7 Inventory, Stock and Provisioning Management

Learning Objectives

Inventory management, stock management, and provisioning management play an important role in logistics. On the one hand, they directly influence the delivery service. On the other hand, inventory costs are a significant cost driver in the supply chains.

This chapter aims to present different approaches to inventory and order planning as well as to the application of established warehousing strategies, of fundamental principles of provisioning, and of procurement-logistical concepts. Furthermore, different approaches in developing cooperative inventory management strategies within the supply chains will be discussed. From this the reader will get comprehensive references in order to meet the challenge between high product availability and low inventory (costs).

Keywords

- Function of inventory
- Demand-oriented (pull) or action-oriented (pull) supply of goods
- Availability versus destocking
- Warehousing strategies
- ABC analysis
- Just in time/Just in sequence
- ECR, VMI, CPFR
- Regional freight carrier concept
- Cooperation concepts

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7.1 Inventory Basics

7.1.1 Contents and Objectives

Inventory management, *stock management,* and *provisioning management* serve logistical purposes and purposes related to warehousing. The objective of *warehousing theory* is to minimize the total inventory costs, order costs, and delivery costs. The basic aim is the reduction of stock and the depletion of safety stock. To this end, decisions regarding order sizes, order dates, and delivery dates have to be made; usually by the material planning department. Other points of consideration include *stock-keeping* of inventory and *delivery*.

The *logistical aim of inventory management* is to optimize the entire supply chain across the different stages to adequately serve the demand. Problems may arise as a result of this multi-stage structure and due to the isolated and often uncoordinated flows of goods at the different stages of the supply and distribution chain. This is owing to the fact that stocks are kept at all these stages to meet the demand of the subsequent stage.

Depending on its position in the value chain, inventory can comprise material goods (raw, auxiliary, and operating materials), intermediate, or semi-finished products (parts, components, modules), or finished products (end products). Players in the supply chain are producers who manufacture ready-for-sale end products. Suppliers produce parts, components, and modules and can therefore be categorized as parts suppliers, component suppliers, module suppliers, or system suppliers. The end products are offered to the consumers through different distribution and sales channels, such as trading enterprises, wholesale stores, and retail stores. Thus, procurement organs and *procurement logistics* as well as distribution organs and the associated *distribution logistics* play a part in the value chain.

7.1.2 Determination of Requirements

There are three traditional methods available for the *determination of material demand*:

- *Deterministic* methods, where the requirements are calculated based on the production program
- *Stochastic* methods, which make use of consumption statistics and forecasts
- *Heuristic* methods, which allow to make inferences as to the requirements by means of comparisons with similar products (analogous estimation) or intuitive estimations without relying on numerical data

The kind of raw materials and parts required and the point in time for their procurement can be derived from the determination of requirements based on the *types of requirements* shown in Fig. 7.1.

Primary demand is dependent upon external factors, such as fluctuations in demand, the state of the economy, or seasonal demand and can therefore hardly

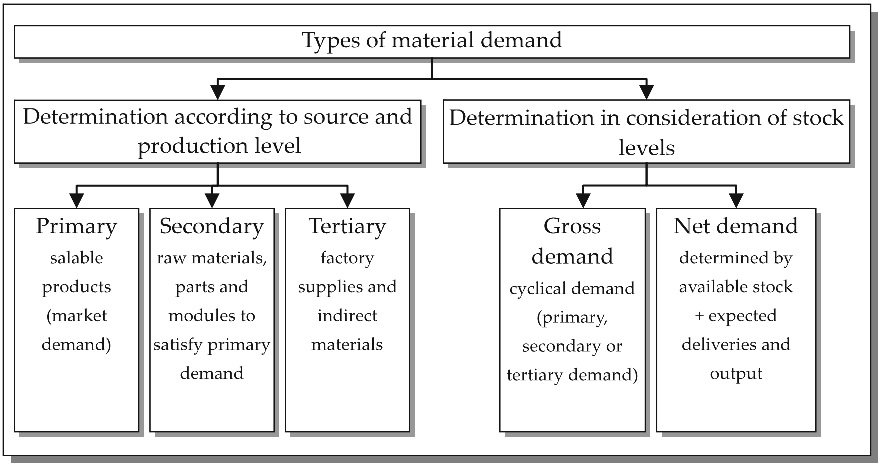

Fig. 7.1 Distinction of types of material demand (Schulte (2001), p. 113)

be influenced. *Secondary demand* derives from primary demand and is calculated on the basis of stock lists. *Tertiary demand* is of minor importance in determining demand since it mainly determines quickly and easily obtainable materials which are not included in the planning stage but are procured as per to consumption.

The distinction between *gross demand* and *net demand* is relevant in relation to the point at which demand occurs. The stock of inventory is taken into account while determining these types of demand.

7.1.3 Functions of Inventory

Inventory can assume different *functions*, which are independent of materials demand.[1]

The *cycle stock* or *adjustment function* of inventory offsets the temporal imbalance between supply and demand within an economy. According to production theory, it is advisable to produce larger quantities even though the products may not be in demand or sold either before or immediately after production. The period between when the end-product becomes available (supply) and when a need for the product arises (demand) can be minimized by means of inventory management. This is to cut costs for storage space and capital commitment.

The availability of raw materials and goods needed for the production of a specific product helps the manufacturer achieve shorter delivery times and higher

[1] Cf. Heiserich et al. (2011), p. 116 et seq.

flexibility to meet different customer requirements. This is referred to as the *acquisition function* of inventory.

Inventory allows *Economies of scale* to be collected if the purchasing department manages to obtain quantity discounts and favorable terms of transport through consolidation.

