Quintessence Series

Rolf G. Poluha

# The Quintessence of Supply Chain Management

## What You Really Need to Know to Manage Your Processes in Procurement, Manufacturing, Warehousing and Logistics

Springer

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*For my own personal Quintessence:*
*Sandra, Kim Helena, Dion William,*
*Tia Eleanor and Mina Estelle*

# Appraisal

A key factor for the success of companies today is the competence to manufacture and bring to the market innovative products with high quality and competitive prices faster than the competition. In addition, companies need to continuously improve and optimise their processes through the integration of new, innovative ideas. The goal is to achieve more effective and efficient processes which are required in order to stay competitive.

It is of paramount importance that companies learn how to adapt and be ready for flexible and fast changing collaboration with various partners and to view this as an opportunity, not as a threat. In the future, this will be the only way to remain engaged and be successful as a value-adding cooperation partner.

This book presents, in a crisp and plain way, how Supply Chain Management can help companies to cope with those challenges and manage them properly in order to ensure long-term business success.

Prof. Dr. Dietrich Seibt
University of Cologne
Cologne, Germany

# Appraisal

We are experiencing an interesting change in the competition between companies: they are no longer competing amongst each other, but rather in a federated way. For instance, Coca-Cola, Nike and Target have built networks with suppliers, wholesalers and retailers.

Due to the sheer amount of literature on this subject, it is often difficult to understand the essential facts and concepts of such fundamental changes and their effects.

Thus, there is a real need for a concise book in handy format that can put things right. This book gives a compact review of Supply Chain Management and includes a clear overview of the most recent developments.

There are many references with additional literature to go deeper into topics of interest if desired. Readers who are looking for advice on the right balance between standardisation and adaptation to a given corporate strategy will not be disappointed.

Dr. Paul Hofmann
Space-Time Insight
San Mateo, CA
USA

# Abbreviations

| | |
|---|---|
| ABC | Activity-based costing |
| AMR | Advanced manufacturing research |
| APICS | Association for operations management |
| APS | Advanced planning system |
| AST&L | American society of transportation and logistics |
| ASUG | Americas' SAP Users' group |
| b | billion |
| BPML | Business process modelling language |
| BPR | Business process reengineering |
| BSC | Balanced scorecard |
| CEO | Chief Executive Officer |
| CFO | Chief Financial Officer |
| CIP | Continuous improvement process |
| CISCM | Chartered Institute of Supply Chain Management |
| CLM | Council of logistics management |
| CPFR | Collaborative planning, forecasting and replenishment |
| CSCM | Certified Supply Chain Manager |
| CSCMP | Council of supply chain management professional |
| CSCO | Chief Supply Chain Officer |
| CSF | Critical success factor |
| DEA | Data envelopment analysis |
| E-Business | Electronic business |
| E-Commerce | Electronic commerce |
| ed. | editor |
| E-Learning | Electronic learning |
| EPM | Enterprise performance management |
| ERP | Enterprise resource planning |
| E-SCM | Electronic supply chain management |
| et al. | et alia (and others) |

| | |
|---|---|
| EVA | Economic value added criteria |
| IIPMR | International Institute for Procurement and Market Research |
| IOSCM | Institute of Supply Chain Management |
| IPSCMI | International Purchasing and Supply Chain Management Institute |
| ISCEA | International supply chain education alliance |
| ISM | Institute for Supply Management |
| IT | Information technology |
| KLU | Kühne Logistics University |
| KM | Knowledge management |
| KPI | Key performance indicator |
| LMS | Learning management system |
| m | million |
| no. | number |
| OEM | Original equipment manufacturer |
| OMG | Object management group |
| p. | page |
| PBC | Process-based costing |
| pp. | pages |
| PRTM | Pittiglio, Rabin, Todd & McGrath |
| RFID | Radio frequency identification |
| SC | Supply chain |
| SCC | Supply chain council |
| SCDM | Supply chain design management |
| SCEM | Supply chain event management |
| SCM | Supply chain management |
| SCMP | Supply chain management professional |
| SCOR | Supply chain operations reference model |
| SMI | Supplier managed inventory |
| TQM | Total quality management |
| VMI | Vendor managed inventory |
| WfMC | Workflow management coalition |
| WIP | Work in process |

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# Introduction: The Real Competition Will Be Between Supply Chains in the Future

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*The cutting-edge businesses seek to make the supply chain competitive as a whole by means of the value it adds and the overall costs that it reduces. They have realised that the real competition is not business against business, but rather supply chain against supply chain.*
(cp. Christopher 2005, pp. 13)

## 1.1 The Competition of Supply Chains

In order to improve the market position of a business, factors that spring to mind are e.g. the price and quality of its products. However, a major factor for market success is the way in which a business plans, procures, manufactures, stores and sells its products. In today's business environment transparency, efficiency and speed are key success factors. The efficient management of processes and workflows is meant to allow businesses to gain advantages across all functional areas: from unleashing potentials in procurement for profit improvement and reduction and outsourcing of inventories, to winning over the customer by means of better delivery service.

The continuing globalisation of procurement and sales markets, as well as the world-wide distribution of production facilities require a holistic planning and optimisation of value-added processes and logistics networks. Furthermore, customer management needs to be developed and integrated accordingly. This leads to new challenges for executives and managers as they are forced to implement



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operational improvements and, at the same time, reduce cost without affecting customer service. To manage the trade-offs between the conflicting goals involved, the activities need to be well-balanced and take all relevant aspects into consideration.

Paramount for businesses involved in a supply chain is the understanding that metaphorically speaking, the weakest link in the chain determines the market success. This means that the *compensation law of planning* which was originally only focused internally upon an enterprise has been extended to the comprehensive, internal and external supply chains. It is obvious that this requires an increased collaboration between the enterprises involved in order to move the bottleneck to a higher level within the supply chain.

According to the *compensation law of planning*, a coordinated flow of activities in an enterprise requires the continuous interdependent coordination of sales potential, manufacturing capacities, purchasing conditions, etc. etc. Over time, this results in constraints in alternating functional areas which impede the full quantitative and qualitative development of the other functional areas due to interdependencies. This requires that the functional plans of the other areas are aligned with this constraint or bottleneck by means of adequate activities (cp. Albach et al. 2011, pp. 261). For the topics of bottleneck and bottleneck management see e.g. Goldrath and Cox (2012), and Heinrich and Betts (2003).

The result is that many businesses face the challenge of consistently and efficiently planning their material and information flows and controls to the letter—from procurement onwards and continuing through to production. Sales plans, however, are often carried out in practice using an inadequate forecasting accuracy and with the omission of a feasibility study, so that businesses are increasingly forced into the formation of excess inventory and costly bottleneck control. Production and procurement can often not respond flexibly to fluctuations in demand. The results are, to an increasing extent, poor delivery and an often costly accrual of excess capacity.

As a result, businesses are now faced with the following questions:

- Taking into account the schedules, costs and service levels, how can we create a consistent balance between the supply side (stock, production and transportation capacity, etc.), and the demand side?
- In what way and to which point in time must the supply side be enlarged or reduced?

Leading businesses proactively deal with these issues and integrate their partners more effectively into the planning. The goal is a continuous and simultaneous increase in consistency and transparency of the entire business processes in order to punctually detect and resolve bottlenecks and postponements. The main challenge in this context is to economically and flexibly integrate the data of the partners (suppliers, logistics providers, sales offices, etc.), into their own procurement, production, sales, distribution and transport planning and to create uniform, consensus-based plans.

In summary it can be stated that: in view of the intensified competition as a result of increasing globalisation, economic crises, etc., businesses must make use of every potential in order to increase their economic viability and thus optimise their value creation. However, this results in an inherent problem: the optimisation in a single area (e.g. through the reduction of stock), has only a limited effect if the upstream or downstream processes (e.g. in procurement and production), are not simultaneously coordinated or adapted. As a consequence, the entire flows of material and information must be considered in order to make real improvements in efficiency. This virtually determines the weakest link in the supply chain efficiency.

Two difficulties arise from these findings: firstly, inter-divisional measures are required—the isolated analysis and optimisation of individual processes is not effective, but must be coordinated. Secondly, operational improvements and cost reductions are associated with conflicting objectives and therefore must be simultaneously considered. These and related issues are examined more closely in further course.

This makes it clear that the ultimate goal is a balance of stock, production and transportation capacity, etc.—i.e. the supply side—with the customer needs—i.e. the demand side. In other words: the primary objective is to recognise where and when the supply side must be reduced or enlarged in order to cover the demand side as

precisely and promptly as possible. The associated control and coordination of the supply chain in the form of work, material and information flows can be simplified and referred to as *Supply Chain Management*, which should help a business to compete successfully with the supply chains of competitors. The various definitions will be discussed in more detail in the following Chapter.

It was debated a few years ago whether this is simply a temporary "fad" or the presentation of known content in various other forms ("new wine in old bottles"). In the meantime, however, the knowledge has become accepted that there indeed exists a serious discipline of business administration, which has its own raison d'être in scientific literature. The result is that supply chain management has become a recognised business discipline.

Today, there are a number of academic institutions which are offering Supply Chain Management Master's Degree Programs, including:

- Erasmus University Rotterdam and Maastricht University in the Netherlands.
- Vienna University of Economics & Business in Austria
- KEDGE Business School and École Supérieure des Sciences Économiques et Commerciales (ESSEC) Business School in France.
- Copenhagen Business School in Denmark.
- Università Bocconi in Italy.
- École des Hautes Études commerciales (HEC) de Montréal and University of British Columbia in Canada.
- Massachusetts Institute of Technology and Florida Institute of Technology in the United States.

The only university with a primary focus on Logistics and SCM is the Kühne Logistics University (KLU) in Hamburg, Germany. It is sponsored by the non-profit Kühne Foundation of the Logistics entrepreneur Klaus-Michael Kühne. KLU offers B.Sc., M.Sc. and Ph.D. programs, as well as an Executive MBA program, a seminar series and international summer and autumn schools for professionals to expand their know-how.

For examples of academic research on Supply Chain Management, please refer to Ayers (2006).

In addition, there are several professional certification programs for SCM staff development, such as:

- International Institute for Procurement and Market Research (IIPMR) bestowing Certified Supply Chain Associate (CSCA), Certified Supply Chain Specialist (CSCS) and Certified Procurement Professional (CPP).
- Association for Operations Management (APICS) bestowing Certified Supply Chain Professional (CSCP) and Certified Production and Inventory Management (CPIM).
- Institute for Supply Management (ISM) bestowing Certified Purchasing Manager (CPM) and Certified Professional in Supply Management (CPSM).
- International Supply Chain Education Alliance (ISCEA) bestowing Certified Supply Chain Manager (CSCM) and Certified Supply Chain Analyst (CSCA).
- Chartered Institute of Supply Chain Management (CISCM) bestowing Chartered Supply Chain Management Professional (CSCMP).
- American Society of Transportation and Logistics (AST&L) bestowing Certification in Transportation and Logistics (CTL).
- International Purchasing and Supply Chain Management Institute (IPSCMI) bestowing Certified International Supply Chain Professional (CISCP, Level 1), Certified International Supply Chain Manager (CISCM, Level 2) and Certified International Supply Chain Consultant (CISCC, Level 3).
- Institute of Supply Chain Management (IOSCM) bestowing Supply Chain Certificate Qualification Level 1–6.
- The Purchasing Management Association of Canada is the main Canadian certifying body; its main designation is the Supply Chain Management Professional (SCMP), with several others progressing towards it.

