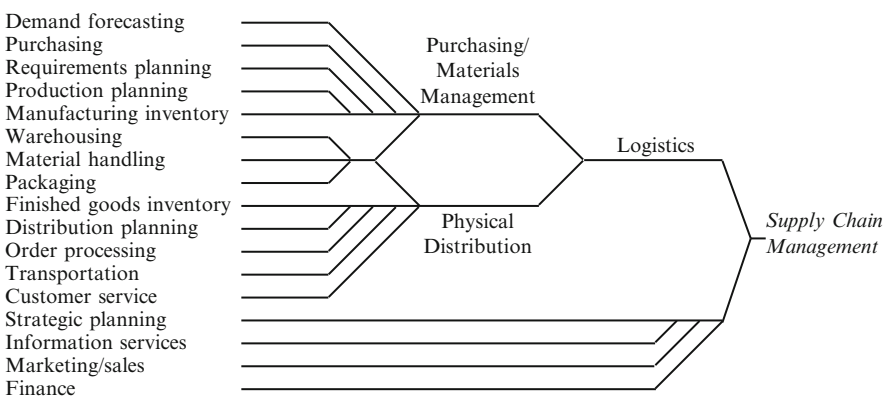


Fig. 2.1 Evolution of supply chain management (Ballou 2007)

While Simons et al. (2004) argue that even though transportation could, by means of the activity definitions, be classified as waste, it is indeed a value adding activity. The whole supply chain should be viewed as one common value adding stream. Transportation should therefore not be viewed in an isolated fashion but as part of a greater picture (Simons et al. 2004).

Efficient transportation is therefore important at an economic, social and environmental level as well as for company profitability (Crainic 2003). As Stank and Goldsby (2000) put it, “benefits accruing from world class operations at the points of supply, production, and customer locations are pointless without the accompaniment of excellent transportation planning and execution.”

2.1.2 Categorization of Transportation Services and Transportation Markets

The choice of the “right” type of transportation service is the key decision with regard to transportation planning and network design. Due to the presence of highly standardized transportation services they can be categorized according to three dimensions as depicted in Fig. 2.2; namely, load sizes, transportation distance and transportation speed.

With regard to the first dimension, Fleischmann (2008a) states that the “appropriate structure of a transport system mainly depends on the size of the single shipments.” Standardized shipment sizes start with letter and parcel consignments. They are usually covered by so-called CEP (courier, express, parcel) service providers that often evolved from postal service providers (Carbone and Stone 2005). Large global players in this section are DHL (Deutsche Post), UPS or FedEx. The big providers will cover almost any distance using different transportation modes and offering different service levels (transportation speeds). They usually rely on their own network of hubs and large fleets of transportation vehicles, including standard trucks, delivery trucks and airplanes. Due to the high investment

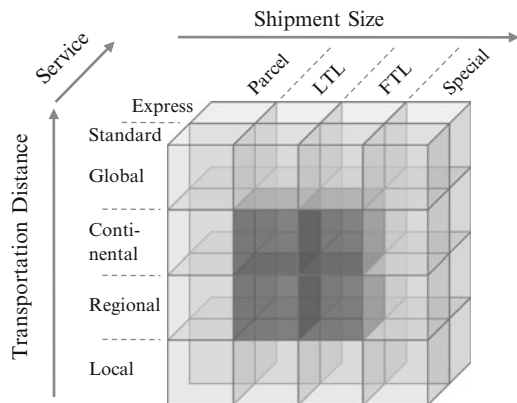


Fig. 2.2 Structure of transportation services

into network infrastructure and fleet, the companies dominating the CEP market are usually of considerable size with a global annual turnover exceeding EUR20 billion (Klaus et al. 2009). This also constitutes a serious barrier for market entries resulting in competition only among the big players. Remote markets are often served in collaboration with partner organizations (Carbone and Stone 2005). Shipment sizes of up to a few hundred kilograms may be shipped economically using CEP providers (Arcelus and Rowcroft 1993).

Larger shipment sizes that will not completely fill a truck or sea container are usually served by specialized logistics service providers. For truck transportation, these are usually referred to as LTL carriers, such as Schenker, Danzas, Ryder. The equivalent for sea transportation is sometimes referred to as LCL (less than container load) carriers. These service providers are specialized in consolidating shipments from different shippers within their own network structure consisting of a number of hub locations as well as their own fleet of vehicles. However, in comparison to CEP providers, these networks are nowhere near as tight and often the area served by a single company is considerably smaller. Therefore, collaboration among several carriers is even more common as is forwarding of transportation orders to partner carriers or subcontractors (Rieck 2009; Krajewska and Kopfer 2006). Since carriers are by far smaller, super regionally operating ones feature an annual turnover of between EUR1 and 10 billion annually and competition is usually much stronger (Klaus et al. 2009).

When shipment sizes get large enough so that a whole truck or container can efficiently be deployed to serve the complete shipment, the mode is often referred to as FTL (full truckload) in case of truck transportation or FCL (full container load) in the case of containerized sea transportation. Apart from the vehicles, no further equipment is necessary to serve these shipments; therefore, the number of competing carriers is very large compared to the market for smaller load sizes. Operations are usually performed on a door-to-door basis; that is, the truck goes directly from the dispatching location to the receiving location and the load is not handled at intermediate locations. This usually results in shorter transportation times for FTL shipments in comparison to LTL shipments (Crainic 2000). In the FTL market segment, collaboration is also very common and small carriers are regularly contracted by larger service providers to fulfill their transportation orders (Rieck 2009; Krajewska and Kopfer 2006).

Load sizes that exceed truck and container capacity are referred to as special loads. For these large load sizes, a differentiation between bulk cargo (for example, crops and liquids such as oil or chemicals) and piece cargo needs to take place. Bulk cargo could easily be split into multiple smaller loads; however, the transportation of large amounts within a single shipment is more efficient. Piece cargo, in contrast, cannot be split into smaller loads; it is therefore necessary to ship it as a whole. Carriers fulfill these transportation demands often using specialized equipment and the market is clustered according to different commodities.

While load sizes have so far been referred to in a very abstract way, it should be clear that they may be measured in many different dimensions. The classical dimensions are weight and volume. An additional factor usually influencing vehicle

utilization is the stackability of the transported goods (super-stackable, under-stackable).

Transportation distance is the second dimension under which transportation services may be categorized. For very small distances on a local and regional level, carriers may deploy drivers and equipment that are permanently located within the region. Often they are assigned to a depot location from where operations start and end. Therefore this market is dominated in every region by a number of local carriers. The most commonly used transportation mode for covering local and regional distances is the road. For longer distances truck transportation increasingly competes with rail transportation. However, even for distances covering several hundred kilometers, the truck is still the most commonly used means of transportation. The majority of overseas volume is transported by ship.

As for transportation speed, usually referred to as the service level, it is often roughly differentiated into standard delivery and express delivery. Express services may be offered using different transportation modes (e.g., air instead of sea) or using different equipment (e.g., using a small truck instead of a 40-ton truck).

The three dimensions are by no means independent of one another, as a parcel delivery in the U.S. may illustrate: While FedEx primarily concentrates on express shipments relying heavily on air transportation, UPS uses a combination of road and air transportation to offer slower, yet cheaper services to the customers. While the FedEx pricing system will charge packages mainly on size (weight and dimensions), UPS also has a stronger distance component (Chopra and Meindl 2007).

The described categorization of transportation services is sometimes extended toward the integration of transportation modes. Chopra and Meindl (2007) differentiate among air, parcel carriers, truck, rail, water, pipeline and intermodal. Considering that the above mentioned three dimensions usually determine the mode choice, a further dimension is of no additional value. Furthermore, the differentiation is by no means exclusive: for example, parcel carriers may use trucks in order to transport the shipments between origin and destination. The mentioned segmentation according to transportation mode is therefore well suited to outline different transportation markets that usually feature different service providers.

The multitude of different services clustered in different service segments makes transportation mode choice a key component in transportation planning (Vannieuwenhuyse et al. 2003). For a detailed analysis regarding the different transportation modes the works of Sahin et al. (2009) and Vannieuwenhuyse et al. (2003) provide a thorough insight into mode choice criteria. The relevant transportation service segments with regard to this research are highlighted in the center of Fig. 2.2.

2.1.3 Outsourcing of Logistics Services

Transportation and storage, as mentioned before, are often regarded as a non-value creating process and therefore may be considered as waste (Simons et al. 2004).

Therefore many industrial corporations have attempted to shift these processes out of their core focus business areas. In fact, in the last several years, logistics has experienced an unmatched trend toward outsourcing (Selviaridis and Spring 2007; KPMG 2000; Langley et al. 2007). Some of the reasons, including the terms and conditions, coverage and trends of outsourcing of logistics in general and of transportation services in particular, will be described in the next few paragraphs.

The reasons for outsourcing logistics services are manifold and often it is a combination of different reasons that drive outsourcing decisions. In general, every outsourcing decision is a make-or-buy decision in favor of the buy side (Baker and Hubbard 2003). In order to better understand outsourcing decisions for logistics services, the reasons for outsourcing are categorized according to their impact horizon—strategic, tactical and operational. Strategic reasons for outsourcing include the following:

- Concentration on core competences (KPMG 2000; Wilding and Juriado 2004),
- Lack of internal know-how (Selviaridis and Spring 2007),
- Lack of willingness to invest and build up one's own assets (Thonemann et al. 2005), and
- Higher asset utilization due to shared assets (Baker and Hubbard 2003).

Tactical reasons that drive an outsourcing decision are usually of mid-term impact and often include the following:

- Lack of one's own resources; that is, over-proportional growth in past years (Selviaridis and Spring 2007),
- Increasing flexibility during transition periods or for future growth (KPMG 2000; Sheffi 1990; Wilding and Juriado 2004), and
- Short-term access to a better infrastructure (Thonemann et al. 2005).

As for operational reasons in favor of an outsourcing decision, the following are usually mentioned:

- Higher operational efficiency due to better resource utilization (Fleischmann 2008a),
- Better operational service (KPMG 2000), and
- Lower costs of operations due to more competitive cost structures, especially for personnel with low qualification profile (Engardio et al. 2006).