Another function of inventory is the *safety stock* function. In this case, stock is kept to ensure the availability of goods at all times. This is important, for example, in the procurement process so that production need not be discontinued if suppliers are unable to provide raw materials or semi-finished goods in time or if delivery is delayed due to busy transport networks or inclement weather conditions. On the other hand, sudden fluctuations in demand may be offset using safety stocks. Without influencing the production process, unsold goods may be kept as inventory in warehouses. Conversely, if sales are above average, demand can be met using inventory stocks and sales shortfalls may thus be avoided.

Furthermore, inventory has a *function of speculation*. Through stock-keeping and the availability of storage capacities, it becomes possible to purchase goods today even if they will only be needed later for production or resale. Such decisions may be economically sensible if market prices are low (e.g. with promotional offers) or if prices are likely to increase in the future (e.g. if prices for raw materials go up or if demand increases).

It is only through the *refinement function* of inventory that certain products become salable after production. Examples of this are typical ripening processes of food and drinks.

Finally, inventories may serve to ensure consistent quality for products that hail from different provenances (place of origin, production series etc.). In these cases, inventory takes on an *assortment function*.[2]

7.1.4 Inventory Cost

Keeping inventory stocks entails *inventory costs* in the form of storage costs (building, technology, staff) und inventory carrying costs (capital commitment, shrinkage, obsolescence). Unavailability of out-of-stock goods leads to production downtime and drops in sales, which can be classified as out-of-stock costs, sales shortfalls, and shortfalls in profit margin. The portion of costs and the share in results that inventory has in the respective reference and target figures can be determined by *material and inventory classification*. Probably the most famous method of inventory classification is the ABC and XYZ analysis. It is the aim of this

[2] Cf. Ihde (2001), p. 44 et seq.

type of analysis to assess a specific inventory's share of value in e.g. turnover and to determine regularities in consumption. Case study 7.1 will demonstrate how an ABC and XYZ analysis can be applied.

Case Study 7.1: ABC-XYZ-Analysis

SoLog, *Solutions for Logistics* PLC is a logistics service provider specializing in logistical services for the entertainment sector. In order to harmonize the internal storage and picking processes with the demand patterns for articles, an ABC and XYZ analysis is carried out. 9 articles have been selected here to demonstrate the procedure of the analysis.

The products to be analyzed are listed in tabular form and are given a rank according to the value of the yearly requirement for each item number (see Table 7.1).

Calculation: value = quantity issued/consumed x item cost.

As a next step, the products are categorized into class A, B, and C based on the original ranking (See Table 7.2).

All inventory including the strongest-selling products up to the position where the accumulated percentage first exceeds 70 % are grouped *A class* inventory. The remaining positions up to around 90 % are *B class* products. The residual 10 % of turnover are taken up by *C class* products.

The differentiation between the individual groups may vary. Action plans for each group of inventory can be deduced from the analysis.

In particular, these are:

A-Articles

- Complex, exact procedures for disposition
- Procurement in very short intervals
- Minimized procurement times
- Precise inventory control

Table 7.1 Ranking according to yearly requirement

Item No.	Item Quantity	Price per unit in €	Value of yearly requirement	Rank
1001	10,000	3.25	32,500	5
1002	12,800	1.10	14,080	8
1003	8,000	1.75	14,000	9
1004	6,000	17.50	105,000	3
1005	12,400	1.60	19,840	6
1006	8,000	6.25	50,000	4
1007	4,000	136.20	544,800	1
1008	6,800	2.10	14,280	7
1009	12,000	37.85	454,200	2
			1,248,700	

Table 7.2 ABC class list

Rank	Item No.	Value of yearly demand in €	Proportion of the overall value in %	% Accumulated	Class
1	1007	544,800	43.6 %	43.6 %	A
2	1009	454,200	36.4 %	80.0 %	A
3	1004	105,000	8.4 %	88.4 %	B
4	1006	50,000	4.0 %	92.4 %	B
5	1001	32,500	2.6 %	95.0 %	B
6	1005	19,840	1.6 %	96.6 %	C
7	1008	14,280	1.2 %	97.8 %	C
8	1002	14,080	1.1 %	98.9 %	C
9	1003	14,000	1.1 %	100.0 %	C
		1,248,700			

- Extensive research into procurement markets
- Careful choice of suppliers
- Very exact calculation of order quantity and time of order placement

C-Articles

- Determination of requirements based on consumption
- Simplified methods of order processing
- Long order intervals and large order quantities
- Large safety stock inventory

B-Articles

- In the middle, to be treated as either A or C articles on a case-by-case basis

However, analyzing the goods solely by their proportion in the overall value is not sufficient. Apart from their value, consistency in their consumption is also a decisive factor. The XYZ analysis determines these consistencies:

- X-items: consistent consumption and therefore high prediction accuracy
- Y-items: fluctuating or seasonally increasing or decreasing consumption
- Z-items: highly volatile consumption and therefore low prediction accuracy

This analysis also allows for action plans to be deduced in conjunction with the ABC analysis. Thus, groups of AX, AY or BX items are highly suitable for just-in-time delivery while BY and CX items are suited to a limited extent (see Sect. 6.3). Additional analyses need to be carried out with regard to replacement times, frequency of item changes, out-of-stock costs, as well as maximum inventory, minimum inventory, and safety stock.

7.2 Inventory Planning and Management

7.2.1 Disposition Procedures

In a general sense, disposition is defined as the quantitative arrangement of orders with their individual service requirements and the scheduled allocation of internal orders to available resources.[3]

Disposition is carried out in the procurement of charge materials for production and in the provision of end-products for trade. A conventional *lot size calculation* may be employed to optimize the procurement of materials for production. This determines the ideal order quantity while taking order and storage costs into account. Scale of discount, price hikes, and promotional offers etc. may also be factored in.[4]

In the trade sector dispositioning takes place on certain levels. Central warehouses may dispose with suppliers, regional warehouses with central warehouses and branch stores with regional warehouses In so doing, different procedures are implemented which can generally be broken down into demand-led procedures and program-led procedures.