In practice the picture is similar: in the past 10 years and on the one hand, the importance of logistics processes has greatly increased within businesses. On the other hand, however, a cross-functional and integrated view of the supply chain has come to the fore, whilst in the past a vertical perspective of the associated processes in procurement, manufacturing, warehousing and logistics was dominant. As a result this has assisted in firmly embedding supply chain management into businesses.

Martin Christopher is right when he says that it is only in the recent past that businesses have come to recognise the vital impact that supply chain management can have in the achievement of competitive advantage (cp. Christopher 2005, p. 1). This has lead to a wide range of activities and initiatives within businesses which will be highlighted in this book.

In conjunction with this fact, an increasing number of businesses has introduced a new position in the recent past, the Chief Supply Chain Officer (CSCO), or Supply Chain President, who often reports directly to the Chief Executive Officer (CEO) or the Chairman. There is also a special website and a related magazine specifically for executives in the field of supply chain management titled *Chief Supply Chain Officer (CSCO) Insights—The Knowledge Source for Supply Chain and Logistics Executives* (www.cscoinsights.com). Further recommendable magazines and journals focusing on Logistics and SCM are e.g. *Supply Chain Technology News, Logistics Today* and *Material Handling Management and Industry Week*. There is even an annual conference known as the *Chief Supply Chain Officer Forum*, which is organised by eyefortransport—*Supply Chain & Logistics Business Intelligence* (www.eft.com).

In the meantime, another consequence is that there are a large number of publications on this subject. However, there is as yet no book that has provided a concise and easily understandable overview for both practitioners and academics. *The Quintessence of Supply Chain Management* is designed to remedy this situation. Within it the essential concepts and basic principles are represented in a compact form and illustrated with numerous diagrams and examples. The book will assist the reader to better understand how the supply chain may be analysed, evaluated, and based upon one's individual goals, may also be structured and optimised. In addition, a number of further

references and reading hints are included in order to study a certain aspect in depth if desired.

A good overview of Supply Chain Management may be found, for example, at Hugos (2011), and Cohen and Roussel (2013). For very current aspects of the topic, see e.g. Chopra and Meindl (2015), and Lambert (2014). For the connection of Operations Management and Supply Chain Management, Jacobs and Chase (2013), and Heizer and Render (2013), are particularly recommended.

The book has served its purpose if the reader can ultimately understand which competitive, critical role is played by supply chain management in ensuring the long-term success of the business. And, as a result, how it can enable businesses to emerge as winners from the *competition of supply chains*.

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# Strategic Importance of the Supply Chain

# 2

*The performance of the supply chain directly impacts the performance of a business.*
(cp. Plattner and Leukert 2015, p. 129).

## 2.1 The Reference System of the Business

In order to develop an understanding of the special importance of the supply chain, the initial necessity to divert from the often widespread functional, to a process-oriented way of thinking and perspective, is essential. The figure below clearly shows the difference in graphical form (Fig. 2.1).

The influence of the process view of the business's success may not be detected other than in operational practice. Even scientific studies to investigate factors that have a significant impact on the company's success show that the market success largely depends on the observation and improvement of key business processes.

> The process view with reference to the supply chain is very well represented in the work of Schönsleben (2012).

Let us examine an example of a concept of integration in which the business processes are at the centre, described in more detail, and are presented as the operational reference system. The graph summarises the integration concept, developed as part-funded by the European



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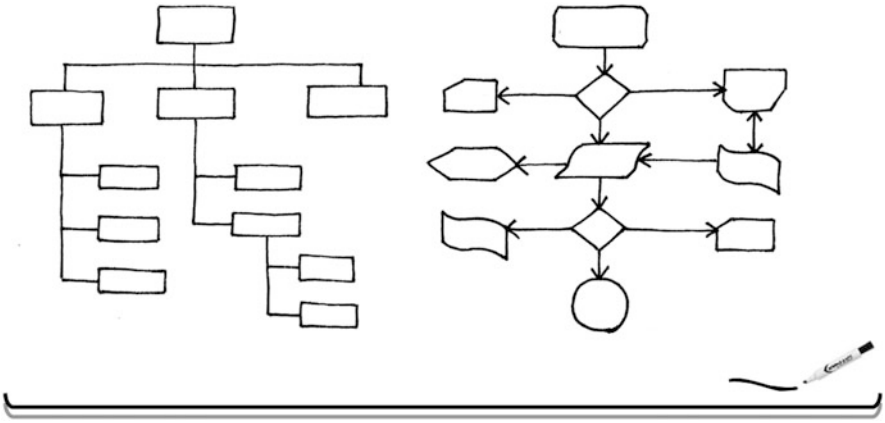

**Fig. 2.1** Simplified representation of functional vs. process views

Commission project CEBUSNET and involving the research groups of six European universities (Fig. 2.2).

As can be seen from the diagram the corporate strategy, goals and policies are paramount. These directly determine the business processes depicted by the thick arrows. Above and beyond this, they also determine the influencing factors, i.e. employees, organisation, and information technology as well as the results (depicted by the dotted arrows). Input variables such as e.g. raw material, labour and data, and output variables such as products and services, as well as activities and process steps, are not explicitly shown in the diagram, but do represent an inherent part of business processes.

The complete working paper with the CEBUSNET study can be obtained at no charge from the following website (cp. Seibt 1997): http://www.islp.uni-koeln.de/fileadmin/wiso_fak/islp/pdf/WP_97_01.pdf.

The central element visually represents the business processes resulting from the corporate strategy and objectives. It is strongly affected by the influential factors and the business's specific context (represented by thick arrows). The detailed influencing factors include the human resources (employees), information technology, and organisation. The influential factor 'employees' includes all process-related aspects that play a role in improving the skills and

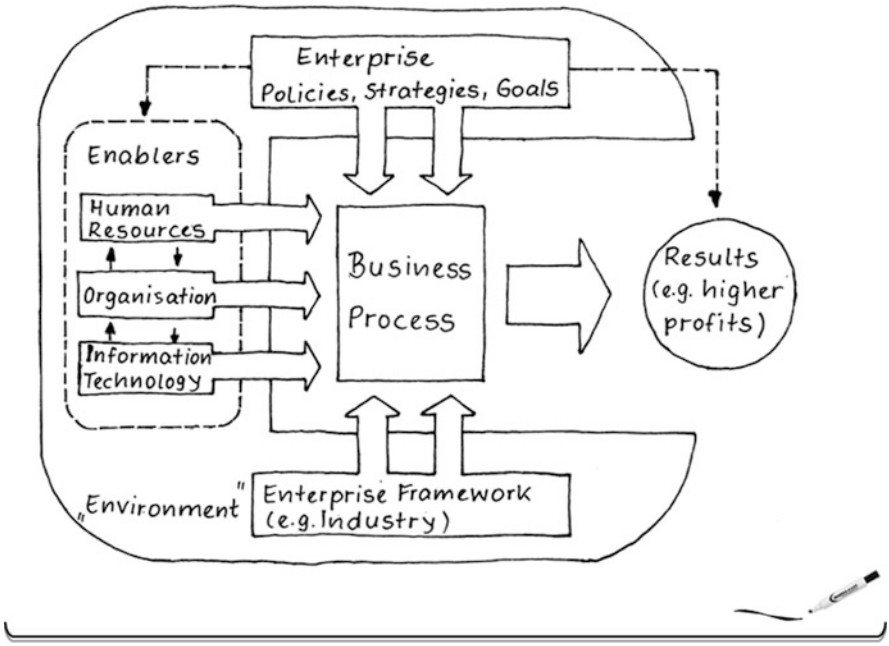


**Fig. 2.2** Consolidation framework for business process design (cp. Seibt 1997, p. 6)

the motivation of employees. Information technology has been considered for quite some time now to be a relevant factor for enabling optimum process handling. It includes the application solutions and information systems, and related procedures and processes. Also, in addition to the organisation as a factor influencing its own structure, the rules and operations are summarised in so far as they are related to the business processes. The business-specific context (environment), is influenced by factors such as the industry, the individual competition, import and export restrictions, and so on.

Depicted on the right hand side are the results of operations or the handling of business processes. These are, for example, the products and services that arise from the business processes. Further results are the key performance indicators, such as customer satisfaction and cycle time which are defined as business targets.

A very compact and outstanding overview of the strategic management and the definition of corporate strategy and objectives can be found at Kotler et al. (2010).

These will be discussed in more detail in further course, as they play an important role in the context of supply chain management. Results may be either intentional or unintentional. An intentional result could be to achieve higher profits; an unintentional result could be the disclosure of losses as opposed to profits. The risk of unwanted results arises partially due to the definition of corporate goals and strategy.

Over and above this and with regard to the four main areas shown which are important for the execution of business processes—namely business, influencing factors, the corporate context and results of operations—feedback processes are of course in existence that are not explicitly shown in the diagram.

Since the concept of integration as a comprehensive framework for businesses and the supply chain runs through all the relevant business process areas, reference to this will be made on several occasions in further course. It is used, in a sense, as a kind of "continuous thread" that runs through the book and will help to keep the focus on the essential—or, in other words, on the actual and required knowledge levels of management and employees with regards to the processes in procurement, manufacturing, storage and logistics. But first, clarification is necessary as to what actually lies hidden beneath the concept of the supply chain.

## 2.2 What Is a Supply Chain?

To view the supply chain in the further course of working closer therewith, we will first attempt to establish a definition of the term. Synonymously, the term logistics chain is sometimes used. The difference is that the logistics chain focuses on the physical activities of the logistics in the narrower sense. In addition to this, the supply chain covers the accompanying monetary and information flows and extends much further.

In literature we find a large number of definitions, some of which are listed below by way of example. Because the term has been mainly developed in the United States and advanced from there, the definition has been heavily influenced by writers from the English-speaking world (Fig. 2.3).

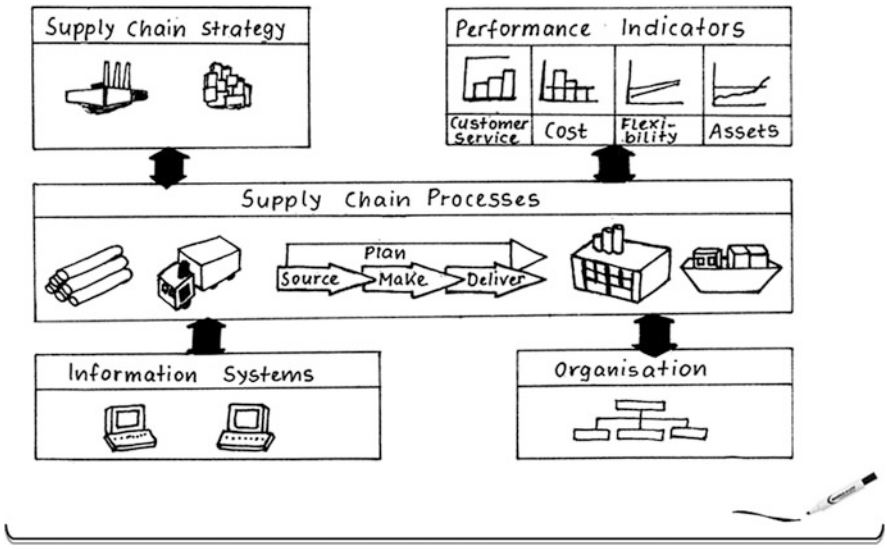


**Fig. 2.3** Typical elements of supply chain (cp. Myerson 2015, pp. 4)

Understanding the supply chain is of particular importance to those who are involved in measures to implement process and system improvements. The definition of a supply chain can vary greatly, dependent upon the perspective from which the definition is made. The current trend leans more towards a broader definition. For example, the area in focus has been extended and added to the view expressed in the CSCMP definition as part of a conference conducted by the Council of Supply Chain Management Professionals (CSCMP) in 2002. In accordance with this, the supply chain can be described as the total of all activities, processes, etc., which are applied to the product from the beginning to the end.