Economic issues are usually stressed when specifying the outsourcing decisions of physical transportation services. Outsourcing transportation to a service provider is considered to be very beneficial in the case of a shipment structure consisting of many small orders, since these shipments can be combined with shipments from many other senders (Fleischmann 2008a). Outsourcing of transportation services seems beneficial also for unidirectional traffic. Using a dedicated fleet for these services would result in poor overall utilization, since one trip would take place with empty equipment. However, outsourcing these trips to an independent transportation service provider may open up the opportunity to combine these trips with transports from different demanders (Baker and Hubbard 2003).

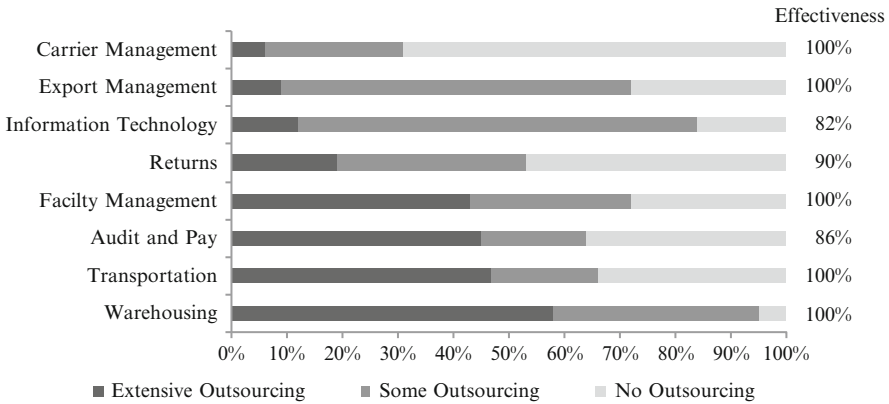


Fig. 2.3 Outsourcing trends and effectiveness in CGI (Grocery Manufacturers Association 2008b)

In general, any logistics process may be subject to outsourcing, but it is by no means limited to logistics. However, in common practice, some processes have been subject to more intensive outsourcing than others. As early as 1990, Sheffi states that transportation and warehousing, the two key logistics processes, are subject to considerable outsourcing activities. And the broad continuation of this trend has not excluded the consumer goods supply chain, as shown in Fig. 2.3. The depicted analysis is based on consumer goods manufacturing companies as well as retailers. For the consumer goods industry alone, outsourcing shares for physical transportation are reported to be considerably higher (Langley et al. 2007). Outsourcing of the two physical processes – transportation and warehousing – not only enjoy great popularity but are also characterized by high effectiveness. With regard to logistics processes, however, it is the physical tasks that are more likely to be subject to outsourcing than the administrative ones. While transportation itself is largely outsourced, carrier management is seldom handed over to outside companies (Wilding and Juriado 2004).

The trend toward the outsourcing of logistics services is still very strong. However, since a large share of logistics activities is outsourced by now, growth rates for operational processes are diminishing (Langley et al. 2007). However, outsourcing of logistics services that exceed the boundaries of the merely physical operation is gaining significance. KPMG (2000) distinguishes the status quo as well as the trend with regard to outsourcing within the three levels of operational, tactical and strategic processes:

- *Operational*: Transportation 85%; Warehousing 50%; Trend: Growing, but not at high speed.
- *Tactical*: 20–25%; Trend: Toward mode selection, inventory management, freight payment. Growth up to 50% until 2005.
- *Strategic*: 5–18%; Trend: Virtual warehousing, inventory ownership, network optimization.

Generally, a transportation process involves two key players: the sender and the receiver and either may be responsible for transportation. The contracts that determine the terms and conditions for the traded goods usually contain clauses regarding responsibility for transportation. *Incoterms*, or international commerce terms, are the standardized and internationally common terms used in these transactions. They not only specify transportation cost responsibility but also transportation risk responsibility and responsibility to cover customs and duties. There are contractual settings that specify the selling side in charge of these actions (free incoterms: for example, delivered duty paid, DDP, or delivered duty unpaid, DDU), and there are incoterms that specify the responsibility at the buying side (not free incoterms: for example, free carrier, FCA, or ex works, EXW). The responsible party for transportation along a particular segment of the journey will subsequently be referred to as the *shipper* (Chopra and Meindl 2007) throughout the rest of this research.

After the first two parties have been introduced — the sending or usually selling party and the receiving or usually buying party, the transportation may very well be carried out by none of these parties but by a *carrier*, an independent transportation service provider. They are often referred to as a *third party logistics [service provider]* — the 3PL (Wilding and Juriado 2004) or just *logistics service provider* — LSP (Selviaridis and Spring 2007). These terms will be used as synonyms throughout this text and although they are usually associated with the offering of multiple services rather than being limited to transportation, the latter will be the service of most relevance within this context. However, the terms 3PL and LSP do not only refer to transportation service providers but to logistics service providers in general.

The increase in outsourcing activities on a tactical and strategic level has led to the development of an additional type of logistics service providers referred to as the fourth party logistics service provider, in short 4PL (KPMG 2000; Skjøtt-Larsen 2000). Due to a high number of 3PLs operating in large transportation networks, the 4PL or LLP (lead logistics provider) has been devised as the additional, independent instance with the task of controlling the deployment of 3PL services (Schmitt 2006). Even though this concept was introduced in 1996, the practical application of these concepts is not prevailing, nor has it in many cases left the status of an implementation pilot (Selviaridis and Spring 2007). In the progress of this work, referring to outsourcing of transportation will relate to the outsourcing of transportation operations. Tactical or strategic processes are not assumed to be outsourced but are covered in-house. For most of the administrative activities it is of no relevance for the processes, tasks and decisions whether they are covered in-house or from an external player. For the physical processes of transportation, however, there are some differences that are discussed in the following paragraphs.

2.1.4 Introduction to Transportation Planning in a Supply Chain Planning Context

Transportation planning must in general be put into the context of general supply chain planning and logistics planning. As pointed out in Sect. 2.1.1 the interdependence of numerous processes and process steps has helped with the acceptance of the supply chain management concept. In an advanced planning systems (APS) context, transportation planning is linked to other planning tasks in the supply chain context; namely, to strategic network design, master planning, demand planning and production scheduling (Fleischmann 2008a).

Industrial supply chain planning generally deals with decisions on how to deploy a company's assets and resources in order to source, convert and distribute its products and services. The high complexity of the planning task is reduced by splitting the planning process into different sections according to the temporal planning impact (i.e., long-term planning vs. short-term planning). Such a differentiation is shown in Fig. 2.4. In addition to a temporal fragmentation, segmentation according to the planning object is very common.

Another important strategic issue is the make-or-buy decision with specific regard to logistics services already mentioned in Sect. 2.1.3. When making

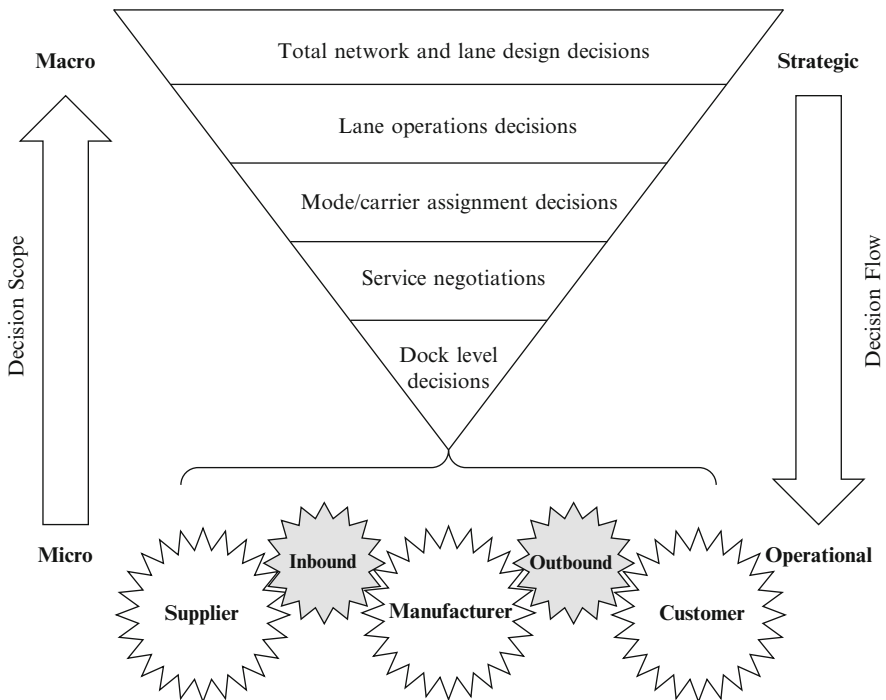


Fig. 2.4 Transportation decision making in an integrated supply chain (Stank and Goldsby 2000)

transportation decisions, a distinction must be made as to whether they are taken from a shipper's point of view with transportation being outsourced, or from a fleet provider's or carrier's perspective:

- The carrier as a fleet operator makes long-term investment decisions toward vehicles and operating decisions promising the maximum return on these assets (Chopra and Meindl 2007).
- The shipper will try to minimize total costs (transportation, inventory, information and facility) at the appropriate service level (Chopra and Meindl 2007).

Fleischmann (2008a) puts the essence of transportation planning for outsourcing transportation in an APS environment as follows:

An LSP may consolidate the transport flows of several shippers, operating in separate supply chains, in his own network. Then he is responsible for planning how the transports are executed, i.e., by which vehicles along which routes. However, the decisions on the transport orders, i.e. the quantity, source and destination of every shipment, remain a task of the APS of the shipper. Usually, it is not practicable to include the flows of all other shippers of an LSP into the APS. However, the additional flows have an impact on the transport costs and should be taken into account implicitly by appropriate cost functions.

Within the shorter planning horizons of tactical and operational transportation planning, complexity with regard to the interdependence of many different parties is largely reduced. Therefore, the integrative perspective of supply chain management falls behind and operational problems dominate the real life planning environments (Mayer 2007). These vary largely in different supply chain segments and business sectors. With regard to the consumer goods supply chain the different operational problems are subject to a more detailed analysis in Sect. 2.2.4.