Applying *Consumption-led disposition*, procurement becomes dependent on demand. This demand is determined by outward materials movements within the framework of inventory control. Order quantities and time of order placement are established on the basis of these movements and existing inventory. The producer then places the order with the supplier. Subsequently, the supplier processes the order and identifies the order quantity and the delivery date.

Program-led disposition is characterized by its dependency on the production program. Based on an initial forecast about the future demand of a specific product (primary demand), the parts and components needed for the production of the end product are identified (secondary demand). These requirements are then reconciled with the existing stock inventory (net requirements) so that procurement requirements (determination of order quantity) and provisioning dates (order scheduling) can be established.

Another consumption-led disposition procedure is called *stochastic disposition*. It utilizes forecasting models that are based on past figures. Exponential smoothing, for instance, is used as a forecasting procedure to visualize *trend functions* (constant functions, linear functions, quadratic functions). This is a recursive calculation of exponentially smoothed averages for which only the actual demand of the latest period and the smoothed average of the preceding period are required.[5] The effect of past averages on the new forecast can be altered by means of smoothing parameters.

[3] Cf. Gudehus (2010), p. 43.

[4] Cf. Stölzle et al. (2004), p. 84 et seq.

[5] Cf. Stölzle et al. (2004), p. 63 et seq.

This procedure (exponential smoothing of the first order) is suitable for articles with stable sales and demand structures. Extraordinary fluctuations in demand triggered by e.g. seasonality or marketing activities can be taken into account using seasonal factors (exponential smoothing of the second and third order).[6]

7.2.2 Warehousing Strategies

Individual *demand-led disposition procedures* differ with regard to the parameters used by the manufacturer to determine order quantities and the time of order placement. These procedures, also termed warehousing strategies, include[7]:

- Order rhythm – lot size (t,q)
- Order rhythm – order level (t,S)
- Order point – lot size (s,q)
- Order point – order level (s,S)

Applying the *order rhythm – lot size procedure* (also called t-q policy), orders are placed in regular intervals, which is represented by the parameter t (see Fig. 7.2).

The inventory level is always restocked by the same amount q. Uneven outward stock movements may lead to highly fluctuating inventory stock levels S. Thus, a high volume of outward stock movements within a given interval t bears the risk of inventory shortfall.

Using an *order rhythm – order level procedure* (also referred to as t-S policy), orders are placed in set intervals, represented by the parameter t. The inventory is always restocked up to a pre-defined level S. The capacity limit can therefore never be exceeded. Due to varying order volumes, suppliers may experience difficulties in

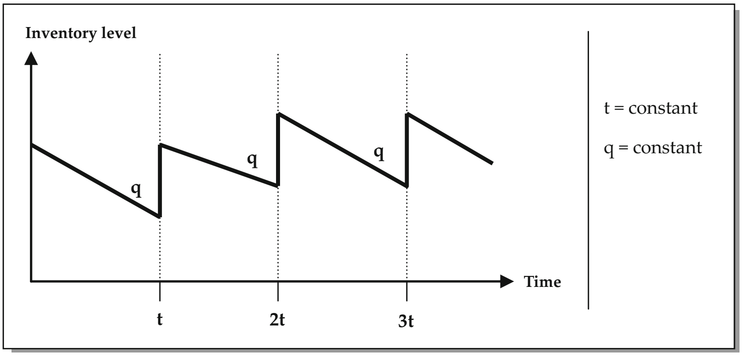

Fig. 7.2 Warehousing strategies and order policies of the t-q policy

[6] Cf. Kernler (2003), p. 65 et seq.
[7] Cf. Stölzle et al. (2004), p. 91 et seq.

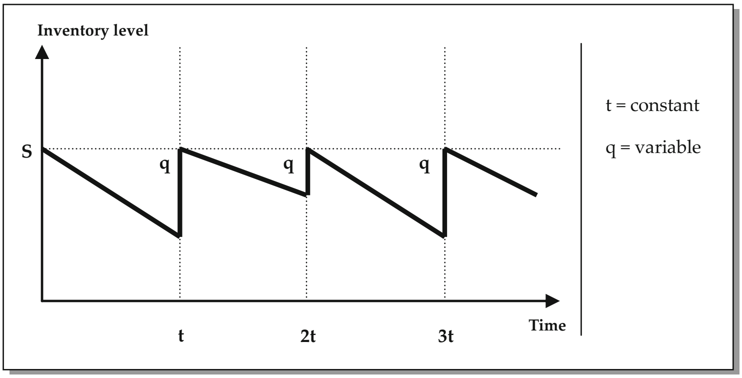

Fig. 7.3 Warehousing strategies and order policies of the t-S policy

defining realistic capacity levels, which lead to shortfalls or delays in delivery in cases of capacity bottlenecks. Downtime consequences can be interruption of production (see Fig. 7.3).

With the *order point – lot size procedure* (also termed s-q policy), a fixed quantity q is ordered as soon as the inventory level reaches or falls below a certain order point s. Orders are therefore placed in irregular intervals since outward stock movements are dependent on demand and thus may differ from one period to another. The risk of inventory shortfalls is relatively low. They are only experienced if the inventory level has dropped near the order point s, no orders have been placed yet, and if a larger quantity than s is needed for the next withdrawal from stock (see Fig. 7.4).