The Council of Supply Chain Management Professionals (CSCMP) was founded in 1963 in the United States under the original name National Council of Physical Distribution Management (NCPDM). The name was later changed in Council of Logistics Management (CLM) and the acronym finally renamed CSCMP. Further information can be found on the following website: www.CMP.org

In this sense, a supply chain approximately begins with the extraction of mining ores and the planting of seeds, i.e. acquiring raw materials

from the earth. The chain flows through a variety of conversion and distribution processes that deliver the product to the end user. It ends with the final disposal of the product and its residues. In accordance with this understanding, however, the supply chain is more than the physical movement of the goods: It also includes information, financial movement and the creation and distribution of human resources.

> The *product lifecycle* includes the essential stages of the product development through the production and right up to recycling. Changes and improvements must constantly be carried out above and beyond the lifecycle, which will only then create a lasting success in the market (cp. Stark (2015), pp. 5).

In summary this suggests that the supply chain covers all processes throughout the product lifecycle, including the physical, informational, financial and knowledge-based processes for moving products and services (from suppliers through to end users). With the inclusion of the process side, it follows that this results in a supply chain being composed of all people and businesses involved in the development, production and supply of a product or service to the market.

### 2.2.1 Meaning of Supply Chain

The definitions to be found in the scientific and application-oriented literature include a whole range of perspectives—from a very narrow to very broad concept delineation. Although the spectrum of the supply chain has expanded considerably in recent years, even today narrower or barycentric definitions can be found. The following explanations represent an overview of the various approaches to the definition given to the supply chain. Their comprehension is a prerequisite for also understanding the approaches to the management of the supply chain.

Initially, the difference between the definitions can be distinguished by studying from which side the supply chain is approached, i.e. the customer or supplier side. In the supplier-centric approach, the supply chain is a network of suppliers which manufactures goods. These goods are exchanged both mutually and with other parties. The

goods come from the original supplier, and finally reach the target customers. In between, they often pass through middlemen and processing businesses.

In contrast, the customer-centric approach assumes that a supply chain consists of all stages that are, directly or indirectly, involved in and required in order to fulfill a customer request. The focus in this case lies specifically upon the transportation businesses, warehouses, retailers, and the actual customer. The combination of the two approaches leads to a higher-level definition of that, for which a supply chain is recognised, namely the coordination of organisations in order to provide the market with products and services.

A good overview of the customer- and supplier-centric approaches can be found, for example, at Chopra and Meindl (2015).

This comprehensive view can still be raised to a global level and placed into the context of a global organisation network. A supply chain is, in this sense, a global network of organisations which work together to improve the material and information flow between suppliers and customers. The operational objectives are the lowest possible cost and the highest possible speed. The ultimate goal is the satisfaction of customer requirements. The material flow runs, so to speak, in a forward direction (i.e. from suppliers to customers). The flow of payments, however, runs backwards (i.e. from customers to suppliers).

To observe the supply chain from the viewpoint of the material and information flows, Bolstorff and Rosenbaum (2011) and Govil and Proth (2002), are highly recommended.

In addition to this, information flows from customers to retailers, manufacturing businesses, logistics businesses and raw material suppliers. Material flows from the original raw material or component suppliers to customers. It is imperative for both material and information flows, that the process amongst supply chain partners is carefully coordinated. This implies that a close coordination, both forward- and backward-facing, is necessary.

This approach can be further differentiated by the supply and demand aspect. A supply chain then has the primary purpose of delivering products and services from the suppliers to the consumers (e.g. organisations, businesses, and individuals). The activities within the supply chain change, depending upon the product and the nature of the demand. However, a number of generally applicable value-adding activities allow themselves to be identified:

- Producing: manufacturing materials, components, etc.
- Combining: assembling, packaging, etc.
- Moving: distributing, collecting, etc.
- Storing: movement into storage, out of storage, etc.
- Customising: installation, configuration, etc.

The demand-side supply chain, which is also called the demand chain, focuses on the market demand to suppliers. The specific observance of the demand element accentuates the fact that the role of such a supply chain is virtually governed by the requirements and actions of the customer. This is sometimes called "The Concept of Control by Demand Pull" (as opposed to "The Concept of Supply Push").

In the case of the prevalent *supply-push approach*, semi-completed and completed products are manufactured and stored until they can be sold and delivered due to customer orders and within the next stage of the supply chain. This often results in long lead times and high inventory levels. In contrast, the *demand-pull approach* is characterised by the customer's decision to purchase a particular product for which he specifies his exact requirements in terms of type and delivery time. Based upon this, the required quantity of resources is procured. The production and distribution process should lead, as far as possible, to a close correspondence with the customised delivery, as requested by the customer (quality, time, location, etc.), (cp. e.g. Poluha 2007, pp. 8 and pp. 25).

Just as a supplier can have a variety of supply chains which he must control, the supplier's customer has his own particular demand chains, which can be separately analysed. The demand chain enables the conversion of the customer's goals into information, which can be used as a working guideline by the supplier. It is governed in this sense by a decision-making process, which in turn is characterised by four generally-accepted stages: the first stage is the definition of the purpose of the demand chain. In the second stage the planning takes place, for example, in the form of a categorised plan. The third stage can then include the monitoring, control and management of usage and requirements within the inventory. Finally, the focal point of the fourth and last stage deals with the purchase transactions, e.g. the call order within a framework agreement.

Another approach is the organisation-specific observation of the supply chain. In accordance with this, the supply chain is a series of processes within the business as well as with other businesses (intra- and inter-business processes), which produce goods and services for customers and also deliver to them. It includes activities such as the material procurement, production planning, and distribution.

The organisation-related perspective is well represented by Bovet and Martha (2000).

These activities are supported by the necessary information flows. Purchasing, manufacturing, inventory management, warehousing and transportation are usually considered to be a part of the supply chain organisation, whereas marketing, sales, financial accounting, and strategic planning, are not. Product development, sales planning, order entry, customer service and cost accounting are not clearly classified: although they clearly belong to the supply chain processes, they are rarely a part of supply chain organisation (see Fig. 2.4).

If the process- and organisational-side perspectives are combined, the supply chain includes all the organisations and processes that are required for the procurement, storage and disposal of raw materials, and semi-completed and completed products. The material flow is connected by physical, monetary and information-side processes.

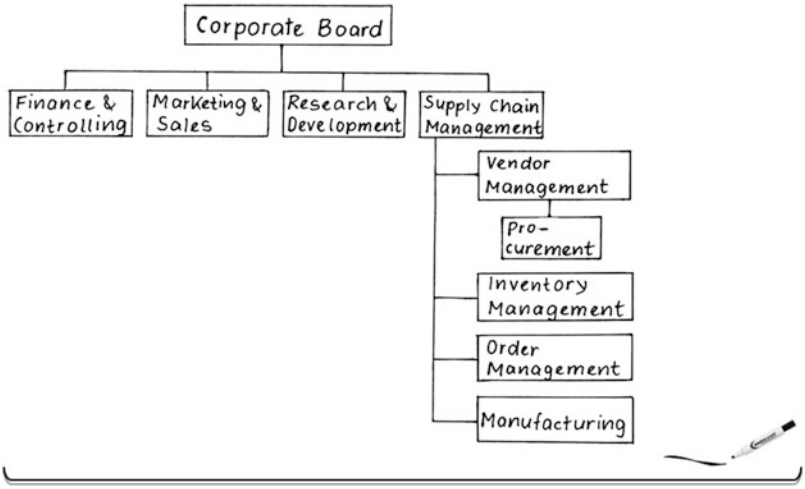


**Fig. 2.4** Example of a supply chain organisation (cp. Cohen and Roussel 2013, pp. 91)

The approaches already discussed arise from a one-dimensional method of observing the supply chain. A further-reaching distinction can be made on the basis of stratification into different levels. Thus, a supply chain is a sequence of suppliers and customers that starts at one end with a raw material and provides a finished product to the end customer at the other end. The supply chain can then be broken down into several levels.

A single-stage supply chain only represents the direct customers and suppliers, whereas a multi-stage supply chain can be extended to encompass the suppliers of raw materials on the one hand and the removal of worn-out end products on the other. The complexity increases disproportionately with an incremental number of levels. Therefore, most businesses have neither the means nor the resources to monitor the entire supply chain network, and are therefore limited to one or two levels. In addition to the levels, consideration must be given to the components flowing through the supply chain, and these must also be included into the illustration: goods and services in one direction, payments in the other, and information in both directions.

The understanding of a bi-directional flow of information reflected herein represents the reality far better than the one-directional flow of

information previously described. Current approaches such as the concept of Collaborative Planning, Forecasting and Replenishment (CPFR), are based upon an information flow in both directions.

> The concept of *Collaborative Planning, Forecasting and Replenishment (CPFR)* provides both suppliers and customers with a cross-business cooperation for demand and sales forecasts, as well as a regular update of plans based upon a dynamic exchange of information, and has optimal inventory levels for customers and a reduced inventory for the suppliers as its goal (see e.g. Handfield and Nichols 2002, pp. 298).

Another criterion that can be included and flow into the description of supply chains exists in the form of the decision aspect. Within a supply chain that includes a relatively large number of supply chain partners, a number of decisions must be made. These decisions usually apply to investments, strategies for coordination and cooperation with partners, customer service, and profit maximisation strategies, etc. Some of these decisions have far-reaching effects upon the supply chain and are of a complex nature, because an ever increasing degree of uncertainty pertaining to the impact and variety of variables must be taken into consideration due to increasing market dynamics. The resulting supply chain is sometimes referred to as a market-driven supply chain.

If one integrates the corporate functional areas and the associated core activities, this leads to a functional description of the supply chain. The following five core activities can then be identified within a supply chain:

- *Sales activity*, which includes all market-orientated activities, including marketing and retail.
- *Purchasing activity*, which includes those tasks required in order to purchase raw materials, components, resources and services.

- *Manufacturing activity*, which involves the creation of products or services as well as the required guarantee for maintenance and repair of the resources, and the training of employees—in its entirety therefore, the implementation of all tasks that are necessary for production.
- *Movement activity*, which includes the transport of materials and personnel, both inside and outside the supply chain.
- *Warehouse activity*, which involves the products currently under development (Work in Progress, or WIP), as well as raw materials, whilst they await transportation or alteration, and the end-products before they are sent to the customer.

The incorporation of the functional area-related activities highlights the transition from a static to a dynamic perspective of the supply chain.

For the "penetration" of the supply chains due to the Internet and its implications for the supply chains, cp. for example Gottorna (2012/1 and 2012/2), and Ross (2011).

The flows of material, payments and information previously mentioned have hitherto been regarded as linear and coupled. The introduction of the Internet and the related acceleration of the flow of information mean that these flows have been, to a certain extent, uncoupled from each other, and the information flow occurs largely independently from the material and payment flows. Thus, the supply chains have, in the traditional sense, further evolved into networked supply chains, which link the partners within the network to the most suitable components, technologies and customer services. These networks are also dynamic in nature, allowing supply chain partners to be subjected to inclusion or exclusion in accordance with certain criteria (such as customer preferences, technological advantages or product lifecycle).

