2 Value Chain Management

The theoretical background is defined around the central term *value chain*. Chapter 2 presents research concept*s to manage the value chain* structured by their area of specialization either on supply, demand or values. Secondly, within an integrated framework, the results of the specialized disciplines are combined with the objective to manage sales and supply by values and volume. *Value chain management* is defined and positioned with respect to other authors' definitions. A *value chain management framework* is established with a strategy process on the strategic level, a planning process on the tactical level and operations processes on the operational level. These management levels are detailed and interfaces between the levels are defined. Since the considered problem is a planning problem, the framework serves for structuring planning requirements as well as the model development in the following chapters.

2.1 Value Chain

Value chain as a term was created by Porter (1985), pp. 33-40. A value chain "disaggregates a firm into its strategically relevant activities in order to understand the behavior of costs and the existing and potential sources of differentiation". Porter's value chain consists of a "set of activities that are performed to design, produce and market, deliver and support its product". Porter distinguishes between

- *primary activities*: inbound logistics, operations, outbound logistics, marketing and sales, service in the core value chain creating directly value
- *support activities*: procurement, technology development, human resource management, firm infrastructure supporting the value creation in the core value chain

Fig. 3 illustrates Porter's value chain.

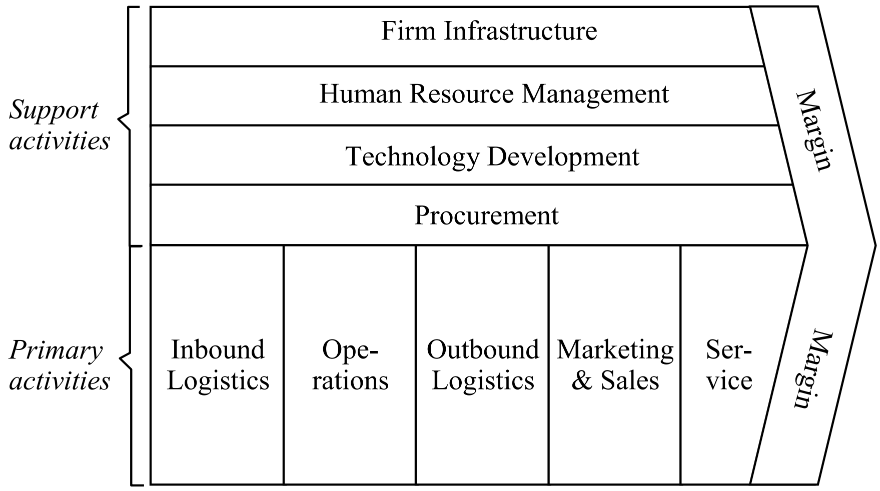

Fig. 3 Value chain by Porter

Porter formulates the general strategies for the value chain of *cost leadership* and *differentiation* to reach competitive advantage (Porter 1985, pp. 62-163). These cross-value chain strategies established a principle that competitive advantage can be reached only by managing the entire value chain as a whole including all involved functions.

Some authors argue that Porter's value chain is characterized by classical functional separation and thinking in organizational units instead of processes, since not processes but activities are listed by organizational function (Corsten 2001, p. 93). Over the years, the value chain was further enhanced towards

- cross-company-orientation defined in the term *supply chain*
- network-orientation defined by the term supply chain network

Supply Chain and Supply Chain Network

Porter's value chain is one basis for the development of the *supply chain*. The term *supply chain* was created by consultant Keith Oliver in 1982 according to Heckmann et al. (2003). Compared to the company-internal focus of Porter's value chain, the supply chain extends the scope towards intra-company material and information flows from raw materials to the end-consumer reflected in the definition of Christopher (1992): "*a supply chain is a network of organizations that are involved through upstream and downstream linkages in different processes and activities that product value in the form of products and services in the hand of the ultimate consumer"*. Core ideas of the supply chain concept are:

- a better collaboration between companies in the same supply chain will help to improve delivery service, better manage utilization and save costs particular for holding inventories (Alicke 2003)
- individual businesses can no longer compete as solely autonomous entities, but rather as supply chains (Christopher 1998)

Various illustrations and definitions for the supply chain exist as shown in fig. 4.

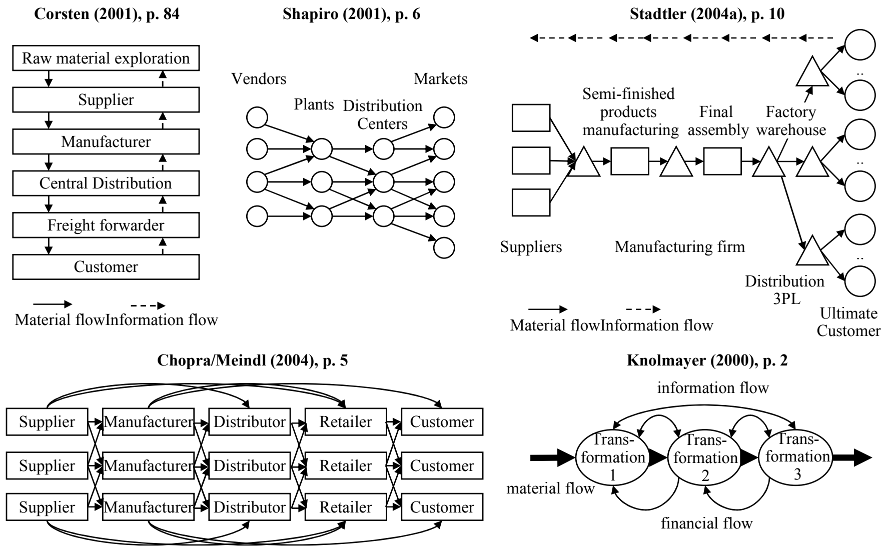

Fig. 4 Supply chain illustrations in literature

Corsten points out that a supply chain is a special type of network composed of multi-level logistic chains owned by legally separated companies. The focus in the supply chain is the coordination of flows of materials and information between these companies. Corsten's examples show the supply chain structure starting with raw materials up to the final consumer (Corsten/Gössinger 2001).

The network aspect in supply chains is illustrated by Shapiro where supply chain networks are composed by notes connected by transportation networks (Shapiro 2001, p. 6). Compared to Corsten, Shapiro extends the supply chain including many-to-many-relations between vendors, plants, distribution centers and markets.

Stadtler addresses the aspect of multi-level manufacturing of semi-finished and final assembly products as well as multi-level distribution steps. He also introduces different node types for procurement, production, distribution and sales and confirms the one-directional flow of material and the one-directional flow of information similar to Corsten. Stadtler emphasizes the difference between intra-organizational and inter-organizational supply chains (Stadtler 2004a, p. 10).

Chopra and Meindl support the aspect of many-to-many relations and a supply chain network. Additionally, they add the aspect of direct relations between partners in the supply chain across several supply chain steps. The primary purpose of the supply chain is to satisfy customer needs, in the process generating profit for itself (Chopra/Meindl 2004, p. 5).

The review of Knolmayer supports the cross-node communication to ensure collaboration across the chain. Additionally, communication is not only one-directional but bi-directional as well as supply chain does not only cover material and information but also monetary flows (Knolmayer/Mertens et al. 2000, p. 2).

While the previous illustrations are focused on the *intra-company* supply chain structures, *inter-company* structures of the supply chain are related to Porter's value chain as shown in fig. 5 (Meyr/Wagner et al. 2004, p. 113 based on Rohde/Meyr et al. 2000).

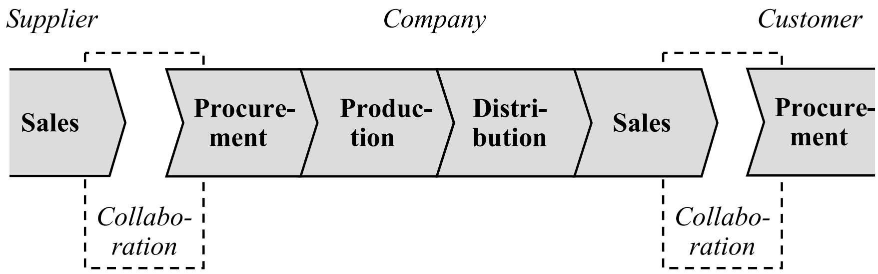

Fig. 5 Company-internal supply chain structures

Here, the focus is on the primary value-creating activities influencing directly the bottom line of the company. Different to Porter,

- *procurement* is a primary value-creating activity and core element in the supply chain and not a support function,
- market-facing activities are combined into *sales* including customer services
- inbound and outbound logistics activities are combined in *distribution*,
- operation in Porter's value chain is more specified with the term *production*.

Concluding, the supply chain and supply chain network concept extends Porter's value chain concept towards cross-company networks in order to improve efficiency and delivery service, minimize costs and inventories based on a given demand across the chain. The focus shifted from value creation within a company towards ensured supply for a given demand and cross-company material flow and information management.

This approach requires a cross-company coordination and information exchange platform in order to create transparency and accurate information about material flows in the chain as basis for decisions. In addition, full collaboration and trust rather than the competition between different companies is required. These assumptions are similar to approaches in planned economies with a central planning office trying to optimize complete industries composed by state-owned companies.

In market economies, however, companies are confronted with competition when selling to customers and they use the market competition when purchasing from suppliers. On the other hand, market constellations can change, when many customers compete for limited resources or raw materials provided by few large suppliers. In these situations, prices, values as well as ensured profitability within each company are decisive for the sustainable survival of the business. While the supply chain emphasizes the supply aspects including ensured supply and availability (Corsten 2001, p. 94), an essence of Porter's value chain underlining the value focus and the supply chain concept is required as basis for the study.

Value Chain and Value Chain NetworkUsed in the Study

The value chain in the study focuses on the company internal value creation in the primary activities consistent to the company-internal supply chain structures by Meyr et al. (2004) and Rohde et al. (2000) as illustrated in fig. 6.

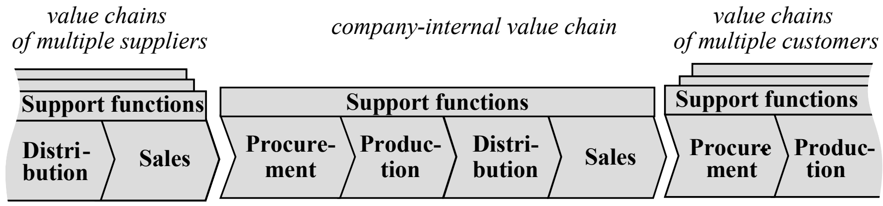

Fig. 6 Value chain considered in the study

The considered value chain is characterized by

- the primary functions of sales, distribution, production and procurement as well as the support function consistent to Porter's support functions excluding procurement

- *sales* covers besides core sales activities also marketing and sales-related service function
- *distribution* covers inbound and outbound logistics with warehousing and transportation
- *production* covers Porter's operations functions; production is not a mandatory function e.g. in case of retailers in the consumer goods industry
- *procurement* is a primary function directly impacting volumes and values

- the value chain has clear interfaces with the procurement functions of multiple customer and the sales functions of multiple supplier interfaces
- the functional structure is consistent with the value creation process and supports the definition of cross-functional management processes

The company-internal value chain is basis for end-to-end volume and value management as well as collaboration and negotiation between other value chains.

The value chain network combines illustrations of the different supply chain network (see fig. 7).

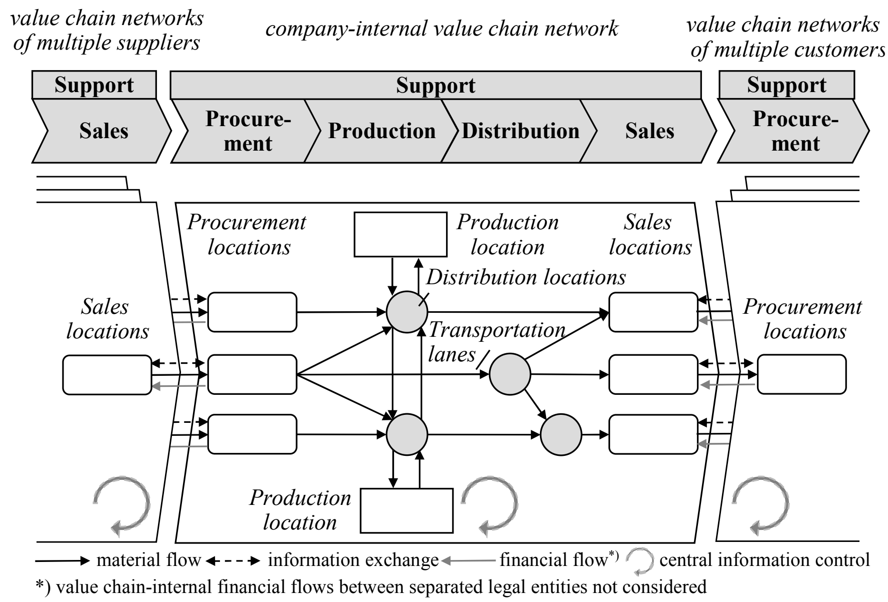

Fig. 7 Value chain network structures

The network is composed by locations and transportation lanes between these locations consistent to supply network structure definitions e.g. in

APS (Dickersbach 2004, pp. 13-15). The company-internal value chain consists of procurement, production, distribution and sales locations:

- procurement locations group one or multiple suppliers to a logical location for purchasing of raw materials and/or finished products for production or trading purpose
- production locations group one or multiple production sites to a logical location
- distribution locations group one or multiple warehousing or logical distribution centers e.g. cross-docking centers
- sales locations group one or multiple customers to a logical sales locations

The value chain network includes the aspect of aggregating multiple customers and suppliers to logical location(s), which is an important aspect in industry value chain networks operating with hundreds and thousands of customers and individual sites.