The combinations of relevant network arcs and nodes are often regarded as network processes and are referred to — depending on the perspective — as supply or distribution processes. Since these processes are usually installed for a long-term period, the planning task must be regarded as a strategic one. Different processes may be applied within the same network structure. This is best described by a simple example from the consumer goods industry. A product is distributed from a plant to many customers via a distribution center, where the product is stored. One of those customers requires special packaging. Packing may in one process alternative take place at the plant, directly after production. In another process alternative the product is re-packed at the distribution center just before dispatching the ordered quantities to the according customer. The described process alternatives are based on the same network architecture. The procedure for network process planning is characterized by a two-stage procedure. First, it must be decided which processes are generally admitted within the network. In the second stage, the products and material flows are assigned to these processes. The data required for decisions in the first stage is usually highly aggregated (e.g., product groups and time) while the data used in the second stage is often more detailed concerning the product information. Some well-established network processes are just-in-time (JIT) and just-in-sequence (JIS) concepts (Grocery Manufacturers Association and Booz Allen Hamilton 2006). Network process planning is of high relevance

for total landed cost or factory gate pricing concepts (Garnett 2003; McKinnon and Ge 2006). These have gained increasing popularity over the past few years, usually driven by integrated purchasing and logistics organizations for inbound material flows (Ghodsypour and O'Brien 2001).

The term supply chain planning integrates many different, yet interdependent planning tasks with a large impact on transportation processes within a supply chain. However, their degree of interdependence relates to the characteristics of the actual planning problem. A more detailed view on the consumer goods' specific planning problems is therefore provided in Sect. 2.2.3. Transportation planning in practice largely depends on the availability of information. In the past, this has been the key obstacle to achieving high quality transportation planning (Stank and Goldsby 2000). In particular when transportation is outsourced and planning responsibilities are shared among different organizational units, information availability is usually poor.

2.2 Consumer Goods

Defining the term *consumer goods*, the Industrial Marketing Committee Review Board determines that they are “goods destined for use by the individual ultimate consumer and in such form that they can be used by him without further commercial processing [...]” (Industrial Marketing Committee Review Board 1954). In order to receive a wider definition a market perspective on consumer goods is taken. Webster (1978) differentiates marketing activities in consumer goods from those of industrial goods in four dimensions:

- *Functional Interdependence*: On consumer goods markets, marketing is neither as integrated nor as dependent on other business functions as industrial goods.
- *Product Complexity*: On consumer goods markets, products are usually less complex than on industrial goods markets.
- *Buyer-Seller Interdependence*: This dimension can be observed in substantial negotiation processes on industrial goods markets.
- *Buying Process Complexity*: In consumer goods markets, buying decisions are usually analyzed in terms of different types; for example, routine purchase. In contrast, industrial goods buying decisions are taken against a complex organizational background.

Although this differentiation seems straightforward, Fern and Brown (1984) give some counterexamples. This becomes evident when considering that the consumer goods industry will supply retail organizations who are selling the goods to the final customer. In this case, the relationship between the consumer goods industry and the retailers will in many cases resemble the relationships in industrial goods markets. Furthermore, any services offered by a consumer goods manufacturer for the retail organizations (shelf-ready packaging, transportation etc.) are surely to be defined as industrial services. In the context of this research,

the term “consumer goods” is therefore also tackled from the sales side. From a product perspective, consumer goods in this study are mainly contained in UNSPSC Segments 49 (food, beverage and tobacco products) and partly 53 (home and personal care) (United Nations Development Programme 2001). They can be characterized by the following:

- Low degree of product differentiation (Meyr and Stadtler 2008),
- High availability requirements (Mars 2008),
- Expected long product lifecycles (Meyr and Stadtler 2008),
- Physical existence (Industrial Marketing Committee Review Board 1954),
- Retail traded (Meyr and Stadtler 2008).

In accordance to Großpietsch (2003), this text concentrates on product categories with a high turn rate — so called *fast moving consumer goods*. They are often abbreviated as FMCG.

2.2.1 Profile of the Consumer Goods Supply Chain

Consumer goods are not only a major part of the world’s economy, with an annual retail volume of US\$11,480 billion. Food, beverages and tobacco also account for 17% of total consumer expenditure worldwide (The Economist Intelligence Unit 2005). Thonemann et al. (2005) assess the relevant consumer goods retail volume — supermarkets, department stores, discounters and drugstores — in Europe at EUR1,100 billion for 2004. In Germany the food processing industry turns over approximately EUR100 billion, of which approximately 50% is generated by fresh food (Lütke Entrup 2005). The food market in Britain has a total volume of GBP103.8 billion (Garnett 2003).

The biggest market for consumer goods is the United States with US\$4,310 billion followed by Western Europe (US\$2,380 billion) and Japan (US\$1,240 billion). Overall growth in this sector has been a steady 3–4% p.a. over the past years with the strongest growth rates observed in Eastern Europe, Asia, the Middle East and Africa (The Economist Intelligence Unit 2005). The largest corporations in the consumer goods industry are listed in Table 1.1.

Apart from the high trade volume that consumer goods markets steadily generate, there is also high demand volatility. On the one hand, this volatility is consumer induced, due to seasonal consumption behavior of many food products (e.g., ice cream in warm seasons). On the other hand, the behavior is also induced by industry and retail. A high number of promotions (Michael et al. 2002) together with pricing incentives often lead to sales peaks reaching a multiple of regular sales, as shown in Fig. 2.5. The management of these peaks imposes a great challenge on the entire supply chain.

The consumer goods market can be divided into two sections along the consumer goods supply chain (Großpietsch 2003). In the first section consumer goods are produced. Further upstream the supply chain markets are referred to as raw

Table 1.1 Top ten consumer goods manufacturers according to definition (Deloitte 2009)

Company	FY 07 net sales (mn. US\$)	Country	Sector
Nestle S.A.	89,724	CH	Food, drink, tobacco
The Procter & Gamble Company	83,503	US	Personal and household
Altria Group, Inc.	73,801	US	Food, drink, tobacco
Japan Tobacco Inc.	56,277	JP	Food, drink, tobacco
Unilever	55,086	UK	Personal and household
PepsiCo, Inc.	39,474	US	Food, drink, tobacco
Kraft Foods, Inc.	37,241	US	Food, drink, tobacco
The Coca-Cola Company	28,857	US	Food, drink, tobacco
Tyson Foods, Inc.	26,900	US	Food, drink, tobacco
Imperial Tobacco Group PLC	24,308	UK	Food, drink, tobacco

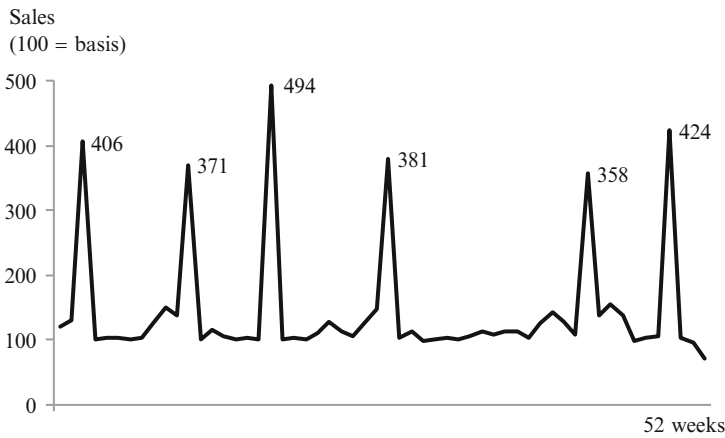


Fig. 2.5 Demand volatility (Großpietsch 2003)

material markets. The goods traded in these markets do not meet all of the above mentioned requirements of consumer goods. After the production stage the goods are moved toward the customer and the influence of retail organizations. This is considered the second stage of the consumer goods supply chain. In most consumer goods markets, the industry and retail tasks are taken on by different, legally independent organizations. The greater focus of the following work is dedicated toward supply chain processes in general and transportation processes in particular in the sphere of the consumer goods industry. It is important to distinguish between an industry and a retail section of the consumer goods supply chain since their key players usually feature different legal entities. However, the two sections can face common challenges, such as demand volatility. Yet in contrast to the retail markets that are characterized by high concentration (Ernst and Young 2007; Michael et al. 2002; Caputo and Mininno 1998), the consumer goods markets appear less concentrated at first. Still, when considering certain commodities, such as coffee, a substantially higher degree of concentration can be observed for the consumer

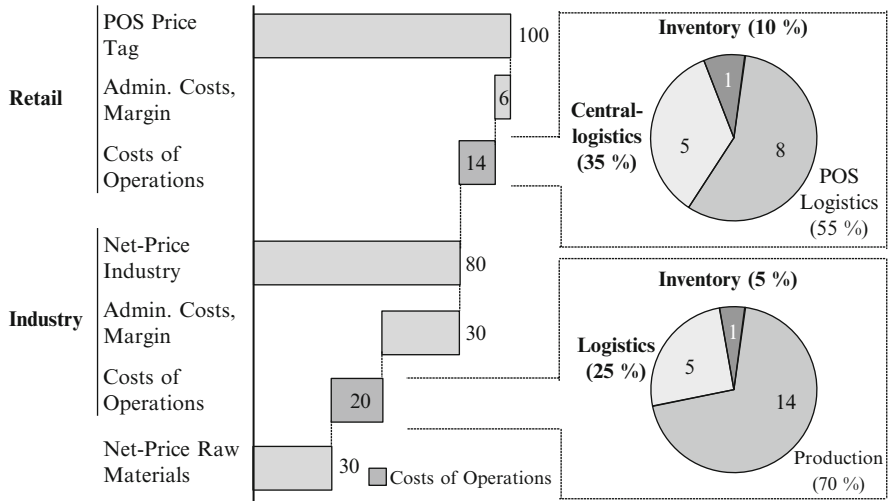


Fig. 2.6 Cost structure in consumer goods (Thonemann et al. 2004)

industry as well (Cap Gemini Ernst and Young 2002; Lütke Entrup 2005). With regard to value creation, the consumer goods industry has the largest share along the consumer goods supply chain. As shown in Fig. 2.6, half of the value of a product is generated within the industry section of the supply chain.

According to Thonemann et al. (2004), raw materials account for approximately 30% of the total sales price of consumer goods. Since raw materials are highly standardized goods, they are subject to just as standardized trading processes. On international commodity exchanges, goods as well as derivatives are traded to guarantee the long-term demand and supply of raw materials. Since many raw materials are subject to seasonal availability variation, raw material storage is very common and often requires a large raw material inventory to be stocked over considerable time (Caputo and Mininno 1998).