The value generation in the sense of profit gained by corporate activity constitutes the initial aim of the productive activities of businesses. It is measured using the difference between the performance of a business entity and the intermediate performance rendered in order to secure the provision of the said performance. There is usually an expectation that the added value created (value-add), will lead to higher business revenue (non-profit organisations are the exception). The generation of value embraces the increase in not only monetary, but also non-monetary values, which is regarded as desirable by the business's management, its employees, and its shareholders. In this respect, a generation of value results not only from an improved and increased profitability (of income in relation to expenditure or performance in relation to costs), but also from the improved effectiveness and greater efficiency of operational processes (see e.g. Thurow 2008, pp. 419).

These dynamic supply chains drive, amongst other things, the development of new business strategies, in which the integration of customers, the outsourcing of business functions, the customer and supplier cooperation, and warehouse management are the focal point. Traditional linear supply chains are thus converted into dynamic networks.

Another integral element of such supply chains is their value-adding character. The supply chain, accordingly, is a network of organisations linked to each other in both a forward-orientated and backward-orientated fashion, in order to generate value within different processes and activities. This value is reflected by products and services which are delivered to end users. This generation of value may be seen in both a cross-business and business-internal respect.

The relationship between the value generation and the corporate strategy may be summarised as follows (in accordance with Normann and Ramirez 2000, p. 186):

Strategy is the art of generating value. It provides the notional framework, the concepts and models and the regulatory guidelines, which are designed to enable executives to identify opportunities

that offer the contribution of value to customers and thereby helps them to attain and secure profit for their own organisation. In this sense, the corporate strategy defines the way in which a business presents itself and competes with others within the market.

In order to finalise the supply chain strategy one must first clarify and define the level of the desired value generation. The aim is to answer questions such as: with which products and services is the business joining the competition? Does it offer a standard product of a single model for all customers, or an individually customised serial product? What scope of quantity is envisaged (few, many)? Does it offer only a single product, or also for example, the performance of additional services such as the replenishment of the customer's stock levels? To what extent is the level of in-house vertical integration sufficient?

The best information about the concept of the value chain can be found in Porter (2008). The concept of a value network is well illustrated in Bovet and Martha (2000) and Christopher (2005). On how to gain competitive advantages through the use of information technology, see e.g. Porter and Millar (1985).

One approach which establishes the aspect of value generation in relation to the supply chain is the concept of the value generation chain, or value chain in short, which was developed by Michael Porter. With given consideration to the generation of value, the aspects of Information Technology can ultimately be included in order to ensure that a supply chain is operational. The result is a so-called value network or value net. In this way, a value network is a business design that uses digital supply chain concepts to ensure both customer satisfaction and maximum profitability. The value network is focused primarily upon the competitive factors of time and flexibility, and therefore has the primary goal of being able to react quickly and flexibly to customer requirements.

The strategic triangle encompasses three decisive factors in competition: cost, time and quality. In the more recent strategic square another factor arises, namely flexibility (cp. e.g. Poluha 2007, p. 13 and p. 313).

The special characteristics of a value network can be described as follows, and differ significantly when in comparison to a traditional business design:

- Focused on the customer.
- Based on cooperation and integrity (i.e. is holistic).
- Mobile and scalable.
- Possesses fast material, information and cash flows.
- Based upon information technology (IT).

The term value network therefore rises above the supply chain itself. It presupposes its own circumstances and focuses explicitly on the generation of value for all involved parties (businesses, customers and suppliers). Whilst it still remains, for the most part, a static system, the (bilaterally) flowing information contained therein is, however, often supported by modern IT systems.

The approaches previously represented emanate from the assumption, that the participants in the supply chain are physical partners (businesses, persons, etc.). A relatively recent development is the establishment of so-called *virtual networks*, in which the construct of the *virtual enterprise* represents the focal-point, or in other words the temporary fusion of core competencies of the involved businesses. The resulting entity becomes apparent to the customer in the form of a single unit. Inwardly however, a virtual enterprise has no interlocking legal or organisational structure. The linear, physical supply chain model as it has been previously known has shifted accordingly, as shown in Fig. 2.5.

The transformation goes beyond the physical boundaries of a marketplace and enters into the global and rapidly evolving digital

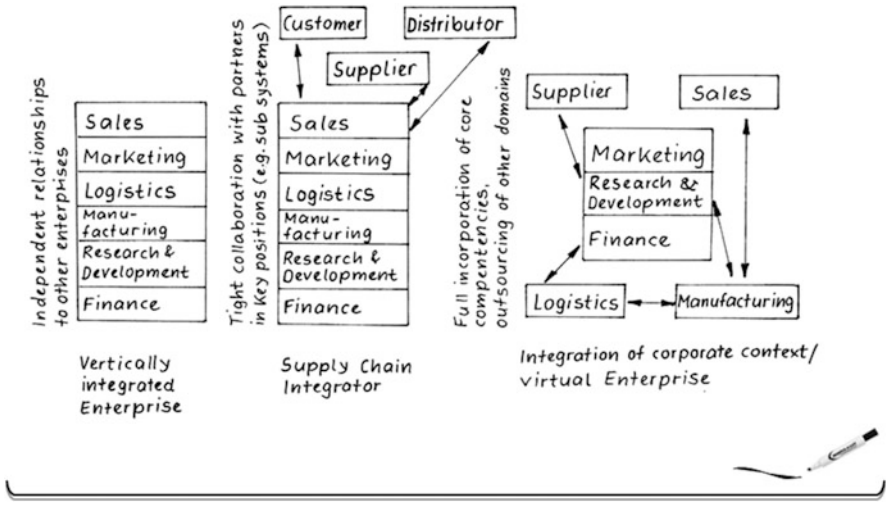


**Fig. 2.5** Development of virtual enterprise structures (cp. Simchi-Levi et al. 2008, pp. 1)

economy. With the introduction of the Internet and the new role of technology as a catalyst for new strategies, businesses see themselves simultaneously confronted with new strategic challenges and management problems. Whereas in the past, business-strategies have driven Information Technology, IT can be implemented today in order to create the possibility of new business models.

The *core competency approach* provides a frame of reference to analyse the strengths and weaknesses of a business and assumes that there are certain core competencies that constitute a competitive advantage. These core competencies can be resources, capabilities or general assets in the balance sheet and a business must seek markets within which it can achieve the highest returns based on these core competencies (see e.g. Prahalad and Hamel 1990). For more information with reference to virtual networks and virtual businesses, see e.g. Sroka and Hittmár (2015).

The real-time exchange of information and the interactive capabilities of the Internet have changed the business environment to the extent that now both customers and other businesses have better access to alternative products and services. New distribution channels have thus been established, which offer alternative new ways to optimise the generation of value and simultaneously allow interactions to become more transparent. The winners in these virtual value networks will be those who have faster access to information and resources, and are, at the same time, in a position to be able to derive the appropriate competition and supply chain strategies from it.

As a result, the traditional physical unit has developed into a virtual unit, in which a large number of potential partners exist and which exchange information with each other. In this sense, the virtual network represents a series of market partners who work together as a virtual unit, in which each individual adds a component of value, so to speak. The value-generating activities extend from the supply side in the form of raw materials, inbound logistics and production procedures, and right up to the demand side in the form of outbound logistics, marketing and sales.

Michael Dell, founder of computer manufacturer DELL, has literally described a virtually integrated business as an organisation which is not cross-linked by the wealth of physical assets, but is rather more connected into a network by means of information or, in other words, through information and communication technology.

Thinking consequently ahead, the supply chain represents part of a superior and comprehensive Electronic Business concept. E-Business must be differentiated from the related concept of Electronic Commerce (E-Commerce), which in general describes the electronic processing of business transactions. Thus, it constitutes a part of the overarching E-Business concept and is therefore subordinate to this.

Due to its pronounced process-orientation, one highly suitable description of E-Business is expressed as follows according to Dietrich Seibt (cp. Poluha 2007, p. 15): *A business may then considered to be operating Electronic Business, if several and up to all business processes*

- *within the business*
- *between itself and its business partners*
- *between itself and third parties (e.g. authorities)*

*are completely or partially provided with the assistance of electronic communications networks and supported by the use of Information and Communication Technology systems.*

An excellent overview of the relevant aspects of Electronic Business and related concepts, such as Electronic Commerce, may be found in Laudon and Trave (2015), and Jelassi et al. (2014). For further-leading information on Electronic Supply Chain Management (E-SCM), Graham et al. (2013), and Ross (2003), are recommended.

The concept which specifically concerns itself with the supply chain-related area of E-Business is also often referred to as Electronic Supply Chain Management (E-SCM). In this sense, E-SCM represents the tactical and operational components of a corporate strategy, the target of which in the first instance is the linkage of the communal production capacities and resources of overlapping supply systems by means of the usage of internet technologies, with the primary goal of creating customer benefit. The main difference compared to the "conventional" management of a supply or value chain becomes apparent in that E-SCM Internet technology is used to support the optimal management of work processes and the material and information flows (Fig. 2.6).

### 2.2.2 Types and Characteristics of Supply Chains

The definitions previously described have focused upon different properties or characteristics of supply chains. Based upon this,

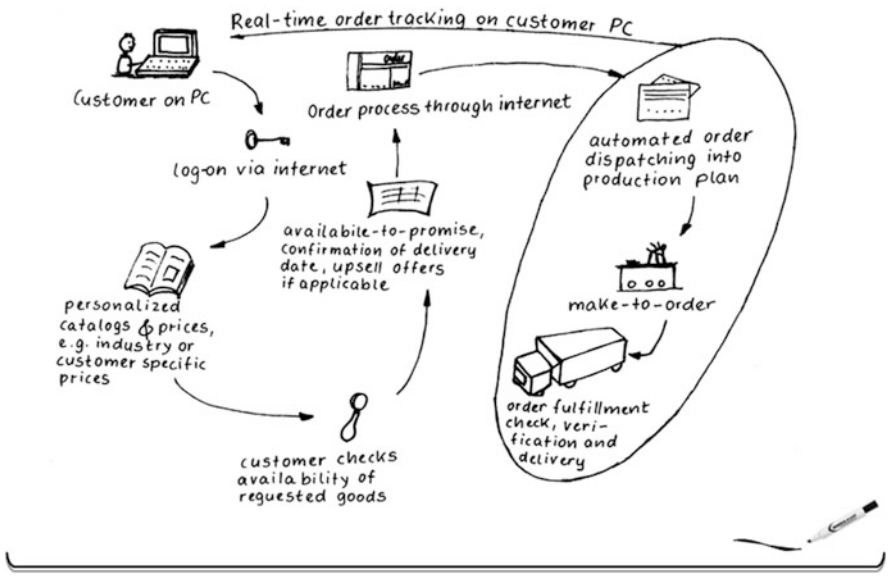


**Fig. 2.6** Example of the practical implementation of electronic business concepts in supply chain management (cp. Poluha (2010), p. 27)

various categorisations allow themselves to be put into effect, which we will discuss in detail in the following. One possibility lies in the decision as to whether the supply chain is predominantly focused upon the product, or rather upon the target customers. This results in a differentiation into two categories:

- Product-centric supply chains are those which are tailored to accommodate very special products. This specific tailoring can lead to the fact, that separate supply chains must be introduced for several products on offer.
- *Customer-centric supply chains* however, are tailored to accommodate specific market segments. This may result in single or multiple supply chains, which are organised around market segments.