Distribution locations are included in the company-internal value chain network, if distribution volumes and values are under the control and in the books of the company independent if the warehousing and transportation is outsourced to 3PL distribution companies or not. Therefore, a company value chain network is enclosed with a central control of all volume and value information for the respective network and clear interfaces to customers and suppliers out of the network. While the internal value chain network is focused on material flows evaluated with respective internal costs, dedicated interfaces to multiple suppliers and multiple customers are characterized by material flows, financial flows and mutual instead of one-directional exchange of information as proposed for supply chains by several authors.

The value chain network structure is built on the assumption that not all but specific company-internal value chain information can be shared with customers and suppliers specifically capacity and inventory information. Capacity and inventory information are important factors in price negotiations as well as customer and supplier relationship management: excess inventory weakens the supplier position in price negotiations; shortage in capacity can lead to the fact that important customers change suppliers. Instead of "*opening the books*" between all companies, structured information exchange needs to be established at those interfaces between value chain networks with respect to the specific *demand* and *offer* information as well as *collaboration* and *negotiation processes* e.g. investigated by Dudek for supply chains (Dudek 2004).

The value chain network structure fosters an evolution towards market and pricing mechanisms at the interfaces between networks comparable to financial markets, electronic marketplaces and exchanges with multiple buyers and multiple sellers. While the supply chain concept is concentrated on the supply volume side, the value chain concept should provide the basis to integrate demand volume and overall value decision making into management concepts.

2.2 Concepts to Manage the Value Chain

Three research areas with respective sub-topics are relevant to the problem of managing a global value chain end-to-end by volume and value:

- Concepts to manage *values* in the value chain
- Concepts to manage *demand* in the value chain
- Concepts to manage *supply* in the value chain

Fig. 8 illustrates these research foci and the respective sub-fields.

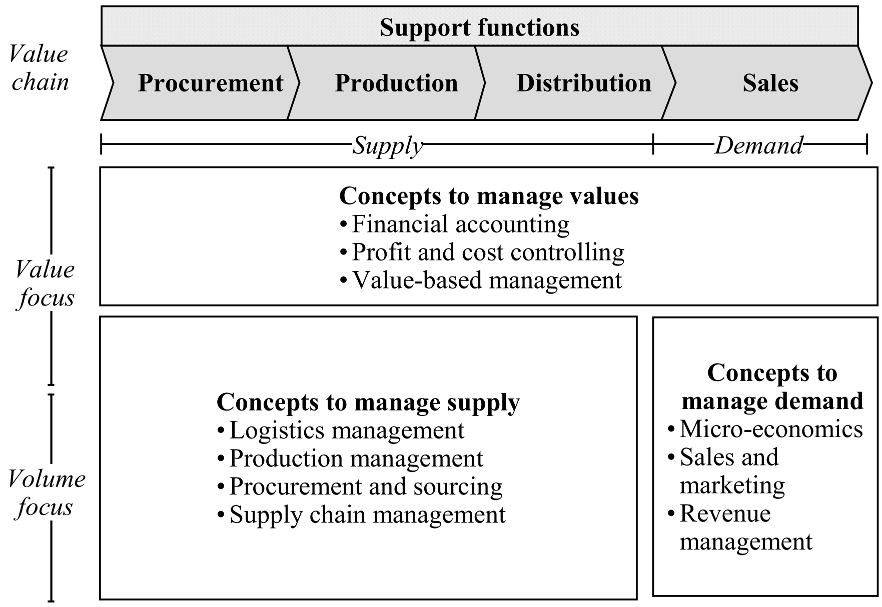

Fig. 8 Management concepts in the value chain

The management concepts focus on the primary activities in the value chain. Management concepts for support functions such as human resources, information technology or corporate finance are out-of-scope in this work. The integration of support management concepts into value chain management is an area for further research.

2.2.1 Concepts to Manage Values

Values in the industry value chain are subjects of financial accounting, profit and cost controlling as well as value-based management research. Out of the scope is the value chain support function of corporate finance concerned with getting required or investing excess financial resources in financial markets, which is not a core activity in the industry value chain and out of the scope in this work. The integration of value chain management with corporate finance is a potential area for further research.

Financial Accounting

Financial accounting is the basis for accurate measuring and evaluation of all values. External financial accounting processes for accounts receivables, e.g. payments from customers, and accounts payables, e.g. payments to suppliers, are key processes in financial accounting (Teufel/Röhricht et al. 2000, pp. 115-170). Inside the company, the accurate evaluation of values in compliance with legal accounting standards such as IAS or US-GAAP has to be ensured (Born 1999). Typical evaluation problems within the value chain are for example the accurate evaluation of assets like fixed production resource value and costs based on depreciation methods or the correct evaluation of working capital such as inventories applying inventory accounting methods e.g. Last-in-First-Out (LIFO) or First-In-First-Out (FIFO) methods (Kremin-Buch 2001; Revsine et al. 2004).

Profit and Cost Controlling

Profit and cost controlling has the objective to provide cost and profitability information as support for management decisions on business and investment using value-based indicators e.g. measuring costs and profitability of the company, customers, products and/or locations (Götze 2004; Götze/Bloech 2004). Profit and cost controlling is based on the structures of cost types, cost centers and cost objects such as products or customers (Götze 2004). Profits and costs are allocated on costs objects such as products to evaluate unit profitability. A key differentiation is fixed costs also called indirect costs and variable costs also called direct costs. Direct costs can be directly allocated to a cost object such as a product, while fixed and indirect costs require volume-oriented allocation methods to reflect potential cause-effect-relations between products and associated fixed costs. A common problem is to allocate capital-intensive production fixed costs such as shifts and depreciations on assets on produced products since the final fixed cost rate depends on the utilization of the production. Here, the calculated indicators depend on the volume situation. Calculated profitability indicators are rather static and rely on ex-post analysis as well as the chosen allocation rules.

Additionally, profit and cost controlling has to consider legal and accounting standards required and applied in formal financial reporting and company business statements.

A guiding instrument for cost and profit controlling is the company income structure as illustrated in table 2 (Revsine/Collins et al. 2004; N.N. 2006a):

Table 2 Income statement structure

Value indicators	Description
Gross revenues/gross sales	Based on gross sales quantity and gross prices
- Discounts/Provisions/Returns	Terms, conditions, provision agreement
= Net revenues/net sales (0)	Net sales turnover
- Cost of sales	Variable cost of goods sold
= Gross margin/EBITDA (1)	Earnings before interests, tax, amortization, depreciation; also contribution margin I (CM I)
- Net operating expenses	Fixed selling, administration costs incl. depreciation
= Operating Profit/EBIT (2)	Earnings before interests, tax, depreciation; also contribution margin II (CM II)
+/- Financial results	Interests payable on debts, investment income
+/- Other revenues/expenses	
= EBT (3)	Earnings/profit on ordinary activities bf. Taxation
- Tax	Based on taxes on earnings
= Net income (4)	Basis for earnings per share calculation/net operating profit after taxes

Different earning results are reported supporting different perspectives on the company's income situation:

- EBITDA has a more short-term perspective focusing on variable costs excluding fixed costs for assets
- EBIT has more a mid to long-term perspective including fixed costs
- EBT compares total earnings considering the financial structure and results of the company independent of location-specific taxes
- Net income is the effective income remaining to the company

EBIT and EBITDA are common indicators used in company-internal decision making supporting operative profitability analysis as basis for volume decisions. Recently value-based management concepts extended the set of indicators to a more shareholder and analyst-oriented perspective.

Value-based Management

Value-oriented management concepts evolved from cost and profit controlling towards value based management concepts. Transparency on profitability of invested capital for the company and its shareholders is an objective of value-based management. Profitability indicators are related to capital indicators. Common indicators are Return on Assets (ROA), Return on Capital Employed (ROCE) and Economic Value Added (EVA®) as presented in table 3 (Hostettler 2002; Revsine et al. 2004).

Table 3 Value-based management indicators

Indicator	Formula	Descriptions
ROCE	$\frac{\text{EBIT}}{\text{(Total assets – current liabilities)}}$	Indicator to measure pre-tax interest rate on total invested capital excluding current short-term liabilities
ROA	$\frac{\text{Net profit}}{\text{Total assets}}$	Indicator to compare total profit return on assets specifically in asset-intensive industries
EVA®	NOPAT – (NOA · WACC)[1]	Profit indicator deducting capital costs from net operating profit after taxes excluding interests; consideration of financing structure of the company

Value-based management indicators target an improved and more meaningful profitability analysis considering also required capital employed such as assets and inventories. Providing the interface to integrate value-oriented indicators into volume-oriented management concepts in the value chain would be an interesting option to link volume decisions with overall value performance of the company.

Conclusions: Value-oriented Management Concepts

Value-oriented management concepts provide the accurate basis for evaluation of volumes and profitability. Integrated management concepts in the value chain and decision support models need to be consistent with

[1] NOPAT is the Net Operating Profit After Taxes excluding financial results; NOA is the Net Operating Assets and WACC is the Weighted Average Costs of Capital of the company financed by equity and outside capital (N.N. 2006b; N.N. 2006k).

the value definitions from value-oriented management concepts and have to take into account effective values that are "in the books".

Value-oriented management concepts share the characteristics to determine values and profitability ex-post based on historic volumes. They currently do not support a future-oriented planning of volumes and values in global multi-level networks since future planning of volumes depends on sales and supply network planning decisions. Also, the allocation of fixed costs on products and customers based on compensation keys and metrics is problematic when operating a global, multi-stage network with hundreds of products and customers, where cause-effect relations are not direct and linear. Finally, they cannot provide information on the future value of working capital employed such as inventories derived from the monthly inventory volume plan. Hence, an integrated value chain management concept needs to provide the platform to integrate value- and volume-oriented management concepts.

2.2.2 Concepts to Manage Demand

Demand management concepts consider demand and sales as active areas of decision making with respect to pricing and sales quantity decisions. Research fields addressing these decisions are primarily micro-economics, sales & marketing research as well as recently revenue management.

Micro-economics

Micro-economics contribute to demand-oriented management with economic research on market and pricing mechanisms (Varian 1994). Relations of demand and supply from the micro-perspective of buyers and sellers as market participants are investigated. Specifically, market-constellations, price-quantity functions and pricing mechanisms are related to sales quantity and price decision making.

Market constellations depend on the number of market participants on supply and demand side differentiated in polypoly (many), oligopoly (few) and monopoly (one) as illustrated in fig. 9 (N.N. 2006c).

Demand \ Supply	Polypoly *(many)*	Oligopoly *(few)*	Monopoly *(one)*
Polypoly *(many)*	Perfect Competition	Offer oligopoly	Offer monopoly
Oligopoly *(few)*	Demand oligopoly	Bilateral oligopoly	Limited offer monopoly
Monopoly *(one)*	Demand monopoly	Limited demand monopoly	Bilateral monopoly

Seller dominance

Buyer dominance

Balanced market powers

Fig. 9 Market constellations

Depending on the market constellations, market participants can dominate sales price and quantity decisions in micro-economic theory. Relationships between and price and quantity in the market constellations are reflected by price-quantity functions as shown in fig. 10 (N.N. 2006d).

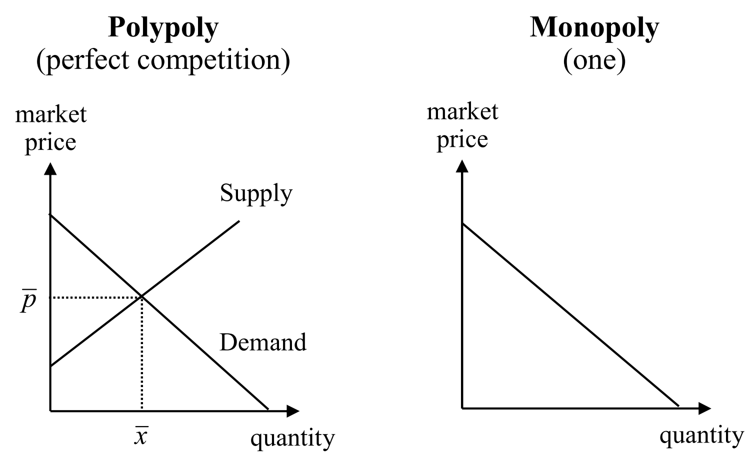

Fig. 10 Price-quantity functions

Price-quantity functions reflect the negative correlation between market prices and sales quantity. In perfect competition, high market prices correlates with low demand quantities. A single supplier cannot influence the market price with his decisions, a market price and quantity is determined by demand and supply as shown in the left part of fig. 10.