Production costs account for approximately 14% of the total sales price of a consumer good (see Fig. 2.6). In contrast to the production of many industrial goods, consumer goods production is hardly continuous but more often batch-oriented, similar to production processes in the chemical industry (Meyr and Stadtler 2008). It is often associated with the term *Make-and-Pack* Production (Neuhaus et al. 2003; Méndez and Cerdá 2002). Batch production is characterized by non-continuous material flows into a production system (usually at the beginning of a production batch, all required material must be ready in full quantity), and also non-continuous completion (again, usually when a batch is ready, the complete production amount is ready at once or within very short time). As a result, consumer goods production systems are very push-oriented requiring high inventory levels (Fleischmann 2008a). The processing of food products as well as products of personal and home care usually prompts sequence dependent setup operations (Meyr and Stadtler 2008; Lütke Entrup 2005) making production planning tasks

very complex. In addition, high quality requirements make continuous quality monitoring along with frequent quality checks and quality gateway processes a core component of every production system.

Since a full demand synchronization of production is by no means possible and sensible, finished goods are usually stored after leaving production. However, the storage does not necessarily take place on the production site but may be shifted toward the distribution center (Fleischmann 2008a). The goods are usually transferred from there to the retailers and, depending on the distribution structure, may again be stored or directly shipped on to the stores.

2.2.2 Logistics Responsibilities, Costs and Performance along the Consumer Goods Supply Chain

In Fig. 2.7, the three-stage distribution process of consumer goods is shown (Meyr and Stadtler 2008). Within consumer goods distribution, warehouses and distribution centers (DC) serve as decoupling points between demand and supply (Meyr and Stadtler 2008). The distribution structure of the consumer goods industry is usually regionally determined. The warehouses feature the complete assortment of the manufacturer and allow a short reaction time toward retail customers (Caputo and Mininno 1998).

The retail distribution structure also has a strong regional component featuring central and regional DCs. However, along the two-stage distribution, the stocked

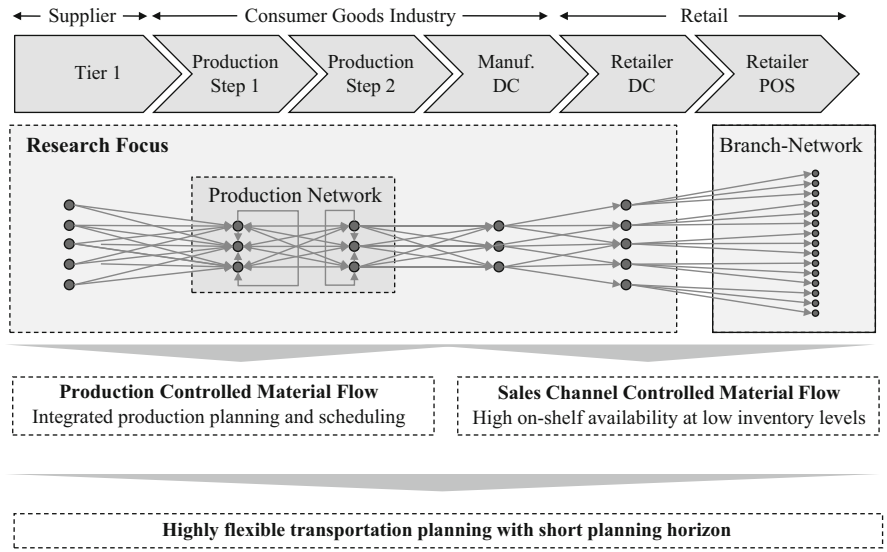


Fig. 2.7 The consumer goods supply chain

assortment may vary. Slow-moving products may be stored within a central warehouse while faster moving articles are typically stored within regional distribution centers (Thonemann et al. 2005). The slow movers are usually picked to order within the central DC and moved via the regional DCs into the retail markets. This way, safety stock levels for slow-moving goods may be lower since the stock is centralized.

All consumer goods supply chain processes aim at delivering the goods to the shelf, so the consumer can purchase them. Therefore on-shelf availability is a key aspect when assessing supply chain performance. Thonemann et al. (2005) show that on-shelf availability varies between 90% and 99% and in the event of unavailability of a product, the consumer will in 50% of the cases try and purchase the article at another retailer or not buy the article at all. Further upstream the supply chain, the average service level supplying the retail organization is therefore usually very high, reaching 97.5% for Germany, and the delivery time amounts to an average of 3.5 days (Thonemann et al. 2004). The finished goods inventory range in retail warehouses averages 30.6 days for German retail (Thonemann et al. 2004). This KPI overview already suggests the high relevance of logistics performance supplying the retail organizations.

Figure 2.7 demonstrates the numerous locations and transportation relations utilized in the sourcing, production and distribution processes of consumer goods. Even though it is the driving force behind the supply chain, the consumer purchase is possible only at the very right in Fig. 2.7, while the inventory levels are distributed across the different stages in order to attain the required service level. Since order cycles between the retail and the manufacturer DCs are relatively short, the retailer DCs do not contribute toward the supply chain's safety stock significantly but rather serve to consolidate and buffer the requirements of the assigned single retail points. Some retail processes (e.g., cross-docking) use this stage as an inventory-free handling location (Thonemann et al. 2005). The largest share of the finished goods safety stock is therefore concentrated at the manufacturer's central warehouses. The operation of the warehouses and distribution centers is also usually outsourced to specialized service providers (Michael et al. 2002).

The determination of the optimal number and locations of central warehouses is a problem typical of strategic network design. On the one hand, many central warehouses reduce transportation time and distance to the customers while on the other hand fewer warehouses result in better inventory concentration and lower inventory levels. The challenges of inventory management are especially obvious for fresh food with short shelf life. These products require frequent transportation in order to keep shelf life balanced throughout the network. This in turn is necessary in order to obtain a high availability while at the same time reducing the risk of obsolescence due to expired shelf life (Silver 1989; Nahmias 1982).

Due to trade promotions or seasonal specials, the products are often repacked into special displays (often also limited to a certain distribution channel) (Mars 2008). This task is usually outsourced either to the warehousing service providers (on-site) or to specialized, so-called "co-packers" off-site. After re-packing, the goods are stocked back in the distribution center ready to be forwarded into the

retail channels. Although it may seem disadvantageous to pack the goods several times, the process will help to minimize overall inventory levels. And since forecasts, especially those for sales promotions, are highly error-prone, availability is best maintained if the product is stored in its standard packaging and proliferation takes place as late as possible (Großpietsch 2003). Transportation in this case is usually performed by service providers as well. Due to an increasing number of trade promotions, consumer goods manufacturers are facing an increasing share of transportation at this section of the network (Mars 2008).

Further up the consumer goods supply chain, hardly any finished goods inventory is stored. Since the production facilities have undergone a strong concentration process in the past years, all inventory is bound to leave the plant after quality clearance. In many locations, buffer space is limited to an extent that makes pickup scheduling crucial for seamless production operation.

High logistics cost and performance awareness are typical of the consumer goods supply chain (Grocery Manufacturers Association 2008b). In Germany, logistics costs account for approximately 5.0% of a retailer's turnover (Thonemann et al. 2004). The highest share of logistics costs for consumer manufacturers is caused by transportation (see Fig. 2.8) and this share is expected to further increase in the future (Thonemann et al. 2005). They amount to approximately two-thirds of the total logistics costs and are split between intra-company transportation and outbound customer transportation. A quarter of logistics costs are caused by warehousing activities in the distribution centers and the rest is similarly distributed between packaging (especially co-packing, see above) and overhead costs.

And while supply chain responsibility is split between retail and consumer goods manufacturers, additional parties are involved when it comes to fulfill customer demand. Apart from raw material and packaging suppliers, the production process is by no means solely in the hands of a consumer goods manufacturer — defined here as the brand owner (Großpietsch 2003). Today, a considerable share of production is outsourced to so-called co-manufacturers (Ferrer and Karlberg 2006). They are independent producers of consumer goods and do not appear as producers in the perception of consumers and may not have their own brand but solely produce on

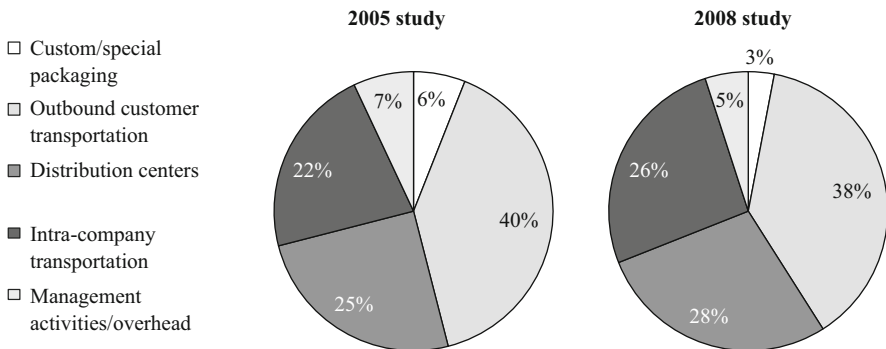


Fig. 2.8 Logistics costs in consumer goods (Grocery Manufacturers Association 2008b)

the account of the consumer goods industry owning the brands (Cap Gemini Ernst and Young 2002).

Transportation from the manufacturer DC to the retailer DC or cross dock is usually organized by the consumer goods manufacturer (see Fig. 2.9). However, the trend toward a stronger supply chain control by the retailers has been identified by Thonemann et al. (2004) and Mars Deutschland (Mars 2008). Transportation responsibility to the stores is mostly in the hands of the retailers. Compared to the consumer goods manufacturers’ facilities, the operations of the retail DCs and cross docks are not subject to such strong outsourcing activities as they are often still operated by the retailers themselves (Cap Gemini Ernst and Young 2002; Michael et al. 2002; Wilding and Juriado 2004). In addition, the vehicle fleets used to distribute the goods to the stores are very often, at least partly, retailer operated.