Applying the *order point – order level procedure* (also called s-S policy), an order is placed as soon as the inventory level reaches or falls below a certain order point s. The inventory is restocked with the difference to a pre-defined order level S. Orders are placed in irregular intervals since outward stock movements are dependent on demand and thus may differ from one period to another. The risk of inventory shortfalls is relatively low since the warehouse is filled up to the

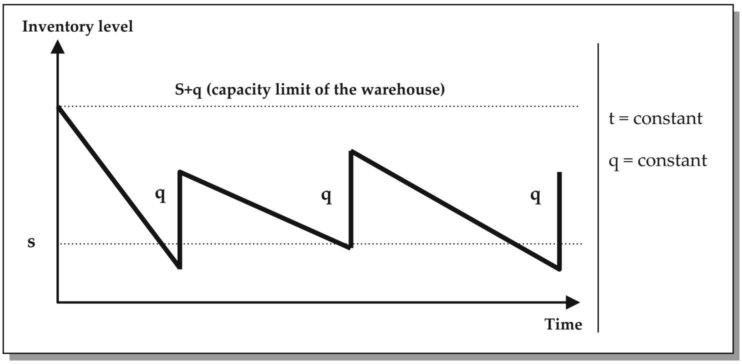

Fig. 7.4 Warehousing strategies and order policies of the s-q policy

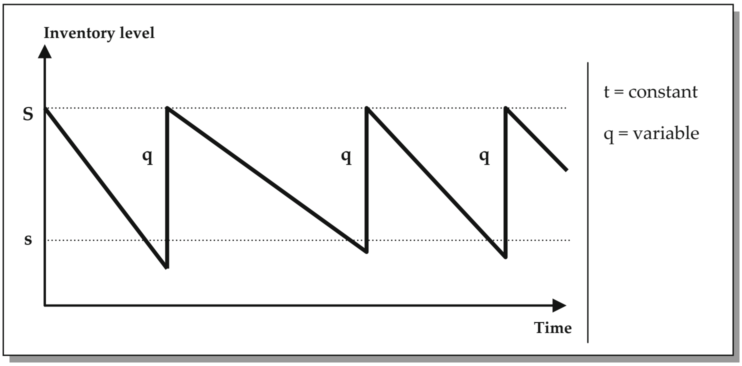

Fig. 7.5 Warehousing strategies and order policies of the s-S policy

maximum level, i.e. high storage costs are deliberately incurred. Analogous to the order point – lot size procedure, shortfalls may occur if the inventory level has dropped near to the order point s (see Fig. 7.5).

7.2.3 Safety Stocks

Regardless of the actual demand, each inventory-carrying stage within a supply chain is planned on the basis of requirements forecasts which, in turn, are based on previous downstream demand structures. Orders are always triggered if the inventory level drops below a pre-defined order point (see order point procedures) which should still allow for demand to be met during the replenishment lead time. Since demand and replenishment lead times are subject to fluctuations, it is necessary to keep *safety stocks*.

Safety stocks are established based on the service level and on the expected probability distribution for demand. The precise amount of safety stocks depends on the extent of forecast errors, expected demand, and on the probability with which this demand occurs. Safety stocks can be calculated by means of the Gaussian normal distribution, which standardizes the frequency of deviations from a mean value. By specifying a certain multiple of the standard deviation, a probability can be established with which a specific demand can be met by keeping a certain level of stock. With a service level of 84 %, a safety stock of one standard deviation of the forecast demand is required. If statistical safety of 97 % is aimed for, a safety stock of two standard deviations is needed. These statistical safety measures are only applicable with normally distributed frequency distributions.[8]

[8] Cf. Alicke (2005), p. 63.

7.3 Provisioning of Goods

7.3.1 Individual Procurement and Bulk Procurement

Individual procurement on demand, in-stock provisioning, and just-in-time provisioning are basic concepts in the provisioning of goods. *Individual procurement on demand* is characterized by low stock levels and therefore incurs minimal storage costs. Risks and disadvantages include delays in production, loss of customers or turnover, and potentially high purchase prices. In the case of *in-stock provisioning or bulk provisioning,* goods are kept in stock. Keeping inventory secures the production process or the supply of customers but also incurs high storage and capital commitment costs. On the other hand, purchase discounts may be applicable.

7.3.2 Production Synchronized Provisioning

Using *production synchronized provisioning*, only the materials needed are procured and provisioned. This type of provisioning may be employed between two stages of production, between production and assembly, or between supplier and assembly.[9] A self-managed control circuit governs the internal production and orders are processed according to current demand and existing inventory levels. This procedure termed KANBAN (card) is organized de-centrally and utilizes a production concept based on the pull principle.

The pull principle is a control concept whereby replenishment orders are triggered after demand occurs. With the push principle, however, replenishment orders are placed according to plan. Applying the KANBAN principle, the self-managed production or procurement at each upstream stage is set off by the demand of the ensuing downstream stage. Materials must not be ordered in too large quantities, too early, or in reserve by the production stage (drain). To realize the potential of the KANBAN principle for the suppliers (source), they must not produce buffer stock and they should only initiate production upon receipt of an order while guaranteeing the flawless quality of the products. The short-term management of production is passed on to the staff members. Cards are used as part-specific information carriers between the provisioning unit (source) and the consuming unit (drain).

7.3.3 Just-In-Time Concepts

On the basis of the KANBAN principle – which Toyota developed into an efficient procedure for production – just-in-time concepts between suppliers and buyers have emerged.[10] High predictability of the demand of the goods is a crucial prerequisite

[9] Cf. Schulte (1996), p. 301.