In case of an offer monopoly, a single supplier can dictate the prices, while buyers can only react with their demand quantity to these prices.

The relation between prices and quantities can be expressed by the price elasticity of demand defined as relative change of quantity divided by the relative price change $E = (\Delta q / q_0) : (\Delta p / p_0)$ (N.N. 2006e). The elasticity is characterized as fully elastic (E = ∞), elastic (E >1), unitary elastic (E = 1), inelastic (E < 1), entirely inelastic (E = 0) or negative elastic (E < 0). Market constellations, price-quantity functions and elasticity are developed from a market perspective considering market constellations, market prices and total sales quantities, not from an individual value chain perspective. However, they provide fruitful input for the integrated management of volumes and value in a value chain, since market constellations and price-quantity relations impact volume and value management in the value chain.

Finally, pricing mechanisms are an important aspect investigated in micro-economics specifically in auction theory. Three different types of pricing mechanism relations exist: bilateral negotiations, single-sided auctions and many-to-many exchanges as shown in fig. 11.

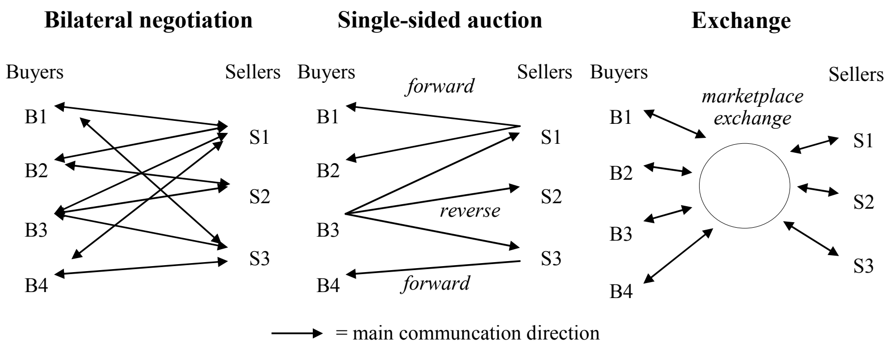

Fig. 11 Pricing mechanisms relations between buyers and sellers

A negotiation is a one-to-one pricing mechanism, where a single buyer and a single supplier negotiate price and quantities. Single-sided auctions have a structured protocol where one auctioneering participant and multiple bidders submitting bids. The winner is determined based on the bidding protocols e.g. First-price-Sealed-Bid or Vickrey auction or Dutch auction. Single-sided auctions exist for selling – called *forward auction* – and for buying – called *reverse auction* –. Finally, exchanges are many-to-many pricing mechanisms with a defined double auction protocol and multiple buyers and sellers submitting offers and bids cleared in one market price

(McAfee/McMillan 1987; Milgrom 1989). Sales price and quantity decisions in value chains needs to consider the respective pricing mechanism applied in the market and reflect it in integrated management concepts.

Sales and Marketing

The area for sales price and quantity decision within a company is a sales and marketing domain. Sales and marketing research has gained increasing importance with the change from seller to buyer markets (Wöhe 2002, pp. 463-465). In the middle of the 20th century in industrialized countries, markets changed from excess demand with insufficient supply towards excess supply and competition in saturated markets. The company focus changed from production-orientation towards sales-orientation. The sales function is an integral part of marketing (Winkelmann 2005). Marketing can be defined as "*an organizational function and a set of processes for creating, communicating and delivering value to customers and for managing customer relationships in ways that benefit the organization*" (Kotler/Keller 2005, p. 6). Marketing can be structured around the so-called marketing mix of product, price, promotion (Communication) and place (Distribution) (Kotler/Keller 2005, p.19). Marketing structures the interface to customers, defines the product portfolio and the pricing as well as the distribution strategy with respect to sales channels, e.g. via wholesalers, web-based shops, direct sales, etc. Marketing also structures the sales functions to sell the products to the customer. Sales and marketing differ in focus as shown in table 4.

Table 4 Focus areas of Marketing vs. Sales

Area	Marketing	Sales
Market	Entire market, market segments	Customers, customer groups
Product	Product lifecycle, portfolio	Customer-relevant articles
Volume	Total volumes, market shares	Sales quantities by customer
Value	Pricing strategy and gross prices Overall product profitability	Customer terms & conditions Customer contribution margins
Topics	Market strategy (segmentation , competitive analysis, positioning) Marketing Mix (product, promotion, place, price)	Customer Relationship Management and Customer Service Collaboration and negotiation, RFP processes Forecasting and sales planning Sales order management

Marketing has a more strategic orientation towards overall product portfolio and markets, while sales has a more operative orientation towards single articles and customers. Specifically, the price as well as terms and conditions are key decisions driving profitability. In industry companies, the price erosions can be observed when companies are facing competition and prices are decreased excessively, since they do not have a systematic price management in place (Homburg et al. 2005). Recent work started to investigated dynamic pricing in industry applications such as the iron and steel industry and in the US automotive industry, respectively (Spengler et al. 2007; Biller et al. 2005). Important in the context of the value chain is that both are managed mainly oriented at sales volume, value and overall profitability targets as basis for active decision making (Bestmann 1996, p. 324).

Revenue Management

Revenue management (RM) is the most recent, demand-oriented management concept in comparison (Cross 2001; Tallury/Van Ryzin 2005). Alternative terms used are yield management or dynamic pricing. Revenue management is concerned with "*demand-management decisions and the methodology and systems required making them*" (Tallury/Van Ryzin 2005, p. 2). Tallury and Van Ryzin distinguish:

- Sales decisions: decisions on where to sell and when to whom at what price
- Demand decisions: estimation of demand and its characteristics and using price and capacity control to "manage" demand

Tallury and Van Ryzin differentiate three basic categories of demand management decisions in revenue management (Tallury/Van Ryzin 2005, p. 3):

- Structural decisions with respect to pricing mechanisms (auctions, negotiations, posted prices), segmentation mechanisms, terms of trade, bundling of products
- Price decisions on how to set posted prices, individual-offer prices and reserve prices in auctions; how to price across categories; how to price over time; how to markdown (discount) over the product lifetime
- Quantity decisions: whether to accept or reject an offer to buy; how to allocate output or capacity to different segments, products or channels; when to withhold a product from the market and sell at later points in time

Revenue management is focused on *demand forecasting* – aggregated and disaggregated – *demand distribution models* or *arrival processes* to develop specific approaches such as *overbooking, seat inventory control* and *pricing approaches* (McGill/van Ryzin 1999).

Initial application fields for revenue management are rental cars (Carroll/Grimes 1995), hotel rooms, transit and highway systems (Huang 2002) or airline seats with a given, perishable capacity (Anjos et al. 2004) with the example of American Airlines to introduce first yield management to better manage profit and airline seat utilization (Smith et al. 1992). Revenue management developed since the late 1970s with the deregulation of the airline industries until web-based pricing mechanisms used in e-commerce applications starting in the 1990s (Phillips 1999, p. 2; Boyd/Bilegan 2003).

Revenue management uses computer-automated pricing mechanisms that support a differentiated pricing for the same product considering utilization and product timing, e.g. different prices for the same hotel room during the week or at the week-end. Pricing mechanisms are based on an analysis of demand patterns in order to ensure that available capacities are sold out in the most profitable way. Current studies reveal that the importance of revenue management as specific demand management concept in the German chemical industry has increased in order to utilize better excess capacities (N.N. 2005d).

Cross formulates basic principles of revenue management (Cross 2001, p. 69):

- When balancing demand and supply does not concentrate on costs but on price
- Replace cost-oriented pricing by market-oriented pricing
- Do not sell to mass markets but to segmented micro-markets
- Reserve your products for your best customers
- Make decisions not based on assumptions but based on facts
- Continuously analyze the value cycle of each product
- Continuously re-evaluate profitability opportunities

Revenue management is not a phrase-based management concept but a discipline based on quantitative methods such as statistics, simulation and optimization as well as systems including steps for data collection, estimation and forecasting, optimization and sales control (Cross 2001, pp. 17-18).

Dedicated revenue management systems are increasingly developed to be applied in airline and non-airline industries (Secomandi et al. 2002). For several recently developed revenue management systems in airlines, hotels, car rentals, telecommunication systems and cargo transportation see Gosavi et al. (2007), Bartodziej et al. (2007), Lee at al. (2007), Defregger and Kuhn (2007), Reiner and Natter (2007). These papers focus on revenue maximization based on pricing and decisions to influence the demand for services such as airline seats, rental car capacity or hotel rooms, which are in limited supply. Active sales and pricing decisions investigated in revenue management are principally relevant for the industrial planning problem considered in this work. However, in contrast to service industries this study deals with physical products and the complex decision making process in a global chemical value chain.

Concluding, revenue management is concentrated on the demand management with a given capacity and supply: *"Revenue management can be thought of as the complement of supply-chain management (SCM), which addresses the supply decisions and processes of the firm, with the objective (typically) of lowering the cost of production and delivery"* (Tallury/Van Ryzin 2005, p. 2). Examples of management practice, where pricing and supply decisions such as lead times or capacities are explicitly linked, are few (Fleischmann et al. 2004, p. 11). Dell is a first example, where PC pricing is dynamically changed based on a production push principle to allocate PCs to the best-price business (McWilliams 2001).

An integrated management concept for the entire value chain from procurement to sales would require integration of both concepts of minimizing costs for supply and maximizing turnover for demand.

Conclusions: Demand-oriented Management Concepts

Up to now, demand management concepts have shared the focus on demand, sales and price decisions to maximize turnover based on a given supply. Supply volatility by volumes – for example due to reduced production or procurement quantities – and values – for example due to volatile procurement prices – is not considered as decision variable in demand management concepts. Authors like Flint (2004) address the challenges to bring marketing and global supply chain management together for customer benefit. But since specifically commodity products require an active sales and price management, the work has to consider the status of demand management concepts and to define the interface to supply-oriented management concepts.

2.2.3 Concepts to Manage Supply

The supply side of the value chain has been subject to research since the middle of the 20th century. The research field can be structured into logistics management, production management, procurement and sourcing, as well as supply chain management.

Logistics Management

Logistics originates in the 1950s motivated by logistic problems in the military sector to coordinate and manage material and personnel in military activities. Logistics can be defined as *"the process of planning, implementing and controlling the efficient, effective flow and storage of goods, services and related information from their point of origin to point of consumption for the purpose of conforming to customer requirements"*. Logistics objective is to allocate resources, like products, services and people, where they are needed and when they are desired (N.N. 2006f). Logistics can be differentiated into inbound logistics for purchased goods, production logistics in production, distribution logistics for finished goods and disposal and reverse logistics for recycled, returned or disposed goods as summarized in fig. 12 (Corsten/Gössinger 2001, p. 81; Günther/Tempelmeier 2003, p. 9):

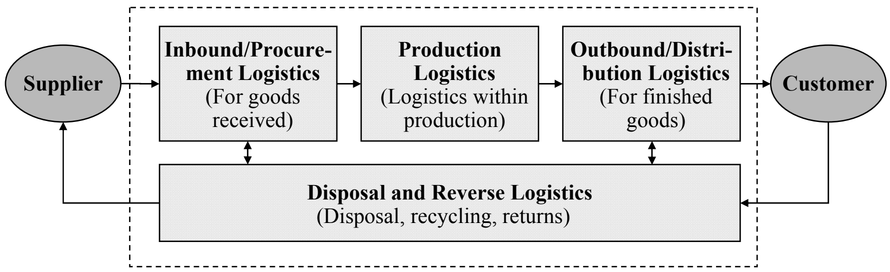

Fig. 12 Types of logistics

Characteristic is that logistics and logistic management are concentrated on the physical material flow in warehousing and transportation (Corsten/Gössinger 2001, p. 81). Logistic research investigates the management of physical material flow

- in warehousing: incl. warehouse layout planning, warehousing systems such as conveyer belts, automated guided vehicle systems (AGVS) as well as queuing, stocking systems, commissioning and packaging problems (Arnold 1995; Günther/Tempelmeier 2003, p. 9)
- in transportation: transport loading, transport routing and scheduling problems (Günther/Tempelmeier 2003, pp. 261-274)

Some authors have extended the scope of *logistics* and used the term *logistics management* comparable to the term *supply chain management* (Schönsleben 2004, p. 7): "*Logistics is defined as the organization, planning and realization of the entire flow of goods, data and information along the product lifecycle"* and *"logistics management has the objective* *to effectively and efficiently manage the daily intercompany and intracompany operations".*

In this book, logistics and logistics management is focused on the operative volume management in the physical distribution as part of the value chain. A clearer differentiation between logistics research targeting specialized logistic service providers for warehousing and transportation compared to supply chain management problems can be observed in recent literature (Baumgarten/Darkow et al. 2004; Günther et al. 2005).