Much integration effort has been put into the harmonization of information and material flow between consumer goods manufacturers and retailers. Collaborative planning, forecasting and replenishment (CPFR) is one initiative to standardize the cross-organizational interfaces and to streamline the order-to delivery process on a shared information basis (Großpietsch 2003; Esper and Williams 2003). However, the high expectations have not been met and in many cases the practical implementations have not exceeded piloting stages (Thonemann et al. 2005). Efficient consumer response (ECR) is another initiative to implement standardized processes; for example, for continuous replenishment and vendor managed inventory (VMI) (Meyr and Stadtler 2008). Thonemann et al. (2005) explicitly mention

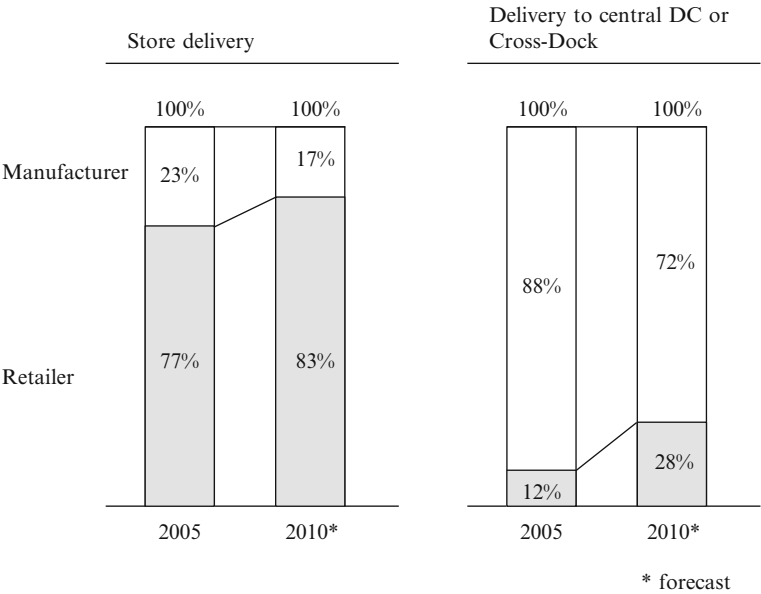


Fig. 2.9 Transportation responsibility along the consumer goods supply chain (Thonemann et al. 2005)

the limited success of these initiatives and provide some reasons for their lack of acceptance. They furthermore show some promising examples for successful collaboration between manufacturers and retail; among them the concept of shelf ready packaging. This is provided by the consumer goods manufacturers (at a possibly higher price than ordinary packaging) and is designed to ease on-shelf presentation in the stores, thereby reducing in-store handling and waste at the advantage of the retail organization.

2.2.3 Supply Chain Planning Processes in Consumer Goods Supply Chains

The supply chain planning processes encompass the planning cycle of general APS planning task from strategic network design, demand planning, supply network planning, production planning, procurement to transportation planning (Günther 2005). However, with respect to the work share between retail and manufacturers, the retailers usually do not have to plan any production activities, yet they still need to manage their resources in the distribution centers and in the stores to guarantee an efficient material flow and high on-shelf availability.

Strategic Network Design

As already stated above, the strategic planning horizon usually covers several years and involves investments of considerable volume (Chopra and Meindl 2007). In the retail sections of consumer goods supply chains, decisions are mostly based on a number of given and known markets. The planning tasks usually focus on the processes that are employed to supply the markets. This includes the number and location of retail distribution centers as well as the employment of inventory-free supply processes such as cross-docking (Thonemann et al. 2005). Another question of strategic relevance is tackled with the assignment of assortment types to physical warehousing locations. Specific assortment requirements, especially refrigeration at different temperature levels, may result in major investment. As a result, only some of the regional distribution centers may be capable of handling frozen goods. Strategic network planning tasks in retail will furthermore include the opening and closure of warehousing locations in changing market environments (e.g., frequent openings of new warehouses by discount channel retailers during the expansion).

The warehousing location decision is usually of secondary importance for consumer goods manufacturers. The central DC policy makes sure that the number of DCs required is generally only determined by long-term factors such as infrastructure and demographic development. Yet, since brands and product lines are subject to be traded between the global players in the consumer goods industry,

their integration into existing networks regularly imposes a serious challenge for supply chain executives (Ballou 2001). More frequently, the planning involving the production locations is subject to decision within a strategic network scope. The past few years have shown a greater concentration of production volume in a few facilities serving several national markets (Meyr and Stadtler 2008). Economies of scale in production and coalescing markets (EU, NAFTA) have favored this development. The decision regarding the locations where a product is made not only influences the necessary investment into production technology at the relevant locations, it also influences the transportation and warehousing effort for the temporal range of the decision (Meyr and Stadtler 2008).

Demand Planning

The result of demand planning is usually a volume forecast and the process rarely results in directly recommended actions. It is designed to supply input data for several other planning processes, especially replenishment and replenishment planning. Still, the importance of demand planning cannot be underestimated. Since it delivers input values for successive planning stages, the quality of all results largely depends on the quality of demand planning (Thonemann et al. 2004). Research on the accuracy of demand forecasts varies widely. While the Grocery Manufacturers Association (2008b) state an average mean absolute percentage error (MAPE) of 31% for a month's planning horizon and 45% for a week's planning horizon, Thonemann et al. (2004) show that better results are possible.

Replenishment Planning

Data from demand planning is required to initialize the replenishment planning process. Results of this process are replenishment strategies (Gudehus 2006). In addition, replenishment frequencies and rhythms are specified. The process therefore determines the inventory and the service level within the network and may differ between the retail section and the manufacturing section of the supply chain. The Grocery Manufacturers Association (2008b) mention an average inventory range of 45 days for U.S. consumer goods manufacturers while Thonemann et al. (2004) indicate a value of 30.6 days for central European manufacturers; for the latter region this results in a 97.5% service level with a delivery time averaging 3.5 days.

Distribution Planning

Distribution planning combines the results of network planning and replenishment planning (Thonemann et al. 2005). Within distribution process design, different order types are determined (e.g., stock order, rush order) that may be employed by

the replenishment process. In addition, parameters determining the source of supply are applied using numerous and often complex sets of rules. Order size, replenishment lead time, demand forecasts, safety stock and inventory levels determine from which DC an order is completely or partially fulfilled.

Production Planning

Production planning is one of the key planning processes that are currently receiving wide attention in academic literature as well as in practice. The recent development to concentrate production capacities of one product for large markets within one facility has increased efficiency expectations from the conversion process. Furthermore, consumer goods often face a multi-stage production process, which can be characterized as make-and-pack production process, combining batch production and continuous production (Fündeling and Trautmann 2005). In addition, the high quality requirements of consumer goods will impose considerable set-up and cleaning operations reducing the effective production time—very often with sequence dependent set-up times (Günther and Tempelmeier 2009). As a result, lot-sizing and sequencing decisions have to be made simultaneously (Meyr 1999). A great deal of research has been published in past years tackling the specific requirements in the consumer goods industry. For a general overview, see Fündeling and Trautmann (2005). For fresh food specific production plans regarding shelf life, Lütke Entrup et al. (2005) have provided a set of models worth considering. Very promising results have been achieved in this area using “natural sequences” in color or taste (bright → dark; mild → strong) forming a production block (Günther et al. 2006). Production planning and scheduling is usually performed with a planning horizon of 1 week (Lütke Entrup 2005).

Transportation Planning

Along the consumer goods supply chain, structured transportation planning approaches across different horizons are only partly in place. According to the overview on transportation planning in Sect. 2.1.4, transportation planning ranges from network design to operative vehicle scheduling. As for network design, its effects on consumer goods supply chains have already been discussed within this section. Strategic transportation planning focuses on the size and specification of the vehicle fleet or on the form of contract for external transportation service providers (Baker and Hubbard 2003). Due to the high outsourcing share of their transportation activities the planning scope for consumer goods manufacturers is rather limited toward the latter. Decisions on the general forms of contract as well as on some transportation modes must be made since they result in lead time parameters for the replenishment process. Tactical transportation planning will, along the consumer goods supply chain, be determined within the replenishment process. In order to receive high quality results regarding the efficiency of the

transportation processes, a thorough planning approach that includes costs, restrictions and requirements of the transportation processes is necessary. The extraordinarily good data quality and IT coverage at consumer goods manufacturers partly allows the implementation of replenishment processes in favor of efficient transportation processes. However, along the retail section of the consumer goods supply chain, the data quality and therefore the accuracy of planning results are reasonably lower (Ferrer and Karlberg 2006).

Only some aspects of tactical transportation planning are applied along consumer goods supply chains. As for the supply of the retail stores, tour planning is usually perceived as the key planning tasks within retail — due to management of the retail stores' own fleet this results in a vehicle scheduling task. On the manufacturers' side, the task is limited to a mere service provider management process without any planning characteristics. Operative transportation planning tasks are limited to a very short planning horizon along every segment of the consumer goods supply chain. This is due to the very short-term generation of material orders (Günther 2005). Retail markets may finalize their orders only a few hours prior to delivery and stock orders for the retailers DCs show an average lead time of 3.5 days (Thonemann et al. 2004), resulting in a planning horizon for transportation planning of a few days. This also accounts for operative transportation planning within the manufacturer section of the consumer goods supply chain. Since production planning for a 1-week planning horizon is performed for 3–4 days in advance (Lütke Entrup 2005), the resulting planning horizon for operative transportation planning is limited to the material flows from the production plan.

2.2.4 Transportation Requirements in Consumer Goods Supply Chains

McKinnon et al. (2004) classify transportation activities along the consumer goods distribution chain into three categories:

- A primary level focusing on transportation from a production location to a primary consolidation center and onward to a regional distribution center,
- A secondary level covering transportation between a regional distribution center and a local warehouse or retail outlet,
- A tertiary level regarding the transfer from local warehouse to independent wholesalers and multiple retail outlets.

The scope of this research largely concentrates on transportation processes controlled by the producers of consumer goods. Within this scope two subsections of the consumer goods supply chain can be distinguished. The first subsection covers the manufacturing facilities as well as the supplier locations. Processes here largely include batch production requiring simultaneous production planning and scheduling. Taking into account that storage space at plant level is very limited,

time windows for pick-up and delivery operations have to be considered. In the second subsection all distribution related activities are covered (distribution centers and some related co-packing activities). They are dominated by the objective of sustaining high product availability at low inventory levels. Flexible and reliable processes are necessary to cover these requirements; therefore time windows are usually applied to transportation orders specifying departure and arrival times of goods at the associated locations (Crainic and Laporte 1997).