[10] Cf. Stölzle et al. (2004), p. 133 et seq.

for this. Ideally, no inventory stocks are kept, which also precludes storage costs. However, high transport costs are likely to arise due to small transport lots and high transport frequency. In addition, there is a risk of production downtime and delays in production. To reduce these risks it is vital that buyers work closely together with suppliers or with one of the supplying branches in the proximity.[11]

Just-in-time provisioning through suppliers is based on a three-stage process:

- *Framework agreement*: forecasts regarding capacities and demand for the next 1 or 2 years, rolling
- *Forecast delivery schedule*: Stipulation of terms of delivery and period-specific obligation to take delivery
- *Just-in-time delivery/dispatch call-off*: Specification of exact quantities, delivery dates, and points of delivery

A stable exchange of information between supplier and consignee is prerequisite for just-in-time delivery. This can be secured, for instance, through a common inventory control or by granting the purchasers access to the supplier's order processing systems and production planning systems (PPS). Furthermore, the supplier needs to offer an extremely high service level as well as exceptional quality assurance so that the purchasers need not conduct quality checks.

Amongst other things, the selection of goods suitable for just-in-time delivery is dependent on the predictability of demand. AX, AY or BX parts are predestined for this while BY and CX parts are suitable to a certain extent (see case study 7.1). Further analyses must be carried out with regard to, for example, the composition of the parts, whether parts are used for a serial product or one variety and whether parts are to be assembled in pre-fabrication (component configuration) or in the assembly of the end product. Additionally, frequency of item changes, out-of-stock costs, as well as maximum inventory, minimum inventory, and safety stock should be taken into consideration.

Just-in-time delivery concepts can be broken down into block delivery and just-in-sequence delivery. With *block delivery*, the supplier receives call-offs several times per day. Following a buffering at the supplier's site, the parts are delivered directly to the buyer's production site. The parts are unsorted since the composition of the parts is not dependent on a specific sequence. *Just-in-sequence delivery*, however, is a direct delivery of small quantities transporting parts to the buyers production site several times per day and synchronously to production. Apart from the timely provisioning of parts at the point of assembly, a sequential delivery according to the sequence of assembly is taken into consideration (just-in-sequence).[12]

[11] Cf. Ihde (2001), p. 274 et seq.

[12] Cf. Vahrenkamp (2007), p. 343.

Case Study 7.2: JIT and JIS in the Automobile Industry

Based on volume and value, the VW plant Mosel procures more than 50 % of its purchased parts through JIT and JIS procedures. The responsibility of the respective suppliers comprises disposition, container management, and transport, including provisioning of the components at the point of assembly. The JIS suppliers are located at a distance of about 30 km from the plant. This makes it possible to process an order and provision the parts just-in-sequence at the assembly line within a few hours after the order was placed by the assembly department at the OEM's site (VW).

Using this principle, the OEM reduces production costs due to short assembly and delivery times and as a result of freed-up production areas and production capacities. This type of provisioning is especially effective with modules suppliers, such as chair producers who deliver pre-finished systems (see Chap. 12). The responsibility of coordinating sub-suppliers is thus passed on to the modules supplier, which reduces the number of direct contacts. All in all, this can be regarded as a win-win situation between the OEM and the modules supplier. Long-term partnerships are forged as a result of a close cooperation. The supplier benefits by taking over certain proportions of the value added, by gaining know-how, and therefore by sharpening the competitive edge.

7.3.4 Goods Receiving Functions

Irrespective of individually applied provisioning principles, goods need to be received physically. This takes place at the *goods receiving department* where all operational actions as to receipt, quantity control, and quality control of the delivered goods take place. In particular, this includes the functions of[13]:

- Receipt of delivery
- Comparison of order and delivery data against type of goods delivered, quantity of goods delivered, and time of delivery
- Approval to unload at a specific unloading point
- Checking goods during unloading with regard to shortfall quantities and damages by means of visual inspection
- Reporting defects and, if necessary, refusing acceptance and returning goods
- Precise quantity control through counting, measuring, weighing, and recording the results
- Comparison of results against delivery documents
- Labeling of goods and approval to store

[13] Cf. Fortmann/Kallweit (2007), p. 83.

From a procurement-logistical viewpoint, a great amount of information is necessary to ensure smooth goods receipt. This includes[14]:

- Categorization of the delivering means of transport according to type, size, and loading height
- Delivery volume and quantity, such as average and maximum volume of delivery, delivery time, number of deliveries per day
- Form of delivery, such as pallets, containers, boxes, or other types of loading aids

Special importance is placed on the *incoming goods inspection* since it has to be verified whether the functionality and quality features agreed on with the supplier have been adhered to. Depending on their extent and thoroughness, quality controls may take a considerable amount of time, which delays the provisioning of the incoming goods for production or dispatch. For this reason, the task of carrying out quality controls is more and more frequently assigned to suppliers. They conduct these controls using stipulated control parameters, control methods, testing equipment, and rejection criteria.

7.4 Transport, Warehouse, and Location Concepts

7.4.1 Regional Freight Carrier Concept

In addition to the procedures of goods provisioning, numerous *transport, warehouse, and location concepts* have been established.[15] A *regional freight carrier* is a logistics service provider who organizes the composition and bundling of shipments from suppliers on behalf of a buyer within a specific area and implements transport of the shipments to the production site of the consignee.

The buyer determines:

- The allocation of the regional freight carrier to the location of the supplier
- The processes the supplier should follow at the point of contact with the regional freight carrier, e.g. scheduling of readiness to dispatch, specification of pickup notification from supplier to regional freight carrier
- Specifications to be observed by the regional freight carrier as to means of transport, containers, load carriers, timeframe for unloading, and delivery times

The regional freight carrier is responsible for:

- Implementation of collection rounds (timetable)
- Consolidation of individual shipments at central transit points

[14] Cf. Fortmann/Kallweit (2007), p. 85.