Production Management

Production management is concentrated on management problems in industrial production. Industrial production is defined as "the creation of output goods (products) using material and immaterial input goods (production factors) based on technical processing methods" (Günther/Tempelmeier 2003, p. 6). Production is characterized by the transformation of input goods into output goods using resources such as machineries or assets as well as human resources as illustrated in fig. 13 (Günther/Tempelmeier 2003, p. 7).

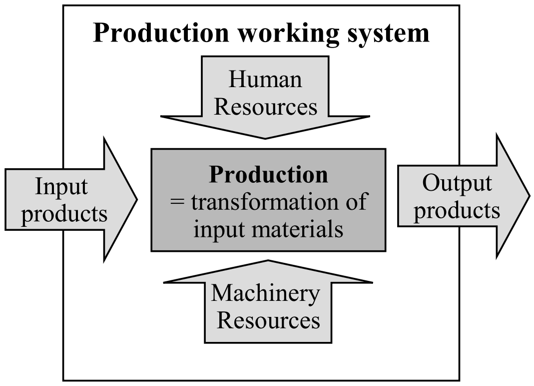

Fig. 13 Production working system structure

Production management concepts started in the 1960s and 1970s with the Material Requirement Planning (MRP I) and the Manufacturing Resource Planning (MRP II) concepts (see for example Günther/Tempelmeier 2003; Lütke Entrup 2005, pp. 5-9). The objective of MRP I was to determine the needs of orders for dependent components in production and raw materials using a bill-of-material explosion (BOM). MRP I hence supported a multi-level calculation of secondary demand for the orders, however, did not consider capacity constraints and did not include feedback loops. MRP II enhanced the concept towards integrated production planning across planning horizons from long term to short term and also between demand and production including feedback loops. Still criticism remains that the assumption of infinite capacity leads to infeasible plans. In addition, the focus of MRP II was transactional and operational for single production plans and not for the entire supply chain or value chain network. MRP I and MRP II are the basis for the evolution towards supply chain management (tools) and the so called Advanced Planning Systems (APS) as described later.

Procurement and Sourcing

Procurement and sourcing is investigated as a separate function (Large 2000; Humphreys et al. 2000; Chen et al. 2002; Talluri/Narasimhan 2004) or together with *materials (requirements) planning/management* (Dobler et al. 1977; Stadtler 2004b) or supply chain management (Melzer-Ridinger 2004; Monczka et al. 2004).

Procurement covers *„all company and/or market-oriented activities that have the purpose to make objects available to the company that are required but not produced"* (Large 2000, p. 2). Other terms found in the context of procurement are *strategic sourcing*, *purchasing, supply management* and/or *supplier relationship management*.

Two basic procurement functions exist: for resale or purchasing for consumption or conversion (Dobler et al. 1977, p. 4). Procurement is a core function of the business (Dobler et al. 1977, p. 5). Key objectives in procurement are to procure specified objects at a defined quality from suppliers, achieve cost savings and minimum prices for these objects and ensure continuous supply and foster joined innovations with suppliers based on contracts and a supplier relationship management.

Strategic sourcing, the centralization and strategic management of purchasing activities, is a primary cost saving lever for companies by bundling of purchasing volumes, consolidation of many to few suppliers and long contractual agreements for large volumes leading to increased economies of scale for selected supplier(s) and lower purchasing prices for the sourcing company (Talluri/Narasimhan 2004). Strategic sourcing also includes make or buy decisions, e.g. the outsourcing of non-core activities of the company to a specialized service provider (Humphreys et al. 2000). Procurement research also investigates efficient procurement processes and pricing mechanisms such as reverse auctions and/or marketplaces (Hartmann 2002). In addition, strategic alliances with suppliers and joined innovation processes help not only to minimize costs but also to jointly develop innovative products (A.T. Kearney 2004).

However, the local optimization in procurement can lead to goal conflicts with other areas in the value chain: long-term purchasing contracts with high volumes to reach minimum prices can reduce the flexibility in the value chain. Typical "battles" in the value chain are that the purchasing department has to fulfil volume commitments agreed with the supplier especially at the end of the year and purchases more raw material volume as required in the value chain. The effect is the build-up of unnecessary inventory and capital employed. Some authors postulate a strategic reorientation of procurement research towards a stronger cross-functional orientation in the value chain (van Weele/Rozemeijer 1996).

Supply Chain Management

Supply chain management is next step in supply-oriented concepts towards cross-functional processes with focus on production and distribution decisions. Main motivation for supply chain management was the bullwhip effect. The bullwhip effect was observed already in the 1950s and 1960s by the MIT: small changes in consumer demand led to significant variance in production and inventories on the following retailer and manufacturer steps of the supply chain (Alicke 2003, pp. 99-130). Time delays in information and material flows between the participants in the supply chain have been identified as main causes for the bullwhip (Corsten 2001, p. 87).

The bullwhip effect motivated research and practice to focus on cross-company supply chain optimization of information and material flows between companies. Several authors specify a set of objectives related to cross-company supply chain optimization:

- *"minimize total supply chain costs to meet given demand*" (Shapiro 2001, p. 8)
- *"reduce lead times, reduce inventories and increase delivery reliability with the overall objective to increase the service level for the end consumer and reduce costs across all value chain steps in the supply chain"* (Corsten 2001, p. 95)
- *"increase competitiveness of entire supply chains instead of single companies by fulfilling a pre-specified, generally accepted customer service level at minimum costs"* (Stadtler 2004a, p. 9)
- *"maximize the overall value generated"* (Chopra/Meindl 2004, p. 6). Besides, Chopra and Meindl point out that a supply chain should be measured by the entire profitability and not by the profitability of individual stages.

Most of the authors except Chopra/Meindl share the objective to minimize costs in the inter-company supply chain between companies with given demand and customer service level. Chopra/Meindl support the objective of value maximization, where it is later proposed to distinguish this objective with the term "*value chain management*".

Definitions for *supply chain management* reflect these objectives. The term *supply chain management* was first created by Oliver and Webber (1982). Since then, various definitions in literature can be found:

- supply chain management is the "*flow of material, information and fund across the entire supply chain, from procurement to production to final distribution to the consumer"* (Silver et al. 1998)
- supply chain management can be defined as *"the integrated planning, coordination and control of all material and information flows in the supply chain to deliver superior consumer value at less cost to the supply chain as a whole whilst satisfying requirements of other stakeholders in the supply chain"* (reviewed by Lütke Entrup 2005, based on van der Vorst 2000)
- Mentzer et al. reviewed SCM definitions and concluded three shared characteristics of SCM definitions as a management philosophy (Mentzer et al. 2001, p. 6):
- "*a system approach viewing supply chain as a whole and to manage the total flow of goods inventory from the supplier to the ultimate customer;*
- *a strategic orientation toward cooperative efforts to synchronize and converge intra-firm and inter-firm operational and strategic capabilities into a unified whole; and*
- *a customer focus to create unique and individualized sources of customer value, leading to customer satisfaction"*
- supply chain management *"involves the management of flows between and among stages in a supply chain to maximize total supply chain profitability"* (Chopra/Meindl 2004, p. 6).

Except of the latest definition of Chopra/Meindl, all definitions share the aspect of cross-company management, the focus on volume management to fulfil customer needs.

Significant savings could have been realized in practice thanks to supply chain management for example minimizing inventory values by postponing final assembly to the latest stage of the supply chain as in the case of Hewlett-Packard (Lee/Billington 1980), by improving delivery accuracy to nearly 100% as in the case of Ericsson (Frerichs 1999) and better utilizing production resources. Several key supply chain management research results are presented in the following in more detail.

Supply Chain Planning Matrix: the Supply Chain Planning (SCP) Matrix provides a framework for supply chain management (Rohde et al. 2000, reviewed among others by Fleischmann et al. 2004, pp. 87-92) illustrated in fig. 14.

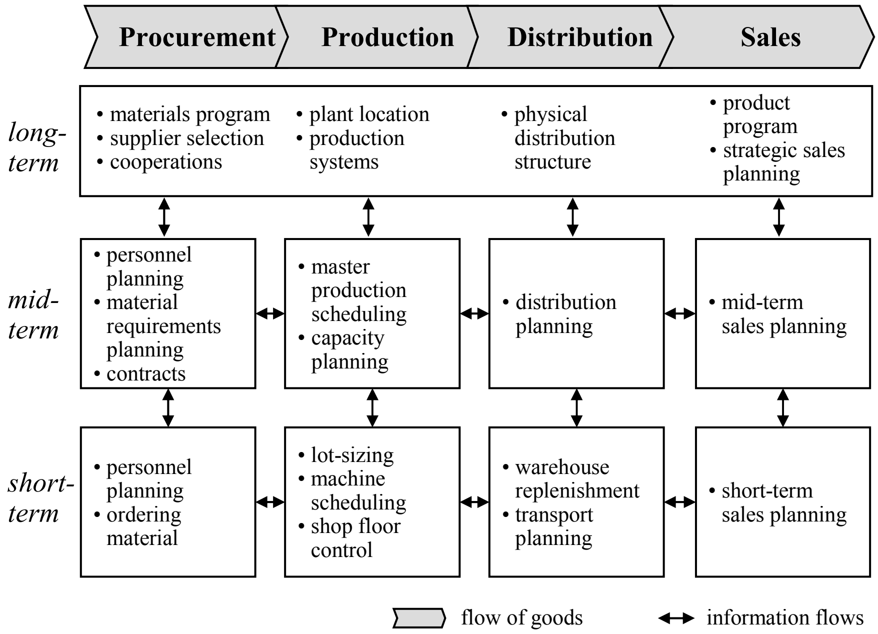

Fig. 14 Supply chain planning matrix

The supply chain planning matrix provides an integrated management framework by planning horizon (strategic, tactical and operative) and supply chain process (Fleischmann et al. 2004, pp. 87). Strategic decisions are related to plant locations or physical distribution centers also called strategic network planning or network design (Goetschalckx 2004). Tactical decisions are related to planning of volumes in sales, distribution, production and procurement also called master planning (Miller 2002; Rohde/Wagner 2004; Pibernik/Sucky 2005). Short-term decisions are related to short-term planning and scheduling of production. This operative and transactional level is related to the traditional focus of logistics and/or MRP I and MRP II concepts. Overall the supply chain planning matrix is related to the term *advanced planning* emphasizing and enhancement of planning not only on the operative level but also on a tactical and strategic level. Hence, a primary research area is related to advanced planning systems (APS) support advanced planning processes.

Advanced Planning Systems: information systems in supply chain management play a critical role to support companies effectively in decision making, handling complex supply chain problems and data (Gunasekaran/Ngai 2004). APS research focuses on the planning systems extending the scope of traditional ERP systems limited to operations

(Bartsch/Bickenbach 2002; Knolmayer/Mertens et al. 2002; Dickersbach 2004; Günther 2005). While ERP systems focus on the operational and transactional level of order processing and scheduling as well as on-line inventory control (Mandal/Gunasekaran 2002), APS are used specifically for demand and supply network planning and integration of production planning and production scheduling (Betge/Leisten 2005). APS are subject to dedicated research evaluating capabilities of developed software packages (Zeier 2002; Lütke Entrup 2005). Key research deliverable is the mapping of APS software modules to the supply chain planning matrix as shown in fig. 15 (Meyer et al. 2004, pp. 110):

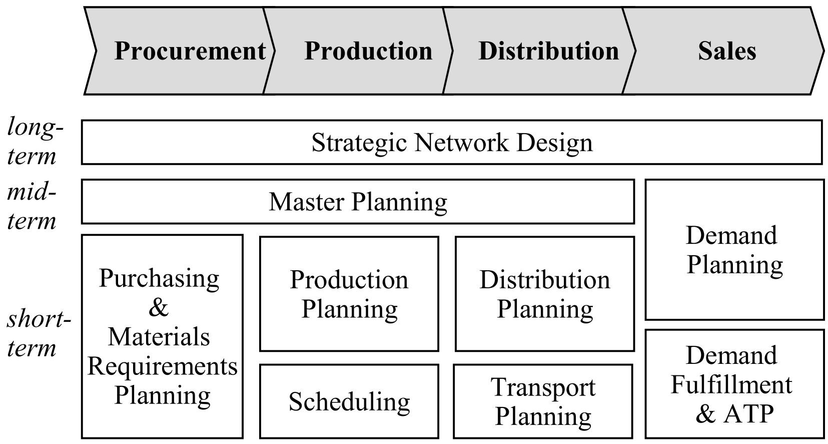

Fig. 15 APS software modules covering the SCP-Matrix

Here, it can bee seen that system modules are not directly matched to process structures defined in the Supply Chain Planning Matrix. Also, the asymmetry between market facing parts of procurement and sales are not intuitive. However, APS extend the perspective on business applications extending the classical tasks of ERP and transactional systems to a management and planning level. With APS implemented in multiple industries and validated specifically in the process industry (Schaub/Zeier 2003) or also for Small and Medium Enterprises (SME) (Friedrich 2000), importance will further grow.