The transportation requirements in consumer goods supply chains are directly deductible from the consumer goods supply chain profile. In order to reach and maintain a competitive market position, transportation services must be provided in an efficient way regarding costs and performance. The objective of high on-shelf availability at low inventory levels defines the requirements for all involved supply chain process steps (Bilgen and Günther 2010). For transportation processes this will result in high reliability together with short order lead times. The resulting short planning lead times and planning horizons have already been identified in Sect. 2.2.3. The case of serving the retail stores with a retailer owned fleet imposes considerable requirements for the transportation planning process (see above). As for the outsourced transport relations, the restrictions may be more severe—within a very short time the best service provider needs to be identified and contracted (Stank and Goldsby 2000).

Transportation Time/Reliability

During transportation the goods transported are non-accessible inventory (Blauwens et al. 2008). Inventory carrying costs, that is, imputed costs, are incurred by the owner of the inventory (according to incoterms) during transit time. However, in-transit inventory carrying costs are in practice much lower than the transportation costs, and the inventory impact of transportation speed is only relevant for very expensive goods. Transportation reliability and punctuality, however, have a major influence on availability directly influencing inventory levels at warehouses and stores and thereby affecting on-shelf availability.

Time Windows

Time windows for transportation processes are very common all along the consumer goods supply chain. Make-and-pack production, together with high quality requirements, imposes a fixed finishing timestamp on every production step. First, all packaging and raw materials need to be available at the plant at the beginning of the production batch. This determines the latest delivery time for the material flow to the plant. Once quality control has approved the product, the complete production batch is cleared. This point in time is usually the earliest timestamp from which the production volume may be picked up for transportation. Due to very limited storage capacity at the plants, the goods' maximum retention time at the plant is limited by

a latest pickup time for onward transportation. In cases when consecutive production or packaging steps are performed in batch mode, the batch starting time at the successive site determines the latest delivery time for the intermediate products in question. Time window length at production sites may be as little as 2–4 h. Warehouse operations are usually less strict in their time window employment. Still, the inbound and outbound material flows are usually leveled in order to achieve a balanced workload within the receiving and dispatching areas. Time window length is therefore usually about 4–8 h. The strictest time windows are usually found supplying the retail stores. Since many stores have very limited storage space, the majority of the material coming into the store is directly stocked onto the shelves (Thonemann et al. 2005). This is usually done by a non-permanent assistant workforce that is scheduled for the shipment arrival times. Early arrival therefore may result in either waiting time for truck and driver or inappropriate storage (e.g., not refrigerated) until the scheduled workforce is ready. Late arrival in contrast will result in idle time for the scheduled workforce thereby wasting resources. Time windows may be as short as few minutes for store deliveries (Mars 2008). In order to provide a reliable basis for workforce scheduling, goods arrivals are subject to rhythmic patterns according to assortment type (e.g., fruit arrives daily at 7:00 a.m., beverages arrive Monday, Wednesday and Friday at 13:00 p.m.).

Transportation Temperature

The goods that are shipped along the consumer goods supply chain may impose strict temperature regulations on transportation processes due to quality requirements (Lütke Entrup 2005). Further upstream the supply chain, along the section that is under control of the consumer goods manufacturers, temperature requirements are usually met using designated reefer equipment. The following four temperature zones are typical of the consumer goods industry, ambient (no refrigeration), temperature controlled, chilled (0–5°C; 32–41°F) and frozen (–18°C; 0°F) (Stringer and Dennis 2000). Within the retail controlled section of the consumer goods supply chain, different goods requiring different transportation temperatures are usually mixed on the trip. This may be achieved by using either multi-temperature zone vehicles with dedicated compartments or insulated loading devices.

Transportation Equipment

Transportation equipment is largely determined by the transportation mode choice. However, especially when transporting raw materials, special transportation equipment requirements may apply. Milk and other bulk material may require transportation in specifically designed silo vehicles. Apart from raw materials the majority of consumer goods today are prepared for transportation on standardized loading devices such as the euro-palette. Standardized transportation containers facilitate

the handling at the plants, warehouses and retail stores and help to maximize vehicle utilization. Furthermore, they have enabled the standardization of transportation services according to commonly accepted rules. Consequently, this has made prices for transportation services easily comparable and enabled their tradability on market places.

Effects on Transportation Mode Choice

Transportation requirements lead to a distinct mode choice along the consumer goods supply chain. As for the supply of the retail markets, road transportation is the generally accepted norm (Vannieuwenhuyse et al. 2003) due to a lack of access alternatives at the destinations. In particular, since many retail stores are located in residential areas for customer convenience and proximity. Access for heavy goods vehicles may therefore be limited due to structural constraints (e.g., narrow roads), traffic or noise restrictions for defined periods. Supplying the DCs heavily relies on road transportation today (Department for Transport 2006), and the existence of rail services between central DCs and regional DCs are still an exception (e.g., COOP, Switzerland) (Perren 2009). Further upstream the supply chain the greatest share of transportation takes place on the road, the exception being raw material supply, which is subject to multiple transportation modes depending on their respective origins. In the case of intercontinental supply relations containerized sea transportation is the predominant mode (Blauwens et al. 2008).

2.2.5 The Consumer Goods Supply Chain's IT-Landscape

The evolution of business applications for supply chain processes has undergone various stages in the past 40 years. The MRP I (Material Requirement Planning) concept was developed and deployed in the 1960s and 1970s. Its functionality focuses on the calculation of net demands by taking into consideration a primary (customer) demand, a product structure or bill of materials (BOM) as well as stock balances (Stadtler 2008a). Based on net material requirements the production orders may be issued and assigned to specific resources (Lütke Entrup 2005). The next evolutionary level was constituted by MRP II. These systems are based on the MRP I concept, but the functionality was extended. Key areas of improvement are primary demand forecasting and the consideration of capacity for production (Lütke Entrup 2005; Shehab et al. 2004). Within the following evolutionary step, ERP systems have been subject to immense popularity resulting in ERP software vendors becoming the largest software enterprises (Chopra and Meindl 2007). These systems have become the IT backbone for numerous business functions such as sales, finance, accounting, human resources, manufacturing, logistics and many more (Lütke Entrup 2005). The final evolution process is advanced planning systems (APS). Actively shaping the supply chain by deploying mathematical

models and algorithms is the key application area of these systems (Günther 2005). However, as APS are decision support tools rather than transaction systems, they rely heavily on the data and information quality in the underlying ERP systems (Lütke Entrup 2005).

The supply chain processes for consumer goods described in Sect. 2.2.2 require extensive IT support. The efficient management of large material flows through a complex network of production sites, warehouses and stores requires a large number of decisions to be made frequently. However, only a fraction of these decisions are of a true planning nature as described in Sect. 2.2.3. The greater share is dominated by operational scheduling, control and execution decisions (Thomas 2008). For example, thousands of decisions are made in a warehouse every day determining which article is picked next, from which place, by whom, and which dispatching zone will be used for shipment preparation and so forth. Not all of these decisions are made by people; in fact, they are made by designated IT systems that follow a pre-determined decision making process. Decision rules and parameters are designed to secure a resource efficient material flow and sustain high on-shelf availability for the customer (Günther 2005).

The system landscape along the consumer goods supply chain can be viewed from different perspectives, revealing several key systems or modules. Within the following paragraphs the focus lies on systems architecture more than on systems functionality or on supported processes. Since organizational limits usually also impose systems' limits, the two sections of the supply chain, manufacturing and retail, are subject to separate investigation (see Fig. 2.10).

Planning processes are covered by dedicated planning tools. These planning tools do not necessarily encompass the scope of advanced planning systems. They comprise a number of different little tools and their level of integration usually

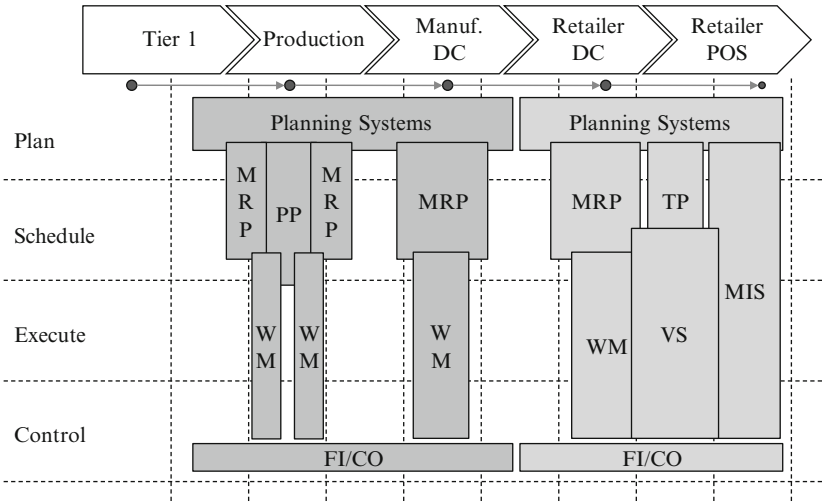


Fig. 2.10 Module landscape along the consumer goods supply chain

varies widely. Their focus is best described using the term *strategic network design* and, in real life, a great deal of the planning tasks is done by simple spreadsheet and database programs comparing different scenarios according to their cost and performance impact.

After the network's structure has been determined by network planning, material flows are planned and scheduled using MRP functionality, thereby converting gross demand into net demand (Stadtler 2008a). Even though MRP functionality is usually covered by ERP systems, it is normally an independent, yet well-integrated system component (Günther 2005). As a result, the ERP systems directly control the level of inventory along the supply chain and thus determine the product availability (Thonemann et al. 2004). Most of the ERP systems also contain a forecasting module in order to generate "demand elements" if necessary. Most forecasting data, however, is supplied by specialized forecasting systems deployed in retail (Thonemann et al. 2005). As for the in-store software, most functionality including MRP and Warehouse Management (WM) is directly integrated into the Merchandise Information System (MIS) (Hertel 1999).

The production stage within the manufacturers' section of the consumer goods supply chain constitutes the area where production planning and scheduling systems are in use. Production volumes and schedules are determined according to the net demands from the MRP run, taking into account the available resources and production material in the planning horizon (Meyr and Stadtler 2008).