A further differentiation can be carried out by using the business strategy and associated business requirements (according to Hughes and others (1998), pp.4):

- *Instantaneous open competition:* in this case, competitive offers and tenders are dominant. Emphasis is on intensive trade.
- *Trading of bulk commodities:* independent trade, forced into being by the necessity of the transaction. Emphasis is on controlling the fluctuation-span of bulk goods.
- *Lean supply chains and system integration:* cost minimisation and gradual transformation of the cost structure. Emphasis is on effective cooperation, but not so much on the savings, which can result in resource bottlenecks.
- *Competing constellations of associated businesses:* market leaders join forces with the best partners in the market. Emphasis is on performance ability, capabilities, and the organisation of cultural compatibility.
- *The interlocking network supply between competitors:* merger for the progressive settlement of transactions. Emphasis is on an association, within which low competitive advantages exist, with the aim being the usage of synergies.
- *Assets control the supply, market leadership is the goal:* gain control over the assets and implement them purposefully. Emphasis is on the proper use of the competitive instruments at the tendering stage.
- *Virtual offer—no production, just customers:* low fixed costs by means of the outsourcing of production. Emphasis is on the marketing and distribution capabilities.
- *Partnerships for the benefit of customers:* trust, candidness and sharing of the work to be carried out. Emphasis is on the performance provided by the supplier to the customer (directed forwards in the supply chain), and the value aspect represented by the customer to the supplier (directed backwards in the supply chain).

For a more detailed illustration of the various *competitive strategy alternatives* according to Michael Porter, the original editions are particularly recommended (see Porter 1998/1 and 1998/2). For a more current summary refer to Porter (2008). Accordingly, the three alternatives allow themselves to be briefly characterised as follows:

- *Overall cost leadership* is a strategy which focuses on the competitive advantage of the lowest cost compared to that of the competition.
- *Differentiation* focuses on creating at least one unique performance characteristic within the whole of the specific branch of the industry.
- The *Focus strategy* involves the focusing of a supplier on a market segment or on a particular demand group. The fundamental assumption is that a supplier can only be successful if it concentrates on one of the three basic types of strategies and the competitive advantages resulting from them. Otherwise, figuratively speaking, the business runs the risk of being "stuck in the middle".

The observation of the primary focal-point of the supply chain is another possible method of categorisation. At the same time a differentiation may be made according to strategic competition and the focus of perspectives upon the distribution flow, the material flow, the work flow, and the information flow.

From the competitive strategy perspective, the supply chain is a series of resources that are used to support the position of a product on the market with regards to the combination of target customers, pricing and sales measures. The primary purpose is to improve the profit margin across the span of product sales.

The focus on the work flow processes is based upon its assumption of a pre-defined sequence of activities within an organisation. The work flow supports an operational and technical view of the processes and provides information pertaining to factors such as costs and revenues. The primary objective lies, consequently, in the most efficient handling of the procedures.

In the material flow perspective, the flow of information between the various parties represents the main integration factor. An integrated supply chain possesses, in this sense, a communal basis of information in addition to the mechanisms required in order to exchange this information amongst the participants.

When focusing on the distribution, it is assumed that the supply chain is the physical history of a product through a number of operating systems and facilities which are linked by a transport network. These facilities and equipment include factories, warehouses, distribution centres, and fleet and distribution centres. The primary objective is to minimise the costs in the functional areas which are relevant to success.

In the information flow perspective, the flow of information between the various parties represents the main integration factor. An integrated supply chain has, in this sense, a common information base and the mechanisms to exchange information among the participants. The primary goal can be efficient information processes, but may also be advantages in the differentiation.

Even though the main focal point may vary, the growing idea of an integrated perspective increasingly asserts itself, by which the business processes, the material and information flows, and the work flow processes are observed and optimised together. This will be discussed in the course of the second chapter.

## 2.3 How Did Supply Chain Management Evolve?

### 2.3.1 From Logistics to Advanced Planning Systems

The role of supply chain management within an organisation has changed considerably over the last three to four decades. In the 1970s, it was known primarily as logistics, limited to the integration of storage and transportation within a business. In addition, high double-digit interest rates that existed in most countries during that decade forced businesses to pay special attention to the use of their capital. Logistics executives were primarily concerned with the reduction of inventory. The focal point was mainly how the business would carry out internal changes which could reduce the inventory and logistics costs. Even efforts to reduce production and delivery

lead times and thus reduce safety stocks were introduced as a priority within the business, as lead times had been mainly considered as input information for the forecasting and procurement processes.

In the 1980s, the focus shifted towards overhauling the cost structures within the supply chain. The attention was then directed at integrating the procedures of the supply chain, thereby reducing operational costs and capital investment. In the late 1980s, the aims and activities within supply chain management then finally shifted from the reduction of costs to the improvement of customer service. The benefits which were sought by improving performance included an increased growth in sales and higher profitability, primarily due to a larger market share and pricing advantage over the competition, which is reflected in the form of higher profit margins.

Interest in improving customer service increased during the early 1990s. Similarly, the growth of the business also came to be regarded as an additional goal of supply chain management. Up until that point this had been considered, within many businesses, to be the responsibility of product development, marketing and sales.

In the previous and current decades, a new wave of change has taken a steady hold in the field of SCM in many businesses, namely the development of a strategic management of the supply chain. Contrary to the traditional view in which it was purely a part of the operational definition of objectives, SCM has since then acquired a strategic function that directly contributes to the success of the business, whilst at the same time becoming a central and immanent part of our business strategy. The current status of the opinion, which is increasingly gaining ground, is that SCM both determines the strategy of many businesses and has even enabled them to introduce the strategy in the first place. In other words, SCM is a prerequisite for the successful implementation of the respective business strategy, as well as an essential factor for the determination of the business strategy.

SCM was initially also strongly focused upon improvements to the supply-side processes. In this context, however, one tended to overlook the fact that businesses wanting to manage their supply chain in an optimal manner could only achieve this goal if they recognised the fundamental connection between supply and demand—and the resulting impact on the supply chain strategy.

Often, however, businesses have reviewed their supply-side options, whilst apparently neglecting the demand factor. The relationship between supply and demand lies in the fact that the demand dictates the target of the supply, thereby possessing a determining position, whilst the supply-side capacity supports the fulfilment of the demand. Businesses therefore need to create new methods for the coordinated control of both the supply and demand chains. Supply Chain Management is a central part of these efforts.

The possibilities of an enterprise to adjust supply and demand with each other are a function of its *reactive capacity*, or in other words, its ability to offer a timely response to market signals. This flexibility is in turn heavily influenced by the capital costs of work and operation. Organisations have often struggled with the task of adjusting supply and demand, because the focus during these attempts has usually been upon improving forecast accuracy, optimising production and inventory levels, and reducing lead times.

However, it should be noted that although these measures are useful they provide no complete solution. Businesses must therefore take into account those measures, which include the cost of labour and resources. And they must find new methods within the business in order to align their incentives both within the business and within the extended (meaning partner-orientated), supply chain.

For the topics of logistics and logistics management, the works of Ghiani et al. (2013), Murphy and Knemeyer (2014), and Rushton et al. (2014), are especially recommended. The books of Heizer and Render (2013), Reid and Sanders (2013), and Stevenson (2014), are very up-to-date and comprehensive on the topic of Operations Management.

Long before the concept of the supply chain was introduced and the new discipline of supply chain management emerged, one spoke of a so-called Logistics Chain. This chain stood in the centre of a discipline that was called logistics or logistics management (and is today still partially referred to as such). The term operations management was also sometimes used, which is again currently being used more frequently. Let us therefore first consider several definitions in order to allow a differentiation between the terms.

In the classical terminology of the aforementioned Council of Supply Chain Management Professionals (CSCPM), logistics are described as the process of planning, implementing and controlling the efficient flow of material, ranging from the storage of raw materials to the stock in the production process (Work In Process, WIP), finished products and services, and related information, from the point of origin through to the point of consumption. This includes goods receipts and goods issues, and internal and external material movements. The ultimate purpose is to be able to meet customer needs.

With regard to the planning levels we can differentiate between:

i) *Operational:* short-term (less than 1 year for the current accounting period or invoice period) and mainly with regards to a part of the operation or the activities.
ii) *Tactical:* medium-term (time span from 1 to 3 years) and mostly for a larger part of the business or of the activities, and
iii) *Strategic:* long-term (time span longer than 3 years) and mainly and objectively with regards to the major product areas, the activities of the operations or the business as a whole, and the aspects critical to success (see e.g. Abraham 2012, pp. 159).

Logistics, however, can also be seen from the organisational aspect. From this perspective, it is a goal-oriented framework to control the process of planning, allocation and control of financial resources and labour, which are intended to deal with the physical distribution, manufacturing, support and purchasing transactions.

Any additional definitions focus on the conceptual idea of integration, in accordance with which the term logistics generally encompasses the creation of time, space, quantity, form and ownership, both within a business and in cooperation with other businesses. The special tools which logistics uses to achieve its goal consist of strategic management, infrastructure and resource management. This goal is to create products and services that satisfy customer

requirements. Logistics are thereby involved in all planning and execution tasks, on both *strategic* as well as *operational* and *tactical* levels.

Logistics management inevitably also has limitations and dependencies. So the logistics activities typically include inbound and outbound logistics, fleet and fleet management, warehousing, material handling, order entry and fulfilment, logistics network design, inventory management, demand and supply planning, and the coordination and management of logistics service providers. To a certain limited extent, they also include procurement and purchasing, assembly and packaging, and customer service.

With this, the connective bridge to supply chain management was already in place, whereby the fundamental difference was in the integrative nature. In this way, SCM involves not only the logistics, but also other business areas, such as purchasing, production, warehousing, marketing and information technology. A major purpose of this is to improve the efficiency of the supply chain. In other words, SCM can be defined as the integrated planning and control of processes in the value chain. The primary objective thereby is the improvement of the efficiency of the supply chain. The overriding aim lies in the optimum satisfaction of customer requirements.

> *Effectiveness* is defined within Business Administration as the degree of achievement of objectives, and is therefore a means of measuring performance. It is therefore a question of doing the right things. *Efficiency* represents a relationship between input variables and output variables and can therefore serve as a measure of cost effectiveness. Thus, it constitutes a potential sub-goal of effectivity. It is therefore a matter of doing things right, i.e. making sure things are being done in the correct manner (see e.g. Poluha 2007, pp. 44).

In this sense logistics management is an inherent part of SCM, which has the task of planning, implementing and controlling the efficiency and effectiveness of the forward- and backward-facing flow of goods, services and related information, with the intention of fulfilling customer requirements as satisfactorily as possible.

SCM consequently represents an integrative functional area which is primarily responsible for the connection of the main business functions and processes within an organisation, as well as those of other businesses that are involved in the supply chain, in order to form a concept in the shape of a consistent and high-performing business model. This role includes, in addition to the activities of logistics management, the production processes as well as the task of coordinating the supply chain processes with the functional areas of product design, inventory management, marketing, sales and finance.

Furthermore, SCM involves planning, managing and controlling all activities of logistics management. Above and beyond this, though, it includes the coordination of, and cooperation with, partners in the supply chain such as suppliers, distributors, logistics service providers and customers, thus ensuring the coordination of supply and demand within the business. However, a clear demarcation of terms is not as easy as one would imagine as far as the proliferation of information and the level of topical knowledge is concerned. In actual fact the term is associated with various meanings and across various businesses (see Fig. 2.7).