Supply Chain Collaboration and Negotiation: since supply chain management across companies is a key objective, several authors focus on the management of the interface and collaboration between company supply chains towards a cross-industry supply chain: the idea is that a collaboration between all companies from natural resource (e.g. metals) to end consumer product (e.g. cars) can lead to lower inventories, lowest costs and highest efficiency (Zimmer 2001; Hieber 2001). This cross-company supply chain managements requires a transparent sharing of available inventories, capacities and demand across all companies. Prices and value aspects are not relevant in this view. This is build on the assumption

- that no competition in supply chain between multiple customers for a limited supplier capacity exists,
- no conflict of interests between buyers and sellers in negotiation exists,
- and market constellations and purchasing powers have no influence on the collaboration e.g. large OEM corporations would not use their purchasing power to achieve minimum prices at their SME suppliers.

Main results are negotiation protocols, collaboration rules and collaboration forms to coordinate multiple companies in an inter-company supply chain. However, it is shown that the ideal world is hard to achieve in practice. "*It is difficult or maybe even impossible, to get a large network consisting of independent companies to agree and implement a centralized planning and control solution*" (Holström et al. 2002, reviewed by Pibernick/Sucky 2005, pp. 77). Companies are not always willing to open the books entirely and share company-internal information e.g. inventories, capacities or cost structures with customers and suppliers in order to protect competitive information. Power in the supply chain for example in the automotive industry with few large OEMs and many mid-size tier suppliers do have an influence on negotiations as well as profitability for the single participants in the supply chain (Maloni/Benton 1999). Recent authors recognize the aspect that companies rather negotiate in a competitive constellation than cooperating with its business partners and propose appropriate negotiation protocols (Homburg/Schneeweiss 2000; Dudek 2004). Since a centralized planning task for the entire intercompany supply chain comprising multiple legal entities is rarely realistic in practice, Dudek has developed a non-hierarchical negotiation-based scheme to synchronize plans between two independent supply chain partners with offers and counter-proposals to minimize total costs; prices and competition among limited supply is not considered (Dudek/Stadtler 2005).

Special SCM Concepts: in addition, some industry-specific terms have been developed in the context of supply chain management in the last years:

- *Just In Time (JIT):* time-exact delivery to the customer's production having no own inventory (specifically practiced in the automotive industry).

- *Vendor Managed Inventory (VMI):* supplier manages the inventory at the customer site to ensure delivery capability (practiced among others in the chemical and electronic industry)
- *Efficient Consumer Response (ECR)* and *Collaborative Planning, Forecasting and Replenishment (CPFR):* both are operations models in the consumer goods industry to ensure delivery capability and avoid stock-outs based on an automated replenishment of outlets using product inventory, historic and/or planned sales information at the point-of-sales (POS). CPFR focuses on a close cooperation between retailer and manufacturer. ECR focus on the customer-facing reaction on customer responses in logistics, sales and promotions.

All concepts can be related to the supply chain planning matrix; most of them are a re-branded description of short-term and operative supply chain planning problems. Concluding, SCM reached the highest level of cross-functional and cross-company orientation of management concepts in the value chain with the emphasis on supply.

Conclusions: Supply-oriented Management Concepts

Supply-oriented concepts have in common to minimize supply costs in order to fulfil given demand. Sales prices and sales quantity decisions are not subjects of research. Supply-oriented research with its definitions and frameworks contributes to main parts of the work's theoretical background. The study needs to combine the research results with management concepts focusing on demand and on values.

2.2.4 Concepts Comparison

Comparing the presented management concepts in the value chain it can be concluded that concepts focus either on values or volumes and/or certain steps in the value chain as illustrated in fig. 16.

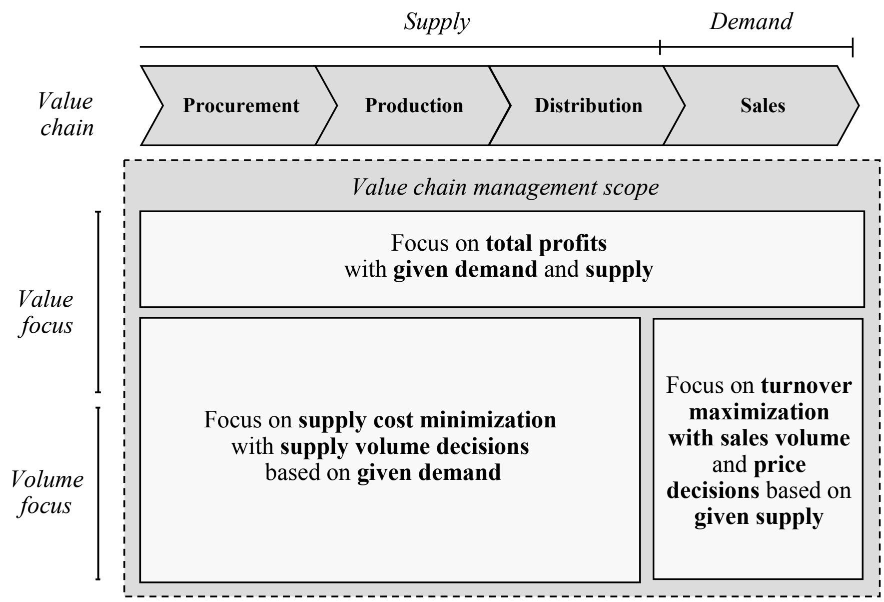

Fig. 16 Comparison of management concepts in the value chain

- Supply management concepts focus on supply decisions in order to minimize costs with a given demand
- Demand management concepts focus on sales volume and price decisions to maximize turnover based on a given and/or unlimited supply
- Value management concepts focus on total profit analysis with given demand and supply

There is a lack of having an integrated concept of managing volumes and values across the entire value chain. The specialized concepts with focus either on demand and supply decisions or on value analysis have to be combined to an integrated approach. This integrated approach is required to manage a global commodity value chain end-to-end by values and volumes.

Some authors already postulate to extend the focus of supply chain management towards integration with demand management and in some parts with value management

- to coordinate purchasing and production with customers by using quantity discounts on both ends of the value chain to decrease costs (Munson/Rosenblatt 2001),

- to integrate logistics into marketing to successfully manage different channels in the consumer goods and retail sector (Alvarado/Kotzab 2001),
- to decide supply chain positioning in a global context driven by demand rather than by production (Sen et al. 2004),
- to integrate supply chain and pricing decisions in Marketing (Christopher/Gattorna 2005),
- to tailor customer experiences to increase customer loyalty and growth by synchronizing supply chain and marketing decisions (Pyke/Johnson 2005),
- to synchronize manufacturing, inventory and sales promotions specifically in industries with seasonal demand (Karmarkar/Lele 2005),
- to synchronize procurement, manufacturing with sales pricing considering specifics such as perishable items, setup costs and demand uncertainty (Yano/Gilbert 2005),
- to synchronize new product development with the supply base (Asgekar 2004),
- to decide integrated financial planning and evaluation of market opportunities with production planning using real options (Gupta/Maranas 2004).

Some scholars suggested using *demand chain management* instead of SCM (Williams et al. 2002; Heikkilä 2002) expressing to shift the focus of the chain towards demand incl. (prospective) customers (Van Landeghem/Vanmaele 2002) and the needs of the marketplace, *before* integrating the supplier and manufacturer perspective. Specifically, time-to-market pressure requires to better link product development, sourcing and sales driving the focus shift towards the ends of the value chain in procurement and sales (Kennedy Information 2005). This shift is suitable for demand-driven industries with a flexible and less cost-intensive supply as in the case of mobile devices described by Heikkilä (2002) or lightning manufacturing (Childerhouse et al. 2002). The shift from supply chain towards demand management can be also observed in spending for supporting SCM software where understanding end-user demand became key priority instead of operations efficiency (Frontline Solutions 2005 reviewing an AMR Research "Supply Chain Management Spending Report 2005-2006").

However, a focus shift from supply to demand would again not consider the overall profitability of the value chain leaving out supply volumes and values supply specifically in procurement. Concluding, a focus on either demand or supply is not sufficient and both have to be managed in an integrated way together with the resulting values. Therefore, the different management concepts have to be combined in an integrated value chain management framework and approach.

2.3 Integrated Value Chain Management

In the following integrated value chain management is defined and a framework is developed as synthesis of management concepts presented in subchapter 2.2. Key methods used in value chain management such as optimization or simulation are presented at the end of the chapter.

2.3.1 Value Chain Management Definition and Framework

Having defined the *value chain*, Porter does not provide a definition for *value chain management* (Porter 1985). The term *value chain management* is used in recent research (McGuffog/Wadsley 1999; Teich 2002; Jörns 2004; Kaeseler 2004; Al-Mudimigh et al. 2004) and in industry practice (Trombly 2000; Harvard Business Review 2000; bitpipe 2007) compared to Porter's initial publishing on the value chain. In addition, a recent dedicated journal "International Journal of Value Chain Management" has been launched (Inderscience 2007).

Teich (2002) provides a comprehensive work on *"extended value chain management"*. He defines *Extended Value Chain Management (EVCM)* as *"the holistic consideration of the value chain where starting at the customer and depending on the situation in production and procurement orders are generated at the same time under consideration of previous production steps"* (Teich 2002, p. 2). He argues "*that previous isolated concepts focused either on advanced planning and scheduling in production or on supply chain management for procurement planning*" (Teich 2002, p. 2). Teich's definition of value chain management covers procurement and production aspects with focus on volumes and schedules. Value in the value chain as a consideration of sales and prices are not covered in the definition. His focus is rather the cooperation of different *competence cells* within a value chain network specifically for small and medium enterprises to improve overall value chain network planning. The concept is used by some authors e.g. to automate finding and negotiations of suppliers within a pool of competence cells (Neubert et al. 2004, p. 177)

Kaeseler provides a more comprehensive definition of value chain management from a consumer goods industry perspective (Kaeseler 2004, pp. 228-229). *Value Chain Management* is an essence of *Supply Chain Man-*

agement and *Efficient Consumer Response (ECR)* with SCM as a *"renaissance of production and logistics planning"* and ECR as *"customer orientation and marketing in retail"*. To overcome the separation of these concepts, Kaeseler proposes Value Chain Management as a *"holistic redesign of processes from the retail customer to purchasing from the manufacturer including Sales, Marketing, Logistics, Production and Purchasing"* (Kaeseler 2004, pp. 229). However, Kaeseler limits the concept on the *volume* management problems in the value chain e.g. avoidance of the bullwhip effect, planning of seasonal demand as well as managing returns and variants in the product portfolio. The *value* management aspect is not covered including purchase and sales prices.

Jörns describes *Value Chain Management* as a superset of the management concepts SCM, *Supplier Relationship Management* (SRM), *Customer Relationship Management* (CRM) and *Enterprise Management.* This perspective reflects a broader scope of VCM compared to SCM without providing an integrated framework (Jörns 2004, pp. 35-36).

Practice-oriented articles as from Trombly (2000) formulate the objective of value chain management to be *"full and seamless interaction among all members of the chain, resulting in lower inventories, higher customer satisfaction and shorter time to market"*. Public websites offer additional definitions for value chain management such as *"the optimization of value chain interactions. Each internal and external operation and the links between these operations are reviewed in a systematic and standard way in order to optimize speed, certainty and cost effectiveness"* (bitpipe 2007). Again the term *"value chain management"* is used in practice mirroring objectives, content and concepts already addressed in supply chain management.

Al-Mudimigh et al. (2004) are among the few authors distinguishing between *supply chain management (SCM)* and *value chain management (VCM)*: they argue that SCM is recognized and practiced in many industries and has reached high popularity "*becoming a way of improving competitiveness by reducing uncertainty and enhancing customer service"*. For VCM in comparison so far "*there is little evidence of the development of an accompanying theory in literature"*. They propose a VCM model from suppliers to end-user in order to "*reduce defects in inventories, reduce the processed time to market and improve customer satisfaction"*. The VCM concept is centered on the value for the customer with four pillars: VCM vision, process management, partnership approach, IT integrated infrastructure and agility and speed. They argue for a broader perspective on the value chain, however, conclude with similar results and concepts compared already in SCM to focus on collaboration and customer service. Aspects of quantitative value-added and volumes and value management throughout a value chain from sales to procurement are not considered.

Concluding, existing definitions use *value chain management* as alternative term for *supply chain management* focusing on supply volume decisions to fulfil a given demand and minimize costs. Especially, value and sales decisions are not covered in an integrated framework.

To continue, an appropriate definition of integrated value chain management has to combine the characteristics of simultaneously managing volumes and values throughout the entire value chain in order to ensure companies' profitability. Therefore, value chain management has to be defined in this work.

> Value chain management is the integration of
> demand, supply and value decisions from sales to procurement
> using strategy, planning and operational processes.

This value chain management definition relies on a three-level structure for strategic, tactical and operative company control introduced by Anthony (1965) and used in controlling and supply chain management literature (Rohde et al. 2000).