Transportation planning tasks other than those covered in strategic network design are tour planning and vehicle scheduling with dedicated system support and integration. They are almost solely deployed in the retail section of the consumer goods supply chain (Mars 2008; Michael et al. 2002). As mentioned in Sect. 2.2.2 the transport relation supplying the retail markets are those with a considerable share of distributor operated vehicles (Mars 2008). While tour planning usually determines only the route and stops of a dedicated tour, vehicle scheduling assigns vehicles and drivers to these tours and is therefore located at the execution end of the process. At the location sites, material flow execution is dominated by warehouse management systems, which control the stock locations and initiate material movements by assigning relocation orders to resources (Thomas 2008).

An entire organization's section of the consumer goods supply chain is spanned by the finance and controlling (FI/CO) modules. Key tasks include accounting, budget-spent alignment, invoicing and the management of receivables and liabilities (Shehab et al. 2004). Although these modules have received little attention in operations management and operations research literature, the financial capabilities of integrated IT systems such as ERP systems have contributed greatly toward their wide propagation (Mandal and Gunasekaran 2003).

Figure 2.10 illustrates that IT system support for the tactical planning, scheduling and control of transportation processes is non-prevailing along the manufacturers' section of today's consumer goods supply chain. Possible ways of closing this gap are discussed in detail in Sect. 4.2.

2.2.6 Responsibilities Along the Consumer Goods Supply Chain

Organizational concepts applicable to consumer goods manufacturers and retailers may be structured using several dimensions, such as sales region, commodity, brand, sales channel and so on. Some supply chain processes may stretch across all these organizational dimensions while others may be subject to dedicated organizational units; more often than not different and widely independent organizational units are involved in the operation of a company's supply chain (Meyr and Stadler 2008).

Large retail organizations often feature multi-national market presence (Michael et al. 2002). They serve these markets using several sales channels such as department stores and discount markets (Axel Springer 2009). The SCM organization in retail is therefore usually integrated into the purchasing organizational unit or split between purchasing, sales and category management (Thonemann et al. 2005). The supply chain strategy is often centralized, whereas its implementation and interpretation may be subject to every sales channel in every region. Still, responsibility for single process steps such as warehousing or transportation may again be centralized (Thonemann et al. 2005).

Today's organizational structures of consumer goods manufacturers are fragmented in three main dimensions. Figure 2.11 shows an organizational chart of one of the biggest consumer goods manufacturers, Nestlé S.A., and the three dimensions are described as follows:

Region: On the first organizational level, multinational consumer goods manufacturers usually differentiate organizational structures into large-scale regional clusters (e.g., continents). These regional organizations usually enjoy a great degree of freedom regarding their business development and are controlled by the global board, largely with regard to financing and reporting (see Nestlé 2009a, b; Unilever 2009; Deloitte 2009). Their key responsibilities are the financing of mergers and acquisitions and the appropriation of profits, in particular when the companies are publically listed. All further decisions, including key strategic issues regarding business development, for example, are taken within the regional/continental organizations. On the second level, country organizations usually have a sales focus and are generally responsible for supply chain processes that ensure customer (i.e., retail) satisfaction. Their area of responsibility on the consumer goods supply chain usually begins at the incoming dock of the distribution centers and ends at the goods receiving area of the retail customers.

Category/product: Category and product responsibility is also usually distributed over several levels and may be extended by brand liability (Armstrong et al. 1996). Commodity representatives are often part of the executive board. On the second and third level the duties are differentiated according to product groups and brands. The main focus within this dimension is on marketing, which makes the involvement in supply chain management decisions of minor importance. Still, product and quality requirements substantially influence supply chain requirements (Armstrong et al. 1996). In addition, commodity responsibilities are concentrated in

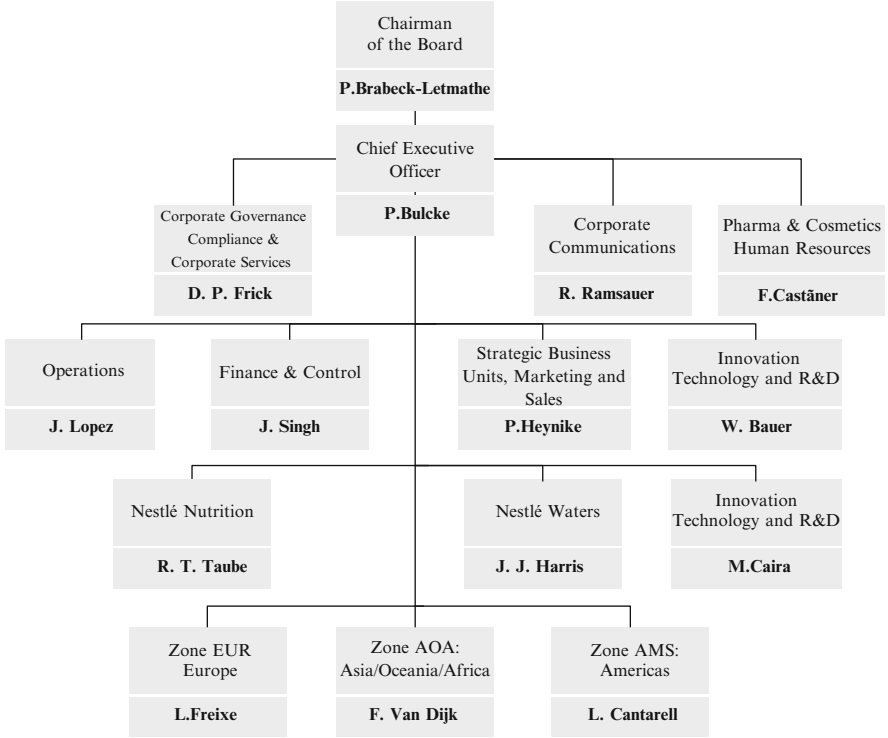


Fig. 2.11 General organization of Nestlé S.A. (2009a)

cross-regional teams. Important players in the sales organization are key account managers (teams) assigned to the large retail customers (Armstrong et al. 1996). Besides pricing they are also responsible for supply chain processes on the interface between manufacturer and retail.

Function: As in many other industries responsibilities are also shared along a functional dimension including finance, strategy, research and development, production and many more (Großpietsch 2003; Armstrong et al. 1996). While purchasing and production currently feature strong centralization, sales units are usually broken up into different sub units featuring a country or are region specific (i.e., Benelux — Belgium, the Netherlands, Luxemburg) sales organizations. Decisions with high relevance for the supply chain are made within production and operations functions.

In every subsection of every dimension, supply chain management decisions are made across the planning horizon from the operational to the strategic. It is, however, not the objective of this research to identify the specific responsibilities and resulting multitudinous areas of conflict. The strong fragmentation of responsibilities, however, shows that the term centralization for any supply chain management activity does not describe binary conditions as either central or de-central. The current trend toward

centralization of supply chain management responsibilities (N.N. 2008a) may therefore affect only fractions of the overall organization.

This description of organizational structures along the consumer goods supply chains shows a very limited consideration of a holistic SCM approach (Thonemann et al. 2005). This restricts the integration effect of SCM as described in Sect. 2.1.1. The size of markets, the extent of organizational responsibilities and the independence of purchasing, production and sales generally allow for centralization only within very limited functional areas. Nowadays, it is very common to find organizational units that concentrate accountability for shared functions for the entire macro region (e.g., continent) (N.N. 2008a; Armstrong et al. 1996).

Organizations along the consumer goods supply chain feature a wide distribution of tasks and responsibilities. The downside of this may be found in a lack of organizational integration and therefore obstacles when striving for a comprehensive and optimal supply chain configuration. Thonemann et al. (2004) describe three conflicting areas in classic consumer goods organizations (see Fig. 2.12):

- *Sales vs. Production:* As one of the classic areas of conflict, production is in favor of stable and long-term schedules and plans, while sales, aligning to customer requirements, seek high flexibility in order to meet every customer demand (Mars 2008). In consumer goods organizations this often leads to production claiming that disadvantageous cost structures result from short-notice schedule adjustment while sales may blame an inflexible production organization for falling short of inventory targets and poor service level.

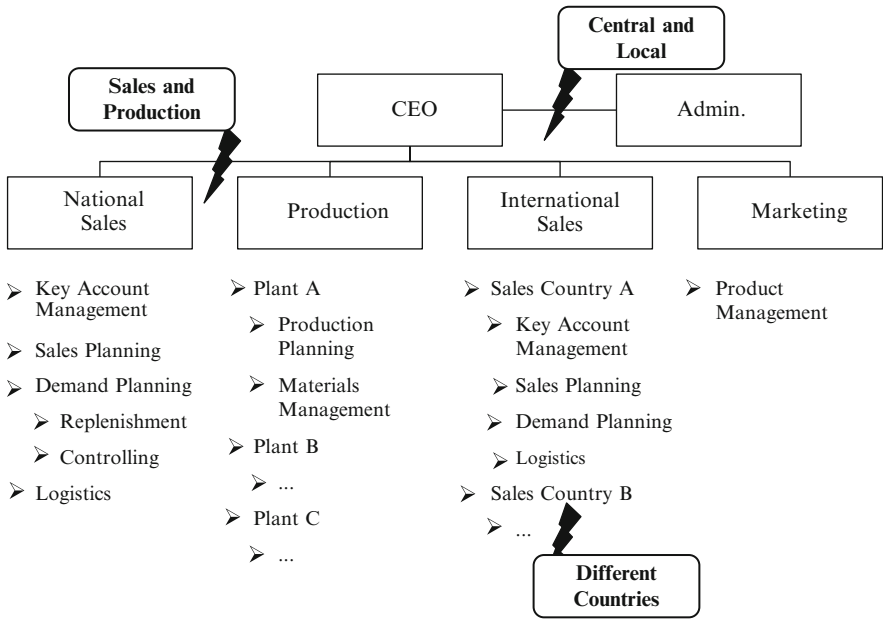


Fig. 2.12 Organization in consumer goods industries (Thonemann et al. 2004)

- *Inter-Regional*: Sales organizations from different countries share the same production capacity in international consumer goods corporations. This organizational structure carries much conflict potential, especially in transitional stages where production and supply will already take place on an international level, whereas sales and distribution remain in the hands of regional or national organizational units.
- *Central vs. Decentralization*: While decentralized organizational units will want to make their decisions as autonomously as possible, they will have to align with company strategy. A central supply chain organization may be better at identifying and striving toward a supply chain optimum; however, this may come at a high price in the regional organizations prompting a potential loss in motivation.