In the broadest sense, it covers all logistics activities, customer-supplier relationships, warehouse management and equipment, as well as the development and introduction of new products.

We principally have the ability to differentiate between *business-internal* and *business-integrated supply chains*, whereby the latter is concentrated upon the interfaces and interactions of an organisation with its external partners.

Practitioners usually define the term more narrowly and restrict the definition to activities within the supply chain of a single business. This would significantly and inevitably reduce the scope of improvement measures, which will be more closely dealt with in the following chapters, to the internal supply chain, but without taking into account the perspective of the interaction with other businesses. To illustrate the range of possible definitions of the terms, let us look below at a series of exemplary attempts at definition.

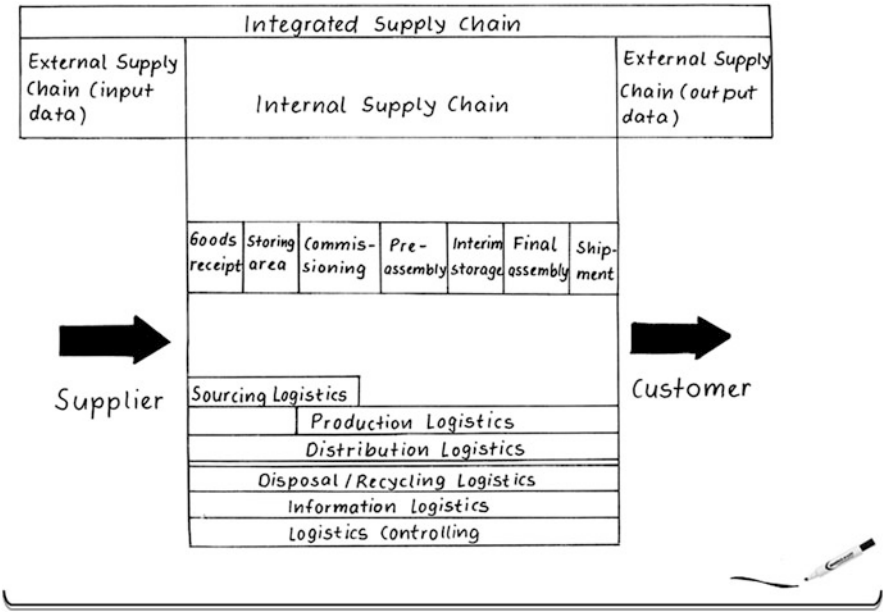


**Fig. 2.7** Internal and external supply chain (cp. Coyle et al. 2013, pp. 509)

Based on the classic planning and control approach, the management of the supply chain is an expansion of logistics into an interactive planning and control approach, which may also be between one or more businesses.

In addition to the term supply chain management, there is also the less commonly used term of *progressive planning system* or *Advanced Planning System (APS)*, which especially highlights the aspect of the support already explicitly incorporated by information technology.

If the planning element is included, SCM can be defined as the coordination of strategic and long-term cooperation between all participants throughout the supply chain network. This includes both the purchase and the shop floor and goes beyond the field of product and process development. The purpose is to develop and manufacture products. Each supply chain participant is active in the field in which he can rely on his own core competencies. The choice of further supply chain partners is based mainly upon how much potential they possess to create an increase in competitive advantages.

A good overview of the various definitions of terms and classifications in conjunction with SCM may be found, for example, at Cohen and Roussel (2013), and Hugos (2011). For references regarding the term *Advanced Planning System (APS)*, the work of Stadtler and Kilger (2014), must be highly recommended.

Based on a process approach, SCM may be described as the process of planning, implementing and monitoring an efficient and effective flow of goods, services and related information from the starting point of the supply chain and up to the point of consumption. The purpose is to satisfy customer requirements. By means of a further-leading differentiation of the process-related perspective, it can then be viewed as the design, maintenance and operation of supply chain processes to satisfy the requirements of end customers. In this sense, SCM extends both to the formulation of the supply chain as well as its subsequent operation and maintenance. This results in new tasks for managers and executives, as traditional tasks need to be completed in a different way. It has basically become apparent that as a result, the introduction of an SCM-discipline involves an extension of the duties and areas of responsibility for a multitude of employees.

The business process-orientated definition can also be extended to the effect that SCM represents the integration of business processes—from the end customers through to the suppliers. This integration provides the products, services and information that generate value for the customer. Accordingly, SCM leads to an alteration of the existing supply chain and generates customer value via the targeted use of information which is associated with the supply chain. In addition, the organisational processes have to be planned, monitored and controlled within the supply chain. For this purpose a universally accepted targeting system is required.

Based on the (physical) material and goods flows, the supply chain includes all activities associated with the flow and transformation of goods, ranging from the raw materials to the end consumer, as well as

the associated information flows. SCM thus represents the integration of these activities through improved relationships with supply chain partners, in order to achieve a lasting competitive advantage.

> The terms *Lean Production* and *Lean Management* denote the principle of increasing efficiency, usually in terms of decentralisation, outsourcing the manufacturing, flatter hierarchies, performance compression and, accompanying this, the resulting decrease in personnel. Total Quality Equating with "lean" in this sense is an oversimplification of the Japanese concept of an all-encompassing quality management or rather Total Quality Management (TQM). It offers the basis for attaining the advantages in efficiency and flexibility that are being strived for and which are visible from the outside as, amongst other things, organisational changes (see for example O'Mara 2013; Schonberger 2007).

The definition can also be determined on the basis of a constantly-evolving management philosophy. As a part of this philosophy the aim lies in the unison of the joint production skills and resources of the business functions, which are both business-internal and business-external (the latter being with the allied supply chain partners). The primary goal is to create a competitive network which is, to a large extent, furnished with benefits for the customer, and which aims at developing innovative solutions and synchronising the flows of products, services and information. The ultimate goal is to create the maximum value for customers.

Retrospectively studying the evolution then allows a further development and transition of previous management approaches, such as *Lean Manufacturing* or *Lean Production*, into the concept which is presently recognised as SCM. The scope for its application will hereby be extended to cover the distribution, whereby the distribution represents a portion of the order management process which focuses on the final delivery to the customer. In this sense, the goal of SCM lies in the improvement of the efficiency of the product delivery process, beginning with the material suppliers and proceeding right through to the end customer, in order to deliver the right product at the

right time and in the right place, using a minimum of security stocks and processing effort. The focal-point of improvement measures lies primarily in the areas of warehousing, distribution, production and procurement—across organisational units and various businesses.

Observed from the functional side SCM allows itself to be defined as the systematic and strategic coordination of traditional business functions, in addition to the tactical and operative measures which span across these business functions. These include the functions within the relative business, and also the various businesses which are integrated as partners within the supply chain. The main purpose is to improve the long-term performance of the individual businesses, as well as improving the supply chain as a whole.

From a behavioural point of view, SCM can be defined as those activities and tasks which are carried out in order to influence the behaviour of the supply chain and obtain the desired results. Seen in this light it represents the coordination of procurement, production, stocks, locations and transportation amongst the participants, in order to secure the best balance between performance capability and flexibility on the one hand and efficiency on the other.

A further possible differentiation can be made by means of using both sides of the supply chain, i.e. the control of the supplier-side on the one hand and the customer-side on the other. Accordingly, the hallmark of the supplier-centric approach is that the business and its suppliers, distributors and customers—that is, all interfaces and connections of an organisation in a broader sense—work together in order to provide the market with a common product or service, for which the customer is willing to pay the amount requested.

For the combination of the normally conflicting targets of cost and quality, there is also the term *Outpacing Strategy* which is characterised by the fact that during the strategic adjustment of its activities, a business changes direction between the two main competitive strategy alternatives in good time (these alternatives being cost leadership and differentiation according to Michael Porter), in order to achieve a stable and sustainable advantage over the competition (see Gilbert and Strebel 1987). Above and beyond this strategy, which is not based upon a simultaneous, but rather on the assumption of a successive application of various alternative strategies, there are also so-called *hybrid competitive strategies* that fall under the simultaneity-approach, which is based upon the assumption that the application of a combined strategy is at least temporarily possible (see e.g. Porter 2011, pp. 1).

The group of businesses that recruit from the supply chain partners or participants functions similar to an expanded business, with the aim of ensuring the optimum usage of shared resources (employees, procedures, technologies, etc.), in order to attain the establishment of synergies. This results in products and services that are of high quality and inexpensive, and can be quickly delivered to the market. Therefore the aim is to achieve a combined and simultaneous use of the normally conflicting targets of the respective Strategic Triangle or Strategic Square.

The definition of the customer-centric approach requires only that the traditional definition is extended as follows (highlighted by underlining): the company and its suppliers, distributors and customers, i.e. all parties in the supply chain in the wider sense, work together to provide the market with a common product or service for which the customer is willing to pay the required amount throughout the entire lifecycle of the product.

For the adjustment of SCM on the customer side, there are also the concepts of *order-orientated SCM* or *demand-orientated SCM*. The primary goal of these concepts is to generate value for the customer, whilst improving the performance in terms of capital investment and cost-effectiveness.

In summary it can be said, that the primary goal of SCM is the increase in sales of products and services to the end user or consumer, whilst reducing inventory levels and minimising costs. An inevitable conflict of goals arises from this, because the underlying competitive factors (cost, time, quality and flexibility), are in competition with each other. Therefore, SCM is aimed at optimising the effectiveness and efficiency of the involved business processes, and the harmonisation of conflicts in goals—with the inclusion of the priorities in accordance with the respectively chosen competitive strategy.

### 2.3.2 Value-Orientated Supply Chain Strategies

In recent years, the number of businesses that follow a value-orientated supply chain strategy, in which the concept of the value chain previously described is the focal-point, has sharply increased. This trend was largely driven by businesses that use advanced information technology to improve their abilities in the field of SCM. In conjunction with this, the aim of the supply chain competence is to better cater for customer requirements, make better decisions, and be able to increase overall operational performance for the benefit of gaining a competitive advantage.

The consequence is that a large number of organisations have developed strategies that focus on the relevant processes to satisfy those requirements. These strategies should ultimately help to optimise order processing times, cash flows, return on investment, market share, and profitability. They represent the basis of a supply chain strategy which describes what a business wishes to attain with its supply chain, and which performance improvements the business wishes to achieve with it. Using this method a business can define how, by means of its supply chain processes and the associated infrastructure, it can contribute to the competitive capability of the organisation. The aim of the strategy definition is the identification of relevant competitive factors and their implementation within the supply chain. The supply chain strategy is thus subordinate to the business and competitive strategies or derived from these, and must, as such, support them. An important feature of a successful supply

chain strategy is therefore the adjustment to the business strategy and with this also the strategic core vision of the business.

> For the combination of corporate strategy and supply chain strategy, as well as the specifications and distinctive features of supply chain strategies please see, for example, Chopra and Meindl (2015), and Dittmann (2012).

SCM represents an interdependent organisational structure which links functions, businesses and countries, synchronises the movement of goods with the demand rate and increases the amount of goods created on the global market. For every product there is a supply chain and for each supply chain there is a competitor. The development of these supply chains is promoted by large corporations—typically major retailers and original equipment manufacturers (OEM)—which have the necessary vision and perseverance to drive the performance of their partners, exchange information, and work in unison, in order to secure a superior market position and the efficiency of their business functions.

The development of value-based SCM approaches results from the realisation that the isolated optimisation of individual parts of the supply chain does not lead to a cost-effective overall solution. In other words: *The sum of local optima does not equal the global optimum* (cp. Goldrath 1999, p. 4).