The key aspect is *integration* of decisions on each level across the company value chain with the defined interfaces to suppliers and customers. But why integrate decisions within the value chain? Why strategic supplier and procured product prices and volume decisions should for example be integrated with sales price or market strategy decisions? The answer is simple: to achieve a *global optimum* in the value chain instead of a *local optimum* in only one area of the value chain. A company for example can reach a local optimum in procurement negotiating very low raw material prices for high fixed contracts volumes. This local optimum will not lead to a global optimum, if sales volumes are more volatile and fixed procured raw material remains as excess inventory on stock. A company targeting a local optimum in distribution minimizes inventory and capital costs leading to lost sales or limited capabilities to hedge risk of volatile raw material prices with inventories and hence no global optimum in overall value. Shapiro et al. support the idea of having one optimum in the value chain stating that a value chain is a *"single mathematical model with an optimal solution"* (Shapiro et al. 1993 reviewed by Schuster et al. 2000).

Integrated decisions also require *simultaneous* decision making instead of iterative or even isolated decision making. Fulfilment of this postulation was nearly impossible to achieve in former years without real-time information technology and decision support methods. Thanks to information technology and operations research method advances, the objective to synchronize decisions in real-time even in larger organizations is feasible today.

The new aspect in *value chain management* becomes clear comparing it to a quotation of Alan Greenspan related to better management of *supply chains*: *"New technologies for supply chain management and flexible manufacturing imply that business can perceive imbalances in inventories at an early stage – virtually in real time – and can cut production promptly in response to the developing signs of unintended inventory build up"*[2] (Datta/Betts et al. 2004, p. 4). Compared to this postulated direction of supply chain management to increase production flexibility in order to follow volatile demand and suppliers (Aprile et al. 2005), value chain management heads for an opposite direction: it is not about fully increasing production flexibility and responsiveness in production to avoid inventories; it is about better stabilizing production utilization by better integrating value and volume decisions in procurement and sales.

The value chain management concept is detailed in a framework being presented in fig. 17.

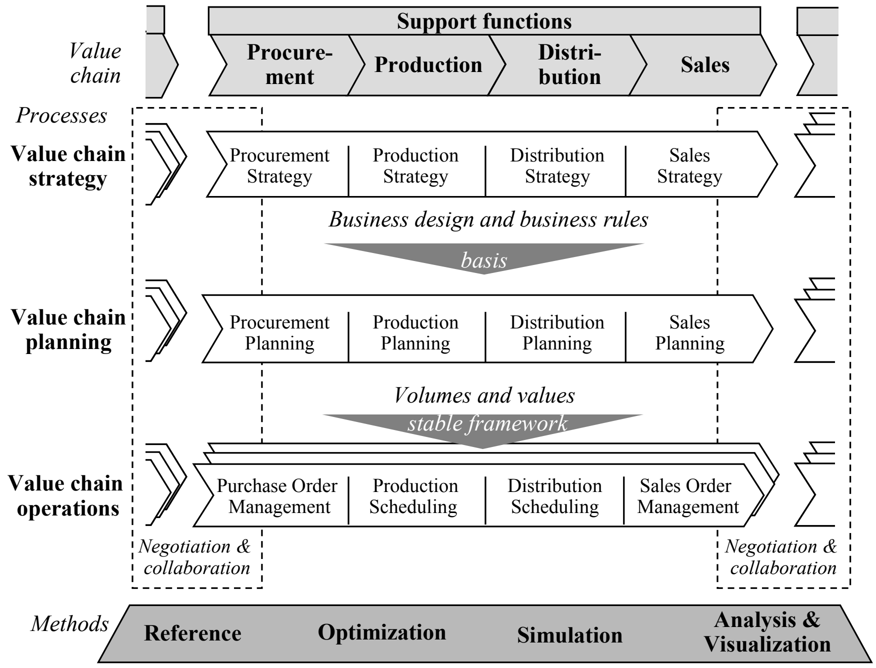

Fig. 17 Value chain management framework

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[2] Alan Greenspan Testimony to the U.S. Senate Committee on Banking, Housing and Urban Affairs, 13. February 2001.

The framework is mainly based on the supply chain management framework of Rohde et al. (2000). Rohde's work is gradually enhanced to address the aspects of synchronized decision making within the value chain and the integration of supply, demand and value management concepts as shown in fig. 17. The framework is structured into the areas *value chain*, *processes and methods.*

The area *value chain* provides the framework structure by procurement, production, distribution and sales. The framework requires having these steps under a central control; typically, this is a company organization with clear interfaces to customer and supplier organizations. The framework supports the idea of having a network of individually managed value chains interacting with each other based on clearly defined interfaces and legal agreements. The framework does not support the idea towards one cross-company industry value chain, where individual companies cooperate and share e.g. plans, inventories and value results transparently based on an agreed central planning control authority. This would assume having only a situation of collaboration between companies without considering competitive and negotiation elements in company relations such as request for proposal processes, multi-sourcing or price and service negotiations to name a few.

Value chain *processes* are differentiated into strategy, planning and operations according to the structure proposed by Anthony (1965), pp. 15-18. The strategy, planning and operations processes are further detailed in section 2.3.2.

Different *methods* are applied in the value chain management processes for decision support. Reference, optimization, simulation and analysis and visualization methods are distinguished as further detailed in section 2.3.3.

2.3.2 Value Chain Strategy, Planning and Operations

The value chain management processes are presented in a process overview initially and then further detailed with respect to process characteristics and compared within the framework.

Value Chain Strategy

Value chain strategy focuses on synchronized decision on business design and business rules in the value chain as summarized in the following definition.

Value chain strategy is the integration of business design and business rule decisions in the value chain.

Business design comprises traditional company network design decisions on production and distribution sites or production resource capacity design. The term *business design* also includes market strategy decisions in sales and procurement as well as product strategy and life cycle decisions. Shapiro criticizes in supply chain strategy studies that these are often too narrowly defined not covering the company strategy as a whole (Shapiro 2004, pp. 855-856).

Business rules define upper and lower boundaries and service levels agreed in contracts or given by physical structures of the value chain. The objective is to integrate business design and business rule decisions throughout the global value chain network already on the strategic level to enable global value optima in planning and operations. The scope of the value chain strategy is illustrated in fig. 18.

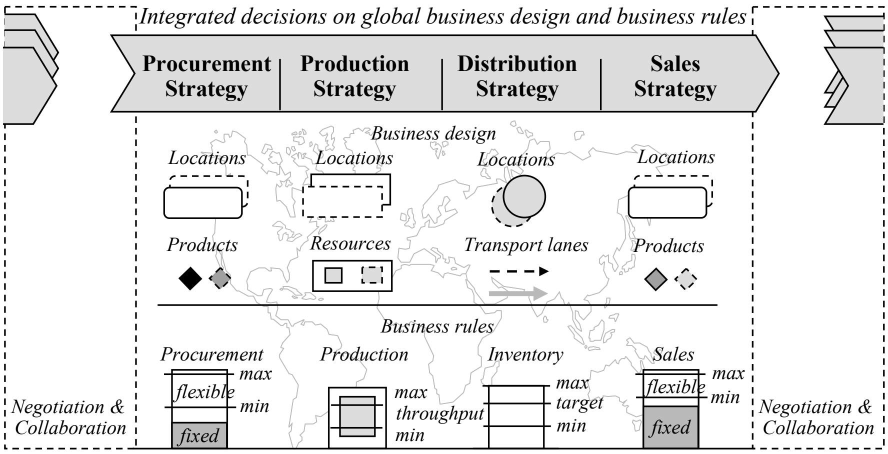

Fig. 18 Value chain strategy

The *sales strategy* needs to decide what product to be sold in which sales market representing the sales location in the value chain network. New markets needs to be evaluated for their attractiveness and the own competitive position with respect to existing products or the capabilities in the development of new products for the respective demand. Sales business rules include decisions on the strategic share of contracted business volumes vs. flexible spot business volumes. These business rules often depend on sales channels and frame contracts with customers. The sales strategy can be matched with classical marketing mix decisions on products, prices, promotion and communication, as well as sales channel decisions.

The *distribution strategy* needs to support the sales strategy in distribution location and transportation design decisions specifically to balance the market requirements of lead times and delivery capability with distribution costs. Examples for distribution strategy projects are regularly found in practice specifically when restructuring a comprehensive distribution network (Sery et al. 2001). Hence, distribution business rules are mainly related to inventory and transportation boundaries effecting the delivery service and support of sales strategies.

The *production strategy* is the most investment-critical decision affecting the opening of new production sites and specifically investments and divestments in resource capacities and technologies. The production strategy is mainly covered by typical supply chain network design models focusing on production site and resource network design decisions (Lakhal et al. 2001). Production business rules are related to the flexibility of the resources with terms of throughputs, multi-purpose capabilities or changeovers to name a few.

The *procurement strategy* needs to decide strategic sourcing regions and suppliers as well as strategic raw materials and products included in current and also new products. Request for proposal (RFP) and reverse auction processes as well as contract negotiations are key elements of the strategic sourcing process. As a mirror compared to the sales strategy, again the company needs to decide, how much volume is procured based on fixed contracts and much volume flexibility is required in order to benefit from lower prices or to reduce the risk not to be able to sell the corresponding volumes of finished products. Procurement strategies in large corporations are often coordinated by a corporate procurement unit in order to bundle corporate-wide volumes for shared products to achieve better prices.

As already mentioned, *negotiation and collaboration* in value chain strategy is firstly related to contract negotiations with customer and suppliers to agree on business rules. Secondly, acquisitions and divestitures – representing a network change in the company value chain network – are important areas of negotiation and collaboration. Thirdly, joined product strategies and development with customers and suppliers – e.g. agreeing on specifications and standards – are important areas of negotiation and collaboration.

Value Chain Planning

Value chain planning is defined in the following.

> Value chain planning is the integration of volume and value decisions in the value chain based on the value chain strategy.

Volume and values in the defined business design with the given business rules are optimized jointly in sales, distribution, production and procurement plans as illustrated in fig. 19.

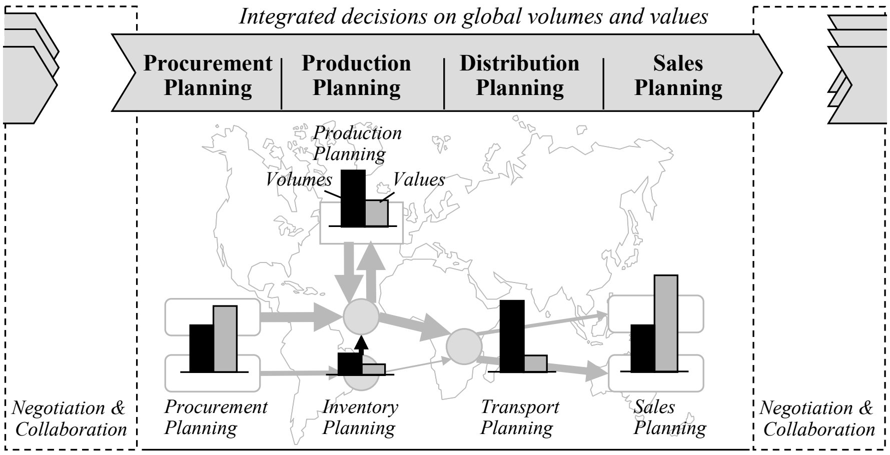

Fig. 19 Value chain planning

Volume and values in all global network nodes are planned as well as the transportation volumes and values between the nodes. Main difference compared to traditional supply chain and master planning approaches is the joined planning of volumes and values throughout the global value chain network with the intention to manage the overall profitability of the company ex-ante based on planned volumes and values for the chosen planning buckets e.g. months. Specifically, the integration of sales volume and price planning with supply planning decisions is an aspect in the value chain planning process different to traditional supply planning as shown in fig. 20.

- Demand is forecasted with price and quantity in a first step and aggregated to a total demand volume with an average price.
- Then, consolidated demand is matched with available supply by volume and value. If demand exceeds supply, sales volumes needs to be lower than the supply. If demand is not profitable since prices are too low in selective businesses, the company also reduces sales volumes where possible to ensure profitability.
- Result is a sales plan to be disaggregated on the individual customer basis. Sales volumes different to demand volumes are possible if sales flexibility in spot businesses exists compared to sales contracts that need to be fulfilled.