2.3 Trends and Future Developments along the Consumer Goods Supply Chain

Many reasons for dynamic business development have been appointed to trends. Within the key focus area of this work — transportation along consumer goods supply chains — development directions are multiple. In this subsection, major drivers and trends are identified and evaluated according to their expected influence. Trends are of special interest when they determine long-term strategic decisions. However, in order to identify the choice associated with decisions and their impact, causes and effects need to be assessed beforehand.

2.3.1 Relevant Trends

The scarcity of all resources, but particularly the finite availability of exhaustible raw materials, has been subject to intense academic discussion and is the foundation for many economic models regarding the influence on prices and in turn on demand (Hartwick 1989; Hotelling 1929). Due to the naturally diminishing supply of fossil fuels, ever-rising prices are generally expected (Grocery Manufacturers Association 2008b; Mars 2008). By no means a new finding, public awareness of these factors has steadily risen, influencing consumer behavior in terms of awareness toward the origin of goods (deducting resource consumption required for transportation—Rieck 2009). The sustainable use of renewable resources as well as fossil fuels has therefore received increasing interest.

Pollution is another environmental factor that has received growing public attention in recent years. For example, greenhouse gas emissions from cattle breeding add to the emission footprint of the consumer goods supply chain as well as transportation. Food transportation already accounts for 3.5% of the

U.K.'s total CO₂ emissions (Garnett 2003). These factors have moved to the center of public awareness regarding environmental pollution in conjunction with the farming and production of food. In contrast to these relatively new developments the contaminating effects of the production and the use of chemical products (such as washing liquids and detergents) have been countered using a greater share of biodegradable components (Banerjee and Solomon 2003).

The increasing public awareness of environmental aspects has not been without influence on consumer behavior (Garnett 2003). Alongside the growing popularity of a healthy diet these trends have not only increased bio-labeled products' turnover but has led to a re-evaluation of fresh products over strict convenience aspects (Nielsen 2009; Michael et al. 2002). This has prompted the introduction of a completely new commodity type, referred to as ultra-fresh processed foods. Products that fall into this commodity type are characterized by a shelf-life considerably lower than fresh foods (such as yogurt or other dairy products). Examples are freshly made juices (the so-called "smoothies"), cut-and-washed lettuce and salad dressings (Mars 2008). Increasing quality awareness has by no means led to a decreasing pricing awareness. On the contrary, the discount retail channels are still growing despite an already strong market share (Thonemann et al. 2005). It should be further noted that consumer activation — for example, trade promotions — is facing growing difficulties due to sensory overload (Mars 2008).

Demographic changes are an additional driver for altered business requirements, especially in consumer goods markets (Breithor et al. 2001). Increasing customer individuality shows in changing consumption behavior (Axel Springer 2009). Consumers are therefore subdivided in patterns that feature a number of demographic elements such as age or household size (Nielsen 2009; Ernst and Young 2007; Breithor et al. 2001). Addressing these customer groups with specific products invariably leads to a growing number of new products or product innovations flooding the markets (Michael et al. 2002). Product differentiation has thus become a competitive instrument for consumer goods manufacturers (Garnett 2003). Approximately 30,000 new articles enter German retail shelves annually — not taking into account the growing number of fresh food products (Mars 2008). In this context, a distinction between true product innovations and product variations seems necessary (Grocery Manufacturers Association and Booz Allen Hamilton 2006). While true product innovations are aimed directly at the consumer's desires, product variations (e.g., different packaging sizes) are often pushed into the markets by manufacturers in order to increase shelf space coverage of the own product, thereby diminishing competitors' shelf space (Thonemann et al. 2004). Demographic development, however, not only affects consumption behavior (Breithor et al. 2001); for example, with more people moving from rural into urban areas (Mars 2008) traffic congestion in densely populated regions seemingly increases (Vannieuwenhuyse et al. 2003).

Driving forces behind demographic changes as well as individual consumer behavior are often of an economic nature. The past decades have seen politically enforced liberalization resulting in the formation of free trade zones (e.g., NAFTA, EC), and even further toward the merging of several national markets into one

domestic market (EU). In other parts of the world, liberalization has boosted economic development (e.g., South Korea, China), which has led to an enormous increase in international trade volumes; today usually referred to as globalization. The opportunity of transferring goods in international markets without customs restrictions or time-consuming border crossing procedures has shifted the manufacturing footprint of many industries toward regions where labor costs are comparably low (Ernst and Young 2007; Garnett 2003). But these markets are not only the destination of production relocation activities. Due to their growth rates they often feature an increasing share of the population that, according to their income, qualifies as potential consumers (The Economist Intelligence Unit 2005). Growth rates of consumer goods sales in these countries exceed those in the saturated consumer markets (N.N. 2008b).

As a result of the dynamic development of markets, some companies' reactions have substantiated trends. The trend toward outsourcing, higher flexibility and shorter lead and cycle times are developments that account for many industries today (Grocery Manufacturers Association 2008b; Rider 2003).

2.3.2 Political Influence and Actors

With political developments having been identified as driving forces behind the expansion of domestic markets, counter movements are not far away. Subsidies for agricultural raw materials, for instance, influence their pricing and have a strong influence on the consumer goods supply chain (Grocery Manufacturers Association 2008b). The enforcement of customs on raw materials is meant to serve as a protection of national domestic markets.

Service markets, in comparison to goods markets, have not been subject to liberalization to such an extent. The European cabotage regulation limits the operations in central Europe of carriers from Eastern European member states (European Commission 2007). Even stricter rules apply to services within the NAFTA region (Beilock and Prentice 2007). Apart from that, transportation infrastructure is often state owned, controlled and even operated. This also accounts for the road network. The state is responsible for vehicle taxes, road charges and petroleum tax. The operation of rail networks, their infrastructure and equipment in Europe is largely controlled by state-owned companies

2.3.3 Implications for the Consumer Goods Supply Chain

The growing customization of products together with product innovations will increase the number of articles or stock keeping units (SKU) (Grocery Manufacturers Association and Booz Allen Hamilton 2006; Michael et al. 2002) throughout the consumer goods supply chain. With shelf space in the retail stores remaining

constant this will inevitably lead to less shelf space per SKU and therefore to less on-shelf and in-store inventory (Meyr and Stadtler 2008; Rider 2003). In order to retain on-shelf availability, either supply frequency must increase while supply lot-sizes decrease or a reduction of replenishment lead time may reduce safety stock levels and diminish total inventory requirement (Rieck 2009; Günther and Tempelmeier 2009). More SKUs will also prompt lower sales per SKU and are likely to increase relative demand volatility, which in turn is likely to raise inventory levels rather than make a substantial decline of safety stock levels possible (Gudehus 2005). In the past, diminishing sales have been avoided by a substantial growth in emerging markets, such as Europe and Latin America (Deloitte 2009; The Economist Intelligence Unit 2005). Taking into account that production is concentrated in very few locations, transportation distances have increased. This in turn opposes the trend toward shorter replenishment cycles (Grocery Manufacturers Association 2008b).

Economies of scale, growth rates in emerging markets and the development of high volume discount sales channels have increased concentration on retail markets (Ernst and Young 2007; The Economist Intelligence Unit 2005; Caputo and Mininno 1998). In the European retail markets, the market share of the top five companies has increased 15–20% points since 1990 (Thonemann et al. 2005), with the effect that consumer goods manufacturers are becoming more dependent on a few retail customers (Ernst and Young 2007; Garnett 2003), which in turn is met by a growing concentration on the manufacturing site (Thonemann et al. 2005). In addition, retailers are challenging the manufacturers' sovereignty by introducing retail brands (Ernst and Young 2007). Furthermore, they are tightening their control on supply chain processes at the interface between manufacturing and retail (Ernst and Young 2007) and taking over transportation from the manufacturer into the warehouse. This trend is part of a supply chain transparency initiative in retail, often referred to as factory gate pricing (McKinnon and Ge 2006). It resembles a total landed cost approach dividing a product's price into conversion cost (= price at the factory gate) and logistics costs (= transportation, warehousing, dedicated packaging) — thus each of the pricing components is subject to separate negotiation. Furthermore, the retailers may calculate whether it is less expensive to collect the goods at the manufacturer or to have it delivered to their own warehouses (or even into the stores, for example, using VMI concepts) (Thonemann et al. 2005).

A growing number of SKUs, lower in-store inventory levels and shorter replenishment cycles all add to the complexity of planning tasks along the consumer goods supply chain (Grocery Manufacturers Association and Booz Allen Hamilton 2006). It also imposes additional restrictions that are likely to result in rising supply chain costs (Mars 2008). However, the dynamic development may also be regarded as offering new opportunities by delivering customized services such as pre-allocated cross docking or shelf-ready packaging (Thonemann et al. 2005). Logistics activities may thereby contribute toward the long expected "revenue generation strategy for the supply chain" (Ballou 2007).

2.3.4 Implications for Transportation Markets

Political, social, and economic developments have an impact on service demand, supply and prices of transportation markets. As a result of a heightened environmental awareness, vehicle taxes, fuel taxes and road taxes have been subject to an over- proportionate increase in recent years (ECR Europe 2000). Road and vehicle taxation have been modified according to the specific emission of a vehicle. Additional measures penalizing vehicle emissions are being discussed. Reporting schemes regarding the carbon footprint are also applicable to transport emissions (Garnett 2003). But it is not only the environmental factors that are subject to political and social discourse. Even though the acceptance of alternative transportation modes (as opposed to the road) features environmental aspects, it is the deregulation and accessibility of rail services that will decide upon their acceptance and intermodal transportation. Hidden and open subsidies for publicly owned railway companies have led to a market situation lacking transparency. Road regulations have also been subject to discussion recently (e.g., in Germany). Plans to increase the permitted gross vehicle weight and extend truck dimensions have recently been abolished.

Mars (2008) states that as a result of several governmental regulations within the transportation sector, transportation costs are constantly increasing at rates above inflation. Decreasing transportation lot sizes and high product proliferation complete the picture of the rising complexity of transportation management for both consumer goods manufacturers and retailers in the near future.



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