It is therefore necessary to look at the sequence of events within the supply chain holistically—starting with the customer order and orientated backwards to the purchase order raised upon the raw material suppliers, as well as forward-orientated through all of the following businesses which are involved in the manufacture and supply of the product or service to the end customer. The focus on the holistic supply chain represents the first step, the focus on the product the second, and the inclusion of value generation within the framework of a value-orientated process organisation which relates to the supply chain—as opposed to the traditional performance measurement, which is based upon the organisational structure—represents the third step. In this way, a type of "value flow" may

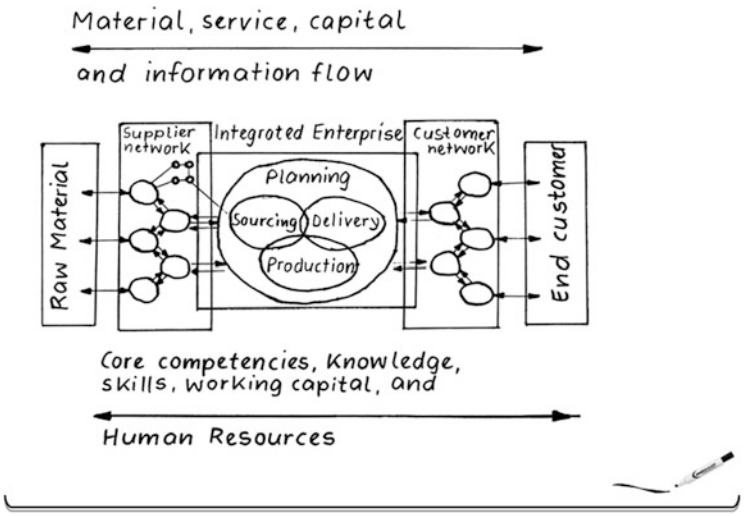


**Fig. 2.8** Integrated supply chain (cp. Cohen and Roussel 2013, pp. 41)

emerge, which better reflects the present business processes as was the case with the traditional supply chain (Fig. 2.8).

The organisational structure represents the scaffolding of an organisation (e.g. of a public authority or a business), and regulates the framework conditions, i.e. which employees and materials are responsible for the completion of which tasks. In contrast, the process organisation regulates all running procedures within this framework, and the information processes (on the topic of organisation structure, see for example Daft 2015, pp. 320).

### 2.3.3 Integration vs. Fragmentation

Fragmented supply chain strategies are a diametrically opposed approach to conventional supply chain strategies, as the latter precisely positions the importance of integration into the spotlight. With the word "fragmented", the opposite of "integrated" in the sense of "incorporated" or "included", is usually understood. That is, "fragmented" stands for "non-included" or "non-incorporated". An example from the practice of current daily business will help to clarify what exactly is meant by this.

The idea of the SMART car was initially created by Nicolas Hayek, founder of the Swatch Group. His vision was that of "Swatch-Cars", which should preferably be small and should have an interchangeable body (similar to Swatch watches). The *Smart* business was founded by Hayek in 1994 as the Micro Compact Car AG in Biel and as a joint subsidiary of Daimler-Benz and SMH SA (Société Suisse de Microélectronique et d'Horlogerie). In September 2002, the Micro Compact Car AG was renamed Smart GmbH. With effect from the 1st of October 2006 the employees were integrated into the then Daimler-Chrysler organisation, and the Smart GmbH was dissolved end of 2006. The manufacturing facilities are located mainly in Hambach, France, which due to this is also called "Smartville", and partly in Born in the Netherlands (www.smart.com).

As part of the development of the so-called *SMART car*, a feasibility study was initially carried out by Mercedes-Benz. The supply chain which was developed and presented for this purpose at the time, in the mid-1990s, represented a completely new approach. In accordance with this, for example, new models were created for the integration of suppliers and the outsourcing of production. These were characterised by pre-assembly at the site of the suppliers, integration of the suppliers into the design and final assembly, and shared ownership of production plant locations, etc. Additional challenges arose, for example, from the fact that the initiating business only contributed about 15 % of the added value within the supply chain.

The specific question which resulted was: how can a supply chain be monitored and controlled, in which the central business only offers a relatively minor contribution in value? Developed as part of the feasibility study, the fragmented supply chain provided the basis for the introduction of the so-called *customer-specific serial production* or *mass customisation* (see Van Hoek and Weken 2000).

The *customer-specific serial production* or *mass customisation* represents another variety of the aforementioned hybrid competitive strategies. Essentially, the understanding of this is—expressis verbis—the customised mass production of goods for a large retail market. The products must therefore satisfy the differing requirements of the purchasers. In this case the prices should represent those of a mass production of standardised products. This approach therefore seeks the balanced combination of continuous mass production with discontinuous single production (see e.g. Kull 2015; Gardner 2009). For the connection between product customisation and supply chain management Anderson (2008), is particularly recommended.

The term *strategic networks* can sometimes be found to describe the fragmented supply chain approach, which is understood to be the opposite pole to the previously illustrated value-orientated supply chain approach. In accordance with this, the value-orientated approaches within the business systems are the most effective, which simultaneously postulates a close cooperation and the maintenance of independent businesses. From valuable experience, four characterising features allow themselves to be identified, which favour the development of strategic networks:

- The speed of adjustment of the supply chain is crucial for market success.
- Some of the critical supply chain activities must have advantages when they are carried out in a fragmented form. This can be as a result of differences in terms of market entry barriers, competitive advantages, etc.
- Specialised investments lead to higher efficiencies. These investments may constitute capital investments or investments in workforce.
- Innovation requires a holistic understanding of the supply chain system, whereby the word *innovation* in this context is understood to mean the development and implementation of examples for new thought and operation patterns.

In the case of the SMART car all of these factors have come into play, which has contributed to a fundamental rethinking with regards to the postulate integration of the supply chain, that up until then had been regarded as irrefutable. One of the associated consequences was, that the use of fragmented elements within an otherwise integrated supply chain has been discussed to a greater extent and increasingly used in daily business practice.

For an introduction into the topics of *innovation* and *innovation management*, the work of Davila et al. (2013), is particularly to be recommended, whilst the book of Davenport (1993), represents a standard reference work on the topic of *process innovation*. A very comprehensive overview of the various aspects in conjunction with innovation and the associated changes can be found in Drucker (2013).

## 2.4 Practical Examples: Consequences of Supply Chain Mismanagement

Listed below are some practical examples, presented to illustrate the serious consequences which may be involved if a business does not pay the necessary attention to the management of its supply chain, or does not have the required supply chain expertise. The potential errors associated with this concern all relevant areas of the supply chain (cp. Lee 2004):

- Design: for example, lack of adaptability.
- Control: for example, inadequate responsiveness or insufficient flexibility.
- Coordination: for example, lack of consideration for the interests of partners, etc.

The effects can be serious and possibly even threaten the existence of the business itself.

### 2.4.1 Lack of Adaptability at Lucent Technologies

Executives often wonder whether it is really necessary to continuously update their supply chains and adjust them if considered necessary. This depends to a large extent on the fact that it is difficult to accept that continuously changing competitive conditions make a permanent process of change and adaptation necessary.

In the middle of the 1990s the executives of Lucent Technologies realised that the business could only gain a foothold in the Asian market if it possessed production facilities on site. Consequently Lucent adjusted its supply chain accordingly. Factories were constructed in Taiwan and China and they could therefore, similar to their competitors Siemens and Alcatel, adapt digital exchange cost-effectively in order to better fulfil customer requests. In order to integrate the interests of the parent and subsidiary businesses, the executives decided to no longer charge the Asiatic business excessive prices for the import of structural components from the USA. This enabled Lucent to recapture its lost market share in China, Taiwan, India, and Indonesia by the end of the 1990s, and to strengthen its competitive position at a later stage.

Until mid-2006 *Lucent Technologies* had been an independent business with headquarters in Murray Hill, New Jersey, USA. The Group developed and distributed systems, software and services for communications networks with emphasis on the convergence of networks, services and communication media. Their clients included service providers, global businesses, and local authorities. In the fiscal year 2004 Lucent Technologies achieved a revenue of 9.1 billion US Dollars (about 8.3 billion Euros at the exchange rate in mid-2015), and employed approximately 31,000 people worldwide. Following the take-over by its competitor, Alcatel in 2006, the group operated under the name of Alcatel-Lucent. On April 15, 2015, Nokia announced that is would acquire Alcatel-Lucent for 15.6 billion Euros (www.nokia.com).

Up until then, the correct action had been taken, but following this Lucent failed to continuously adjust its supply chain. The

management had obviously not realised, that many middle-sized manufacturers had then developed the necessary technology and gathered the required expertise, in order to manufacture components and assemblies for digital switching centres (so-called "switches"). Due to the advantage gained by the scale of the quantities, they could manufacture at a fraction of the cost required by the integrated businesses, and Lucent failed to take advantage of the fragmented elements of the supply chain to counteract. The competitors had recognised the sign of the times and forcefully outsourced the manufacture of the switching systems. Due to the resulting cost savings they could offer them at lower prices than Lucent.

Meanwhile, the management of Lucent Technologies hesitated with the outsourcing of its manufacturing, because the business had invested in its own factories. Finally, however, the group had no other choice than to close its Taiwan factory in 2002 and to begin to build an outsourced supply chain. However, the transformation of the business took place too late to regain control of the worldwide market. In mid-2006, Lucent was taken over by its competitor, Alcatel.

### 2.4.2 Lack of Consideration Shown for the Interests of Supply Chain Partners at Cisco

Different businesses within the same supply chain can have different interests. To not offer adequate consideration to this fact can also lead to serious problems, such as a lack of adaptability. During the 1990s, most experts assumed that Cisco's supply chain was the "ideal" type and therewith practically infallible. The business was amongst the first to use the Internet to communicate with suppliers and customers, and to automate business processes between trading partners. It was due to this, for example, that the previously illustrated concept of Collaborative Planning, Forecasting and Replenishment (CPFR) became more intensely used.

*Cisco Systems* was founded in 1984 by scientists at Stanford University in California, USA. The Group, which has its headquarters in San Jose, California, is now a leading global provider of networking solutions for the Internet. In the fiscal year 2014, Cisco had a turnover of 47 billion US Dollars (about 43 billion Euros at the exchange rate as at mid-2015), with more than 74,000 employees (www.cisco.com).

In addition to this, Cisco was also a pioneer in collaborative production procedures, such as Online Product Tests, that will help suppliers receive high quality results with a minimum amount of manual data entry. The business also outsourced the manufacturing of most of its networking products, and worked upon selecting those sites which were best suited to cover its requirements in order to work closely together with various contract manufacturers (outsourcing).

In 2001, Cisco surprisingly had to write-off stock to the value of about 2.25 billion US Dollars (about 2.06 billion Euros at the exchange rate in mid-2015). As it turned out later, there were several factors that played a role in this, but the most serious was the conflicting interests of Cisco and its partner contractors: above all, Cisco was mainly interested in paying the lowest possible prices to its suppliers and therefore insisted upon freezing the prices for as long as possible. This course of action, however, was not always in the best interests of the contract partners, because even a mere rise in the cost of raw materials or wages and salaries would have forced the already negligable profit margins further downwards. However, when economical growth slowed down in the USA at the end of 2000, the cost of raw materials lay noticeably lower than at the time of the original agreement. The contracted partner manufacturers therefore produced and accumulated large amounts of inventory at an unchanged rate for months without taking into account the actual market demand for Cisco products.