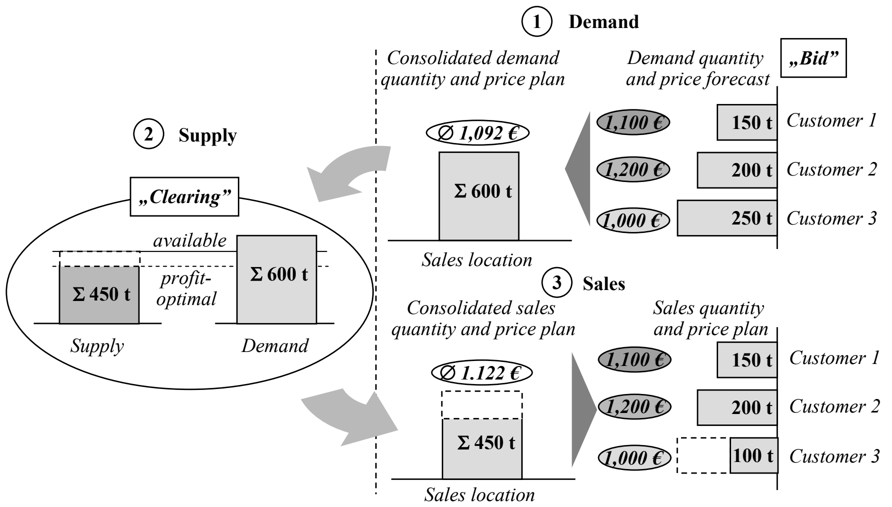

Fig. 20 Integration of sales and supply decisions in the value chain

In this case, the aggregate average sales price increases due to the reduced volumes, since low-price spot customers are rejected. Thinking one step ahead, this sales planning process has many similarities to auction and financial market clearing processes: the demand forecast of the customers has the character of an *ask bid.* The volume and price clearing mechanism is not based on multiple *offers* as in double auctions or many-to-many exchanges, but is comparable to single-sided auctions. Multiple customers compete among a single product supply of the company. The company uses the competition to utilize supply in a profitable way. The result is – again similar to financial markets – that demand forecast bid not fulfilling the clearing conditions are not successful and not supplied.

Distribution planning covers planning of inventories and transportation volumes and values. Both needs to comply with volume boundaries from the value chain strategy to ensure delivery capability and comply with structural and delivery constraints. Distribution planning is one core competence for retailers focusing on buying, distributing and selling without having own production.

Production planning decides on production volumes and values by site and production resource. Production planning normally considers total volumes only, while production scheduling in operations decides on the respective schedule. However, cases exist where production lead times and change-over constraints may require also considering the sequence of products in production master planning.

Procurement planning, finally, decides on spot and contract procurement volumes and values based on the negotiated and/or offered market respectively supplier prices. Procurement planning is based on the sourcing strategy and frame contracts agreed with suppliers. Here, the discrepancy between local optima and the global optimum in the value chain often gets transparent: procurement tends to bundle volumes in fixed contracts to minimize procurement costs. This can lead to the situation that volumes are not consumed due to a lack of sales; however, the company must take the material leading to high and undesired inventories especially at the end of the year.

Negotiation and collaboration in planning is a key aspect of recent research. The negotiation aspect may be less formalized since main negotiations of frame contracts already happened on the strategic level. However, contracts can also be and become more short-term in case of increasingly volatile prices and markets. Here, negotiations specifically on prices and volumes can become integral part of the planning process. If an agreement is achieved, collaborative planning focuses on exchanging planning information to improve planning quality to jointly lower inventory and ensure delivery service. Collaborative planning requires a further integration of planning processes with respect to organization, process and information technologies.

Overall the integrated planning of volumes and values in the value chain planning process continuously reacts on changes on procurement and sales markets and ensures ex-ante the profitability of the company. Therefore, limited supply chain planning processes further evolve by integrating procurement and sales volume and value planning into the process. The company value chains transforms into a marketplace where the company operates as market maker clearing supplier offering in procurement with customer demand in sales through the value chain. This recognition is an interesting change of perspective on the role of large industry companies with many suppliers and many customers: these companies do not have to participate in marketplaces hosted by third party providers but they have a large marketplace already inside their company with suppliers and customers participating.

Value Chain Operations

The volume and value plan is the stable framework for value chain operations as formulated in the following definition.

Value chain operation is the integration of order schedule decisions in the value chain based on the value chain plan.

Customer order schedules need to be integrated with deliveries, production orders and procurement orders. Volumes and values are already defined. Therefore, the focus is on a time schedule of orders considering production and distribution lead times. Fig. 21 illustrates the main task in value chain operations also now focused on a geographical region such as Europe. The individual schedules of sales orders and purchase orders have to be integrated with distribution and production schedules.

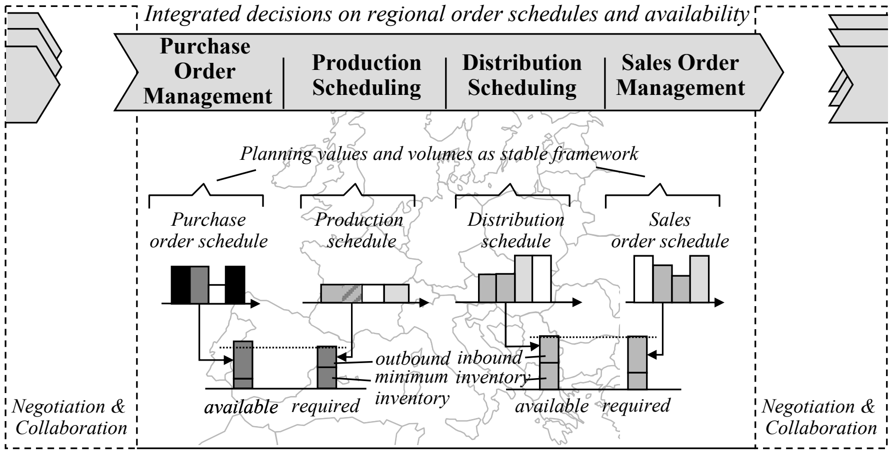

Fig. 21 Value chain operations

The purchase orders, sales and distribution order quantities can be higher or lower each day depending on the available number of transportation units e.g. trucks or ships. The production quantity, however, each day is limited by production capacity and cannot be so easily changed day-by-day. These different volume structures need to be matched by integrating order schedules and availabilities of materials.

Sales order management deals with order entry, order change, availability check and confirmations to the customer. Availability check as a concept and as part of Advanced Planning Systems (APS) is also summarized under the term *Available-To-Promise* (Kilger/Schneeweiss 2004; Pibernick 2005). The availability has to be checked against the sales plan as stable framework for the overall period and the physically available material at the specific point in time.

Distribution scheduling covers warehouse scheduling incl. picking and packing as well as transport scheduling. Transportation route optimization and bundling of transportation volumes have to match the customer order schedule.

Production scheduling of resources and detailed production orders as well as change-overs and throughputs is one of the most challenging problems specifically when multi-purpose resources and production changes have to be considered. Production scheduling can be decoupled from orders using inventories and make-to-stock production.

Purchase order management needs to ensure stable replenishment with raw materials or other procured products for production or trading purpose executing negotiated contracts or spot plans.

Negotiation and collaboration in value chain operations is focused on electronic and automated exchange of orders and further business documents like as invoices, quality certificates or delivery documents using electronic shops, portals or marketplaces.

Special concepts such as VMI or CPFR share the characteristic to be volume and supply-focused as in supply chain management. Although the terms may differ, the detailed processes and tasks match the overall value chain management framework, since the anatomy of the value chain is considered not to be different.

Process Characteristics and Comparison

The processes can be further systematized and compared by process level, decision supported, time buckets, planning horizon, frequency and granularity (s. table 5).

Table 5 Value chain management process characteristics and attributes

Characteristic	Strategy	Planning	Operations
Level	Strategic	Tactical	Operative
Decision	Business design Business rules	Volumes Values	Schedule
Time bucket	Year, quarter	Month, week	Day, real time
Horizon	Years (1-10)	Months (1-12)	Days (1-90)
Frequency	Yearly, quarterly	Monthly, weekly	Daily, continuously
Granularity	High aggregation	Medium aggregation	Detailed

The *value chain strategy* process focuses on long-term strategic business design and business rule decisions. Decisions are based on yearly and quarterly buckets with a horizon of multiple years. This process is conducted or updated yearly with a new or an updated strategy; in case of very dynamic markets, a review could also be quarterly. In decision making a high aggregation level is used not focusing on single customers or articles but rather entire markets and product lines or technologies.

In comparison, the *value chain planning* process is the bridge between the strategic and the operative level deciding all volumes and values in the network. The planning process is conducted by default on a monthly basis, in businesses with short manufacturing lead times also on a weekly basis. Decisions are based on monthly respectively weekly buckets for the next 1 to 12 months at a medium aggregation level. The volume and value decision has to be made on the tactical level. The long horizon of the strategy process does not allow predicting the future volumes and values exactly being influenced by many internal and external factors like raw material prices, changes in demand patterns or geopolitical factors or natural catastrophes. The short horizon on the operations level does not allow a stable volume and value plan, since geographical distances and production resources structure have limited flexibility to react on short-term order scheduling.

Operations processes are on the operative level focusing on order scheduling for a specific day or point in time. The schedules have a shorter horizon than the planning processes focusing on days. The schedule is monitored and updated continuously – daily to weekly. Orders are managed on the most detailed level for single customer respectively suppliers and articles.

Key framework characteristic is the linkage between strategy, planning and operations: the strategy process defines the network to be planned as well as business rules to be considered as constraints in planning. Agreed volume and value plans are the stable framework for operations schedule requiring participants to meet the agreed plans. It is important to mention that decisions are clearly associated only to one process. For example, annual budget plans of volumes and values often are used for individual or organizational target setting. Given the strategic character, these volumes should support business rules or business design decisions e.g. investment decisions in locations or production resources as well as market entry strategies or strategic alliances with suppliers, but they are less suitable for target setting specifically when operating in a volatile business environment. Therefore, actual volume and value decisions as well as target setting should be made in the tactical planning process. Same is true for operations, where it is not be the objective to optimize the overall *volumes* but the *schedule* of already agreed volumes and values in the plan. This is often a complex operations research problem, however, the volume and value optimization potential and degree of freedom is given by the plan.

As shown in the framework, there is *one* strategy and *one* planning process as well as *multiple* operations processes for volumes and values.

Typically, multiple functions-oriented processes can be found, where the same volumes and values are planned several times from different perspectives. Here, all functional units in sales, controlling, marketing, supply chain management, logistics, production and procurement should agree on *one* strategy and *one* planning process. Theses processes interact with the respective *multiple* processes of *multiple* customers and *multiple* suppliers. This is also important to mention, since collaborative supply chain management concepts often rely on the assumption that the company collaborates only with *one* supplier or *one* customer not considering the *competition* of multiple customers and suppliers for company products and production resource capacities as well as procurement volumes, respectively. This is a main obstacle to collaboration requiring 1:1 partnerships while the real world is a many-to-many market system.

Decisions in value chain processes and the processes itself have always a conceptual and quantitative basis, which is complex and comprehensive considering the entire value chain. Several methods have been developed to support decision-making as shown in section 2.3.3.

2.3.3 Value Chain Management Methods

Different *methods* exist to support value chain management decisions in strategy, planning and operations that are applied in respective decision support *models*. A basic definition of *method* and *model* can be found in a review by Teich (2002), pp. 219-220.

Method is based on the Greek term *methodos* meaning *way towards something* or *way or process of examination*. A method can be defined as "*systematic approach with respect to means and objectives that leads to technical skills in soling theoretical and practical tasks*." Methods and methodological approaches are characteristic for scientific work and solution of theoretical as well as practical problems. Primary decision support method categories are shown in fig. 22 (Specker 2001, p.39) reviewed by Nienhaus (2005): *reference, simulation, optimization* as well as *analysis and visualization*.

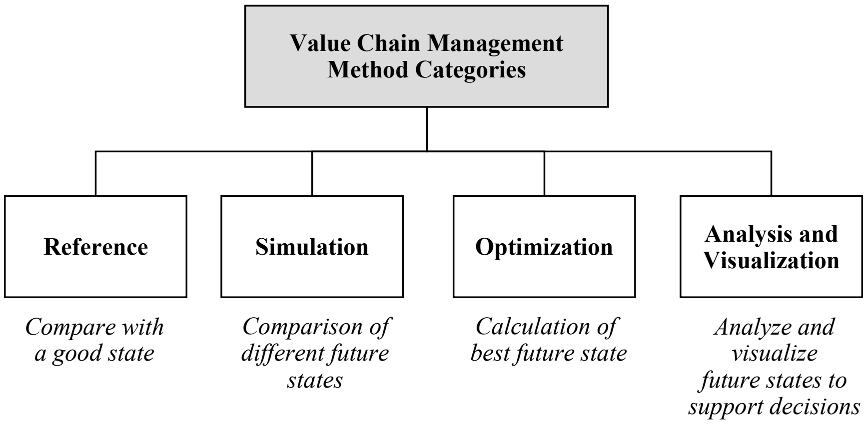

Fig. 22 Value chain management method categories

Reference

The *reference* method develops good states as comparison for decision support on concept design (Nienhaus 2005, pp. 24). Reference models – in industry also often called *best practices* – can be found e.g. for processes, organization, performance management or information technology (IT) concepts. Business *process* reference models have been developed in the context of process-supporting applications specifically Enterprise Resource Planning (ERP) applications (Brenner/Keller 1994; Keller/Teufel 1997; Curran/Keller 1998). These process models used specific process modeling methods such as the *Event-driven Process Chain* (EPC) or Petri networks. ERP application suppliers such as SAP developed process reference models to support the introduction and training of their software in a business-oriented way and use the reference for optimization of processes. These reference models provide processes combined with IT and organization reference, since processes are modeled together with IT functions and organizational roles or units. However, reference processes are often on a very detailed transaction level limited to operations and administration processes in the company. The aspect of volume and value management in the value chain and concentration on these fundamentals is often overwhelmed by a significant complexity and number of processes in the reference models.