[15] Cf. Stölzle/Gareis (2002), p. 402 et seq.

- Transport to consignee in complete, *point-to-point shipments*

The prerequisites for the regional freight carrier concept are:

- Delivery conditions *ex works*, i.e. the regional freight carrier delivers by order of the consignee
- Suitability of goods for consolidated transport
- Limited need for speediness
- Negotiable delivery dates and loading times between suppliers
- Sufficient spacial concentration of the suppliers

Concentrating on one carrier per collection area facilitates scheduling through central disposition. This increases the reliability of incoming shipments. Cost advantages result mainly from the consolidation of goods flows. Bundling a number of individual shipments into consolidated shipments results in a reduction of traffic and thus in a decrease both in environmental pollution and transport costs. In addition, bottlenecks at the buyer's goods receipt may be avoided and the coordination of delivery dates can be simplified.[16]

7.4.2 External Provisioning Warehouse

An *external provisioning warehouse* serves the purpose of merging input materials from several suppliers at a jointly managed warehouse.[17]

The prerequisites for this are:

- Horizontal cooperation between suppliers
- Consolidation during pre-carriage to the warehouse
- Consolidation during on-carriage to the consignee
- Consolidation for picking and loading carried out jointly by suppliers
- Synchronous delivery

Splitting warehouse costs and (jointly) remunerating the employed logistics service providers are difficulties in the realization of external just-in-time warehouses. The advantages are a reduction of traffic, increased reliability due to geographical proximity, as well as greater suitability for just-in-time or *just-in-sequence* procedures. *Consignment warehouses* can be combined with just-in-time warehouses but are different from them in that they are managed by one supplier. The supplier stores contractually stipulated inventory stocks in them, from which the consignee removes the goods in demand. The storage area is normally provided by the consignee. The goods remain the property of the supplier until removal from stock. The resulting capital commitment costs are borne by the supplier.

[16] Cf. Vahrenkamp (2005), S. 233.

[17] Cf. Stölzle/Gareis (2002), p. 410.

7.4.3 Supplier Settlements and Supplier Parks

External provisioning warehouses are different from *supplier settlements* and *supplier parks*. The latter ones are designed to provide settlement space for several suppliers of mostly one buyer and/or of other service providers. Mostly, these settlements are not devised as production sites but as assembly sites. The reason for this is the fact that assembly is in most cases more customer-specific than production, which renders a re-location close to the assembles site of the OEM worthwhile. Among the objectives are cost-cutting by making use of synergies (park/facility management, IT networks, conference rooms, canteen, public transport etc.) and improved service through increased flexibility, reliability, and sped-up processes (see Sect. 4.2.6).

Case Study 7.3: Supplier Park Smartville

Supplier and industrial parks are very common in the automotive industry, which is demonstrated by the *Smartville* project in Hambach, France. The different models of *smart* cars have been produced there since 1997. The supplier park is not located directly next to the production site, but the five system suppliers and two logistics service providers are contained within the premises, forming a *cooperative factory* together with smart France, a subsidiary of Daimler. The layout of the production plant resembles a plus sign as can be seen in Fig. 7.6 and is carried out by smart France. The system suppliers are located around this center and supply prefabricated modules, such as car bodies, cockpits, rear axles with

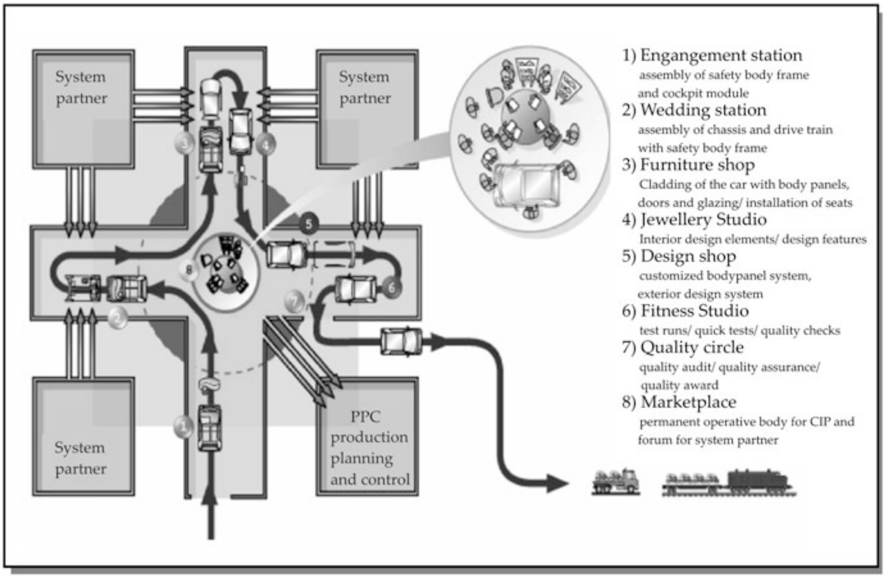

Fig. 7.6 Factory premises at smart France (Smart GmbH 2007)

drive, front-end modules, doors, and plastic covers directly to the assembly line. The advantages of this layout are the short distance between supplier and final assembly as well as the ease of extending the entire structure. Just as on a common production site, the suppliers located in immediate proximity are integrated in the production and develop a high sense of responsibility for the processes. Furthermore, by contractual agreement, smart France motivates its partners by encouraging them to make suggestions for improvement of the end product throughout the entire product life cycle. About 70 % of the materials delivered to the assembly lines are provisioned by the system suppliers located in Hambach. 20 % of the remaining materials are delivered by JIT suppliers which facilitates production with lean inventory. One of these suppliers is the engine factory MDC in Kölleda (Thuringia). The engines are delivered in swap bodies which dock to the respective assembly station. Thus, the distance between material removal and point of assembly hardly exceeds 10 m. The production plant in Berlin is informed at a 3 days notice prior to assembly start in Hambach as to which delivery is required. This becomes possible by specifying so-called *pearl chains,* which signal that from that point on the sequence of production is not changed anymore (see Sect. 12.2.1). Therefore, Daimler is able to schedule its tours well ahead of time and utilize its truck capacities to the fullest.