The *Supply Chain Operations Reference* (SCOR®) model is a reference model for supply chain planning and operations *processes* as well as *performance management* developed by the cross-industry organization Supply Chain Council (SCC) started in 1996 (Supply Chain Council 2006; reviewed by Sürie/Wagner 2004, pp. 41-49). The SCOR® model structures the value chain in make (production), source (procurement) and deliver (sales & distribution) processes as well as the planning and operations level. The SCOR® model also includes a set of best-practices supply chain measures called Key Performance Indicators (KPIs) to share common definitions. The SCOR® model is specialized on supply chain management excluding value and pricing in sales and procurement as well as the strategy level in the value chain.

Specialized *performance management reference* exclusively concentrate on key performance indicators and reference definitions. In addition, integrate performance management framework such as the balanced scorecard structure performance indicators into different performance categories such as customers, processes, human resources and financials (Kaplan/Norton 1997; Zimmermann 2003). Several KPIs such as production utilization, delivery reliability, inventory ranges and planning quality are key measures in supply chain management (Nienhaus et al. 2003) and also in value chain management. However, these KPIs need to be extended to cover the entire value chain including the value aspect of the management. Consistent KPI definitions in Sales, Marketing, Controlling, Supply Chain Management, Production and Procurement are required. Process reference model in this work influences the Value Chain Management Framework with respect to Strategy, Planning and Operations Processes.

Simulation

Simulation methods compare different future states serving as basis for sensitivity analysis and system design decisions. Simulation can be used as prescriptive method in decision support (Tekin/Sabuncuoglu 2004) and is used for example in the area of production and logistics (Rabe 1998). Material flow simulation in physical logistics facilities are one example, where simulation of future running operations is used to design capacities and material flows as decision support for an investment. Simulation methods in value chain management can be used to compare different scenarios in strategy, planning and/or operations e.g. to simulate decision outcome including uncertainty of volumes and prices. Simulation results are analyzed with respect to sensitivity considering risks, validity and optimization criteria (Kleijnen 2005a). Kleijnen distinguishes *spreadsheet simulation*, *system dynamics (SD)*, *discrete-event simulation* and *business games* (Kleijnen 2005b, p.82):

- *spreadsheet simulation* provides simple and easy to use test beds to simulate e.g. focused production and distribution systems (Enns/Suwanruji 2003)
- *system dynamics (SD)* developed by Forrester (1961) initially under the term “industrial dynamics” consider entire industry systems from an ag-

gregate perspective and simulate change of key system parameters based on quantitative cause-effect relations between the parameters; in supply chains, system dynamics is used e.g. to simulate cause-effect relations between orders, production and inventory quantities (Angerhofer/Angelides 2000, Reiner 2005)
- *discrete-event simulation* simulates individual events such as arrivals of customer orders incorporating uncertainties
- *business games* includes human behavior into simulation letting human participants interact based on a defined game or business setup as for example in game theory

Simulation methods are embedded in simulation tools supporting to model simulation problems and partly supporting comprehensive visualization of simulation results (Fu 2002; Mason 2002).

Uncertainty in value chain management is a key motivation to use simulation comparing different scenarios, e.g. of demand quantities and prices, in order to simulate capacity planning in the automotive industry (Eppen et al. 1989)

Optimization

Optimization methods calculate one best future state as optimal result. Mathematical algorithms e.g. SIMPLEX or Branch & Bound are used to solve optimization problems. Optimization problems have a basic structure with an objective function *H(X)* to be maximized or minimized varying the decision variable vector *X* with *X* subject to a set of defined constraints Θ leading to $\max(\min) H(X), X \in \Theta$ (Tekin/Sabuncuoglu 2004, p. 1067). Optimization can be classified by a set of characteristics:

- *Local vs. global optimization* addresses the computation and characterization of global optima (i.e. minima and maxima) of non-convex functions constrained in a specified domain. Global optimization focuses on finding a global optimum of the objective function *f* subject to the constraints *S* (Floudas et al. 2005, pp. 1185-1186) ensuring that no other global optimum exists within other local optima; in value chain management, a global value optimum should be reached instead of local optima in the individual functions procurement, distribution, production and sales.
- *Single v. multiple objectives* is related to having a single objective to be maximized or minimized or if multiple also competing objectives have to be balanced; in value chain there can be a single global objective e.g. to maximize profit or multiple objectives addressing different stakeholders such as customers, employees and the public. Multi-objective optimization often requires a subjective evaluation of objectives e.g.

customer satisfaction vs. profits. Therefore, it is easier and more pragmatic to optimize one objective and to ensure the compliance with other objectives in constraints.

- *Discrete vs. continuous space* is related to the possible values of the decision variables: deciding production quantities for instance is reflected by a continuous decision variable while deciding to make a change-over or not is a binary decision requiring a discrete decision reflected by integer variables in this case 0 or 1.
- *Deterministic vs. stochastic:* an optimization problem can be based on deterministic parameters assuming certain input data or reflect uncertainty including random variables in the model; in value chain management deterministic parameters are the basic assumptions; extended models also model specifically uncertain market parameters such as demand and prices as stochastic parameters based on historic distributions; in chemical commodities, this approach has some limitations since prices and demand are not normally distributed but depend on many factors such as crude oil prices (also later fig. 37).

Optimization models are also classified by the mathematical problem to be solved:

- Linear Programming (LP) for continuous variables based on the SIMPLEX algorithm
- Mixed Integer Linear Programming (MILP) including continuous and integer variables using e.g. the Branch & Bound Algorithm for finding a solution near to optimum defined by the optimization tolerance called MIP gap
- Quadratic programming (QP) is a special problem including a product of two decision variables in the objective function e.g. maximization of turnover $\max p \cdot x$ with p and x both variable requiring a concave objective function and that can be solved if the so-called Kuhn-Tucker-Conditions are fulfilled, e.g. by use of the Wolf algorithm (Domschke/Drexl 2004, p.192)
- Constraint Programming (CP) is a further optimization approach where relations between variables are stated in form of constraints in order to better solve specifically hard bounded integer optimization problems such as production scheduling
- Genetic Algorithms (GA) are used in case of large combinatorial problems and can be applied e.g. for example in complex value chain network design decisions (Chan/Chung 2004)

Where mathematical programming promises exact optimal solutions, *heuristics* can find solutions that come close to optimal solutions. The advantage of heuristics used to lie in simplicity and speed of solutions finding a solution that is close or even match the optimal solution (Schuster et al. 2000, pp. 176). However, today, exact optimization is capable also to solve many complex industry-scale optimization problems in acceptable time thanks to the advance of computer technology and progress has made in improving optimization algorithms since 1950s: large scale problems e.g. of 10 million constraints and 19 million variables can be solved within 1.5 hours (Bixby 2005). Therefore, optimization is widely used in practice e.g. in production scheduling, transportation route optimization or strategic network design problems. Challenges in practices are more the level of specialized knowledge required to operate optimization systems in industry application (Schuster et al. 2000).

Analysis and Visualization Methods

Analysis and visualization methods focus on direct decision support to bridge the gap between comprehensive data results from simulation or optimization towards focused condensation, analysis and visualization supporting action-orientation and decision making. They also target to support the modeling of value chain structures and networks to make processes and network structures transparent and ease the understanding of planning as well as supporting to use optimization and simulation methods without having a profound know-how in these methods (Ünal et al. 2002)

Key Performance Indicators (KPIs) in supply chain balanced scorecards and performance management are one example for analysis methods. Beamon (1998) and Chan (2003) distinguish *qualitative* performance measures such as customer satisfaction, on-time delivery, fill rate or flexibility as well as *quantitative* measures based on costs in distribution, manufacturing and inventory or warehousing.

Besides combined methods exist such as search algorithms or simulated annealing that are applied to analyze optimization or simulation results as presented in the following.

Simulation-based Optimization as Combined Method

Presented methods can be combined to provide advanced decision support. *Simulation-based optimization* combines simulation and optimization in order to use simulation no longer as descriptive but as a prescriptive method and decision support (Tekin/Sabuncuoglu 2004). Tekin and Sabuncuoglu provide a classification on advanced simulation-based optimization methods (Tekin/Sabuncuoglu 2004, p. 1068) as illustrated in fig. 23.

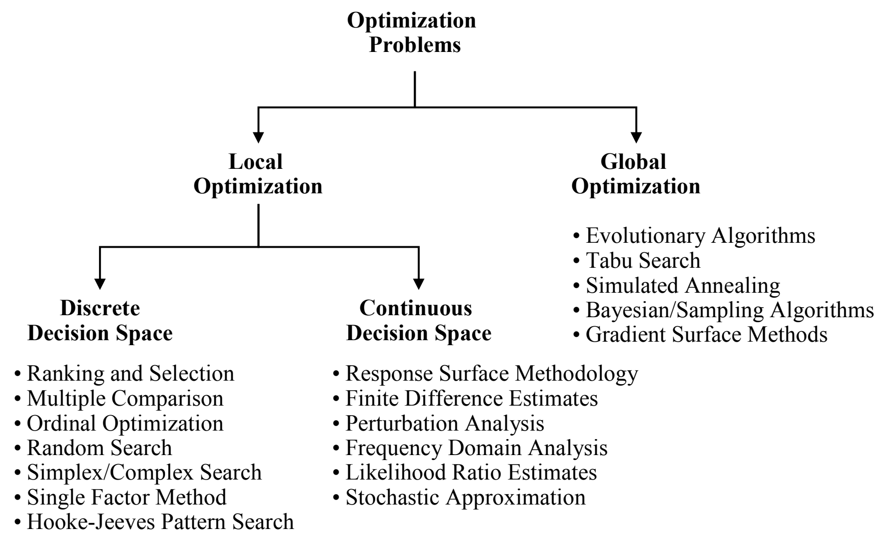

Fig. 23 Simulation-based optimization method classification

In addition to the basic methods such as SIMPLEX, other key methods for value chain management are the response surface methodology (RSM) to find a global optimum in a multi-dimensional simulation result "surface" (Merkuryeva 2005) or simulated annealing applied in the chemical production to find optima e.g. for reaction temperatures (Faber et al. 2005).

Several simulation-based optimization models in the context of supply chain management can be found e.g. in the area of supply chain network optimization (Preusser et al. 2005) or to simulate rescheduling of production facing demand uncertainty or unplanned shut-downs (Tang/Grubbström 2002; Neuhaus/Günther 2006). A basic approach of simulation-based optimization is presented by Preusser et al. 2005, p. 98 illustrated in fig. 24.

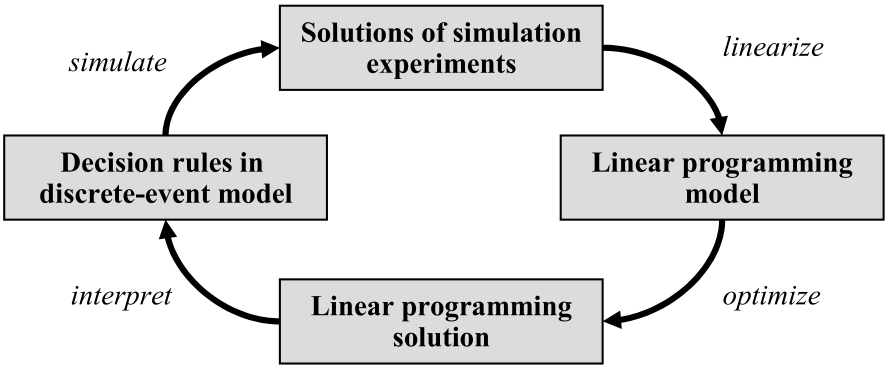

Fig. 24 Interaction between simulation and optimization

By combining simulation and optimization, benefits of both methods can be combined e.g. to simulated different input data scenarios – such as price scenarios – and analyze the resulting optimal plans in comparison. This approach is specifically relevant for planning volatile and uncertain prices of chemical commodities.

Methods used in Models

The introduced methods can be used in a value chain planning *model.* A *model* – derived from the Latin word *modellus* meaning *measure* – is a focused representation of reality focusing on problem-relevant aspects and their functional relations (Teich 2002, p. 219). The model applies reference, optimization, simulation and/or analysis and visualization methods to support decisions based on formulated requirements.

2.4 Conclusions

Integrated value chain management framework is an essence of so far separated concepts in the value chains either focusing on managing supply, demand or values:

- Value chain management is the integration of strategy, planning and operations decisions in the value chain to reach a global value optimum
- In this context, value chain planning is the integration of volume and value decisions based on the value chain strategy transforming the company into a marketplace clearing supplier offers in procurement with customer demand in sales

- Value chain management is based on models using appropriate methods like reference, simulation, optimization and/or analysis and visualization.

The value chain management framework is used as conceptual basis for developing a global value chain planning model for the specific scope of a global commodity value chain in the chemical industry.

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