The residual 10 % of the production materials are made up of standard parts and small parts. These are delivered to a supplier warehouse (consignment warehouse) where they are buffered for 3–10 days on average. While still in the warehouse, these parts remain the property of the producer until the logistics service provider feeds them into the assembly processes.

All modules and bought-in parts generally remain the property of the suppliers up to a defined counting point at the site in Hambach. Billing is then carried out based on the requirements and according to the parts list. This renders incoming goods inspection unnecessary since the supplier carries the responsibility for the delivery date and the quality of the goods up to the point of assembly. Hence, smart France produces without keeping any inventory. This takes inventory risks off smart France and direct capital commitment costs can be avoided.

Having the five main suppliers on site reduces the risk of supply bottlenecks due to delivery problems such as traffic jams and so forth.

7.5 Cooperation Concepts of Inventory and Provisioning Management

7.5.1 Efficient Consumer Response

Apart from requirements planning and management, different forms of cooperation between suppliers and producers or between producers and the trade sector are becoming more and more important for the optimization of inventory along logistics chains.

Efficient Consumer Response (ECR) is a cross-company approach to optimize flows of goods, information, and cash with the aim of an overall optimization of the system including suppliers, producers, the trade sector, and end consumers. The focus is on increasing the efficiency and productivity of the entire value chain and not that of individual links in the chain. To this end, cooperative partnerships are forged between producers and the trade sector for efficient replenishment, efficient promotion, efficient assortment and efficient product introduction.[18] In particular, this calls for cooperation concepts in logistics (Supply Chain Management, *Supply Side*) and for cooperation concepts in marketing (Category Management, *Demand Side*).[19] For our purposes we shall focus on the logistical approaches. These approaches primarily seek to overcome uncoordinated and isolated procedures along the supply chain, to build mutual trust and understanding, and to disclose necessary information.

Efficient Replenishment aims at an efficient management of supply. This pull-system which displays characteristics of just-in-time delivery of industry production depends on the actual sales. Its goal is to synchronize the production of the manufacturers and their suppliers with customer demand by linking all stages in the supply chain together (customers, trade, headquarters, warehouse, branches, producers, logistics service providers) within one integrated system. For the implementation thereof, the instruments of Supply Chain Planning, Supply Chain Execution, and Supply Chain Event Management are used (see Fig. 7.7):

- *Supply Chain Planning* deals with the planning of logistical resources in procurement and distribution, such as inventory, delivery, and transport capacities
- *Supply Chain Execution* supports the operational processes (management and control), such as order processing, stock management, and transport
- *Supply Chain Event Management* monitors all activities and generates notifications or warnings in cases of deviations (anomalies in inventory, provisioning process)

Continuous Replenishment Programs (CRP) are geared towards securing direct and automated replenishment by means of immediate transmission of stock and inventory data. *EDI systems (Electronic Data Interchange)* are used for information exchange since sped-up or partly automated replenishment can be realized by avoiding media disruptions. Manual entry of data from faxes or emails into ERP systems would be an example of media disruption.

[18] Cf. Heiserich et al. (2011), p. 256 et seq.

[19] Cf. Hertel et al. (2005), p. 173 et seq.

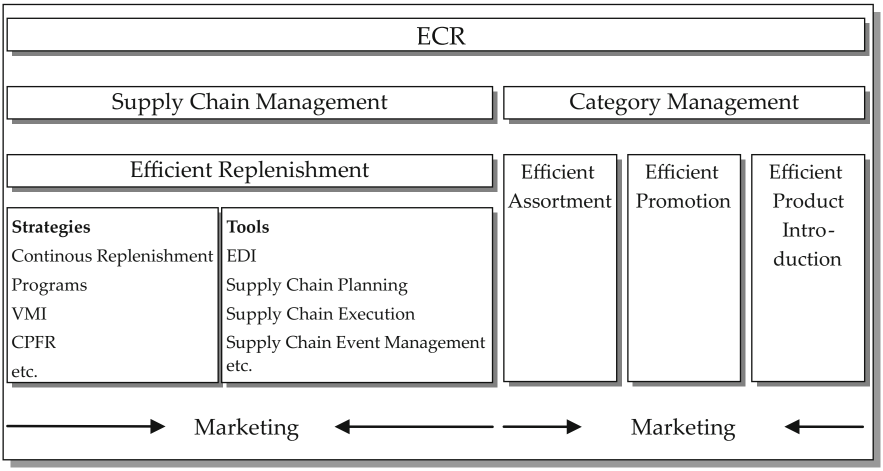

Fig. 7.7 ECR overview (Cf. Gleißner (2000), p. 101)

7.5.2 Vendor Managed Inventory

Along with CRP, *Vendor Managed Inventory (VMI)* is an ECR strategy which optimizes replenishment. While planning and management of goods flows has so far been at the discretion of the trade sector respectively the trade company, we can now observe that the responsibilities of procurement logistics are increasingly being assigned to the producers and suppliers. This means that only the producer makes decisions about delivery rhythms and quantities delivered. The trade sector and buyers, on the other hand, forego the establishment of delivery quantities and delivery dates.

The process of Vendor Managed Inventory involves a continuous monitoring of inventory at the customer's site (warehouse, branch) and – citing the example of a producer-vendor relationship – is based on the processing of sales data (scanning cash register) in retail stores and on the transmission of sales figures and inventory data to the producer. The sales forecast resulting from this is used as the planning guideline by the producer. Thus, the producer determines the delivery quantity based on quotas, order time, and available stocks. An order confirmation is then sent to the trade company. Order processing and delivery is carried out by the producer while the inventory level and the inventory range are jointly determined by the vendor and producer.

A mild form of VMI is *Co Managed Inventory (CMI)*. Here, the trade company is still responsible for processing the order. The supplier issues suggestions as to the order, which only have to be confirmed or adapted by the consignee.[20] If a VMI

[20] Cf. Stölzle et al. (2004), p. 143.

strategy is being introduced, CMI may initially be used on an interim basis to alleviate the reservations of both parties and ultimately make a transition to VMI.

7.5.3 Collaborative Planning, Forecasting and Replenishment

Collaborative Planning, Forecasting and Replenishment (CPFR) is an advancement of ECR in the field of sales planning.

It is advanced in the sense that forecasting and planning of sales are modified and disposition is re-structured. It is especially important to take fluctuations in demand and uneven order frequencies into account and not to amplify their effects through wrong forecasts at the individual production stages and inventory-carrying points in the supply chain.[21] Above all, peaks in demand need to be analyzed accordingly.

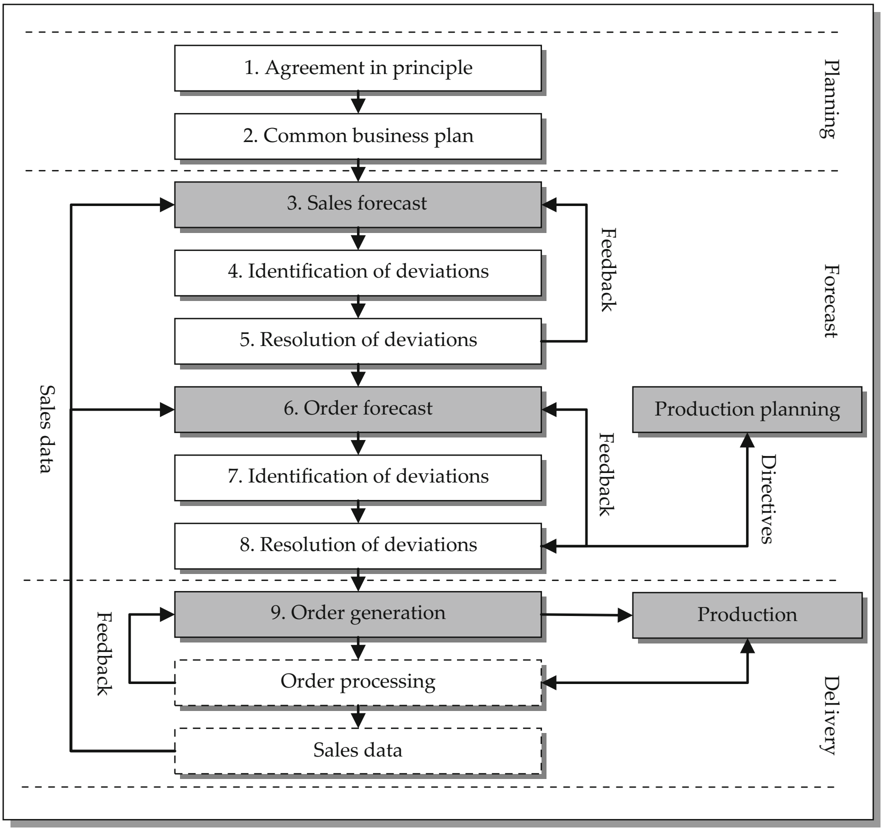

Fig. 7.8 CPFR process model (Cf. Kuhn/Hellingrath (2002), p. 112)

[21] Cf. Ihde (2001), p. 321.

This requires a detailed analysis of past purchase patterns (seasonal influences throughout the year, weekly trends). Special emphasis therefore lies on the collaboration in the forecasting phase, in which the joint handling of critical deviations turns into a learning process through giving feedback.[22] This integrated planning approach is shown in Fig. 7.8.

Additionally, marketing activities need to be taken into consideration (campaigns, advertisements). Electronic marketing, electronic market research, and data from Customer Relationship Management (CRM) systems may help to enrich sales planning with valuable information. Integrated and improved methods for planning and disposition as well as shortened cycles facilitate greater availability and thus more reliable deliveries. In addition, more flexible planning becomes possible since changes in plan at one stage entail consistent changes at all upstream and downstream stages.

The following effects can be achieved through improved transparency:

- Greater product availability with low stocks
- Timely disposition of updated production plans in which changes in plan on the buyer and supplier side can be taken into account
- Quicker reaction to changed customer demand
- Higher capacity utilization of transport means through coordination of distribution plans

Successful implementation of CPFR increases the effectiveness of ECR and/or VMI. However, both ECR and VMI can be employed independently and do not require the use of CPFR.

[22] Cf. Hertel et al. (2005), p. 197 et seq.

Review Questions

1. What are the goals of inventory management?
2. What are the functions of inventory?
3. Name the most important types of inventory costs.
4. What is the difference between order-point procedures and order-rhythm procedures?
5. What are safety stocks?
6. Define the different principles of goods provisioning?
7. Name the most important approaches of Efficient Consumer Response (ECR).
8. Who employs regional freight carrier concepts and runs external just-in-time warehouses?
9. Describe the procedures involved in just-in-time concepts.
10. What statements can be made on the basis of ABC and XYZ analyses?

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