Finally, Cisco realised that it could not use most of the materials delivered, because the demand at the end customer had considerably reduced. The business was therefore forced to sell the excess inventory as obsolete, and write off the loss in capital. With this, Cisco had

therefore paid a heavy price for the lack of consideration for the interests of its partners.

### 2.4.3 Insufficient Responsiveness at Hewlett-Packard

Businesses often overlook the fact that supply chains should be flexible in order to respond as quickly as possible to changes in demand behaviour. This comes largely from the fact that, for some time, the adaptability and the balance of interests have been recognised as relevant supply chain requirements. However, it is a false conclusion to believe that a satisfactory responsiveness automatically accompanies this. The latter represents an additional and more recent requirement. However, even if the supply chain is both adaptable, and respects the interests of all participating businesses, it is dangerous to disregard the aspect of responsiveness.

*Hewlett-Packard (HP)*, was founded in 1939. The business is located in Palo Alto, California (USA). In 2002, it merged with its former rival Compaq Computers. With more than 300,000 employees in 170 countries and a turnover in the 2014 fiscal year of around 114.9 billion US Dollars (about 104.5 billion Euros at the exchange rate as at mid-2015), HP with its two divisions, Hewlett-Packard Enterprises and HP Inc., belongs to the world's leading information technology businesses. The product range includes, amongst others, Computers, printers and printer supplies, digital cameras, consumer electronics, servers, storage devices, IT application solutions and services (www.hp.com).

In 1995, Hewlett-Packard got together with its competitor Canon, to jointly develop and market printers. At the very beginning, the American company tuned its own interests to those of its Japanese partner, i.e. showed exemplary behaviour in this respect. It was agreed that HP would assume the production of printed circuit boards, whilst Canon was to build the motors for the newly-planned LaserJet series.

The division of labour was regarded on both sides as fair and just, and the research and development teams quickly learned to work closely together. After the LaserJet printer had been commercially released, HP and Canon swiftly adjusted the supply network for marketing the product. HP used its factories in Idaho, USA and in Italy. Canon manufactured in its factories in West Virginia, USA and Tokyo, Japan. After some time, however, a problem emerged that neither HP nor Canon had foreseen.

To keep costs low, Canon had agreed to vary the number of motors produced. However, this was subject to the condition, that HP would advise them of the changes long beforehand—in some cases at least 6 months before the printers were due to be put on the market. However, at the earliest, HP was only able to predict the demand 3 months before the printer was launched. At this time, however, Canon could only modify its production plan marginally by a few percentage points. The result was that the supply chain could no longer absorb sudden fluctuations in demand.

As the demand for the LaserJet III declined towards the end of its lifecycle, HP was left with a large and costly amount of its revenue invested in excess printer motors, known as the infamous "LaserJet-Mountain". Although HP had an adaptable supply chain which also preserved the interests of all partners, this fact did not assist the business to avoid the negative consequences that had arisen due to the lack of responsiveness of its supply chain—for which it had to accept significant losses.

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# Planning, Management and Control of Processes in Procurement, Manufacturing, Warehousing and Logistics

3

> *At the end of the day, supply chain management is about relationship management. A supply chain is managed link-by-link, relationship-by-relationship, and the organisation that best manages those relationships will win.*
> (cp. Lambert 2014, p. 6).

## 3.1 Work, Material and Information Flows

The beginning of the previous chapter has already discussed the importance of the process perspective to understand the supply chain, and introduced a process-orientated framework for businesses. A process can be defined, in this context, as a series of sequential activities and actions that are gradually triggered by events and lead to a result. Processes can be broken down into sub-processes. Furthermore, one can differentiate between key processes that include procedures or partial-procedures and contribute directly to the fulfilment of the business's core activities, and support processes, which represent the related actions in support of the key processes.

Typical key processes within manufacturing businesses include:

- Development
- Product Evolution
- Procurement
- Production Planning
- Production



R.G. Poluha, *The Quintessence of Supply Chain Management*,
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- Acquisition of Orders
- Distribution and disposal

The key processes are classified in the previously-mentioned product lifecycle and are often distributed across several businesses, as long as an appropriate division of labour is present. Basically, two primary and superior approaches to the illustration and description of supply chains can be identified: the Process Chain approach and Process Reference models.

For a comprehensive and current overview and description of the structure, elements and control principles of Supply Chains, Chopra and Meindl (2015), is particularly worth noting.

The currently most widely used reference model for supply chains is the *Supply Chain Operations Reference model (SCOR)*. It spans the entire supply chain, from the procurement process to consumption. It is an ideal-typical approach that applies to various types of business, and in which the sequences attributed to the partners within the supply chain are unitarily described. The SCOR model is studied in more detail in the further course of this work.

The *Process Chain Approach*, which is also known as a *Process Chain Model*, forms a business's supply chain from the onset and from a purely process perspective. The result is a type of process-focused supply chain, which is known as the *Process Chain*, or *Event-driven Process Chain (EPC)*. This process chain can be described as a combination of time and logically related activities that serve to achieve a given business result. The process chain model enables visualisation and analysis, as well as the organisation of processes within the supply chain. In this case, each process may be represented by using the following parameters, which are reflected in the form of process chain elements (for an example, please see Fig. 3.1):

- Input variables.
- Output variables.
- Resources.

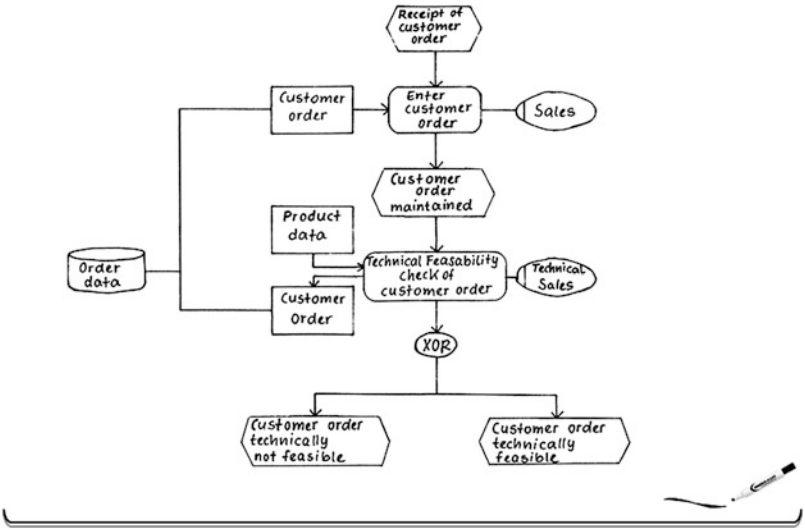



**Fig. 3.1** Example of a process chain.
*Note*: "XOR" is one of the connection symbols (connectors), in process chains. These symbols are used to split or unite the control flow. Three connectors are available: AND, OR, and XOR (Exclusive OR)

- Structures.
- Control.

Additional information on *Process Chains* and *Event-driven Process Chains (EPC)* can be found for instance at Damelio (2011), and Panagacos (2012).

A process chain element is connected to the business environment, on the one hand by the input variables which, as it were, describe the load under which the supply chain finds itself, and on the other hand by the output variables. The respective process chain element transforms a given input variable into a given output variable in

accordance with the design of the process chain. The process, which is stored in the design, is thereby described on a lower, i.e. more detailed level.

The comparison of input and output variables can draw conclusions about the productivity of the process chain (i.e. output quantity in relation to factor input quantity), and thus also on their effectiveness and efficiency. The approach therefore also has the aim of providing the necessary information with which to perform model-based, quantitative performance analyses of the supply chain. The measurement of supply chain costs often represents a region which greatly interests business executives—after all, it often conceals the potential to save on costs. However, the measurement also relates to an area that often involves a complex sequence of activities, so that an accurate measurement is difficult. You will find more on this topic in the next section.

Regardless of whether the process chain approach or a process reference model is used, processes are at the focal point. One method which is concerned with the finding, designing, documenting and improving business processes, is *Process Management*, which is also sometimes referred to as *Business Process Management*. Prior to the implementation of new or redesigned business processes, it is absolutely necessary to investigate which contribution they make with respect to the relevant factors within the strategic triangle—cost, quality and time. The related concept of Business Process Optimisation will be discussed in more detail in the third chapter.

For further information about the subject of *Business Process Management* or in short *Process Management,* Dumas et al. (2013) and Franz and Kirchmer (2012) are highly recommended.

In the integration concept for the design of Business Processes shown in the first chapter, the specific input variables (e.g. raw materials, manpower and data), and output variables (e.g. products,

services and activities), are not explicitly described, but are rather considered to be an intrinsic part of Business Processes. In the context of the supply chain, the material flows, work processes and information flows are of crucial importance with respect to the input and output variables.

The *Material Flow* embraces all processes and their linkage with the profits and the production and distribution of material goods within certain established production areas. In conjunction with the supply chain, the material flow exceeds the boundaries of the respective production areas. More recently, the term *Value Stream* is commonly used, with which the requirement is simultaneously connected of designing material flows only in such a way as to ensure an increase in the material value in the customer's best interest, and to ensure that wastage is avoided. The primary objectives for the improvement of material flows are:

- Shortening lead times.
- Reduction in scrap.
- Cost savings.
- Avoiding energy waste and environmental pollution.

A *Workflow* is a predefined sequence of activities within an organisation, which emphasises the operational-technical view of the processes and provides information on factors such as costs and revenues. In this case, an IT system to support the procedure can provide the organisation with necessary data and process it in accordance with a default or designated algorithm stored in the system. Several international bodies, which span between manufacturers, such as the *Workflow Management Coalition (WfMC)*, have developed special standards for this purpose, such as the *Business Process Modelling Language (BPML)*.

The *Workflow Management Coalition (WfMC)* was founded in 1993 as a global association of users, developers, consultants, analysts, universities and research institutes which have an interest in workflows and business processes. The WFMC creates

(continued)

process-related standards or contributes to them, and provides information about related issues and developments. In this context, the WfMC has, in conjunction with the *Object Management Group (OMG)*, a non-profit consortium of IT businesses (www.omg.org), created the widely spread and highly recognised *Business Process Modelling Language (BPML)* as a standard for the graphical mapping of business processes and workflows (www.wfmc.org).

The goal lies less in the documentation of an organisation or its employees, but rather more in a possible (partial) automation of the execution. In contrast to the business process, the operational level is dealt with in detail, in that the workflow description divides the process into components which are clearly visible at IT level and are in a deterministic relationship.

Workflow models are designed to help ensure the optimal integration of various applications (word processors, spreadsheets, databases, etc.), into the operations of the organisation. For this purpose a so-called *Workflow Control System* or *Workflow Management System*, is often used. This is an IT application solution, which enables the definition and execution of workflows by controlling the workflow instances according to a predetermined scheme depicted by a computer, and which makes the required data and information available by use of queries. The primary task of a workflow control system is to coordinate the operation of who (the role), what (the task), when (the process), and how (the environment), works. The analysis and definition of workflows can also take place without any reference to a computer system.

Under the term *Information Flow*, which is sometimes also referred to as the *Information Stream*, one understands the way to acquire and utilise oral or written information before it arrives at one or more recipients. The scientific study of information flow within organisations is called *Information Logistics*, in information technology it is referred to as a *Data Flow*. With regards to the information flow, it is important that the recipients receive the information in a punctual manner.

Disturbances in the flow of information can lead to misunderstandings, mistakes or even business failure. Severe consequences can ensue when the information reaches a person who is responsible for forwarding it, but he or she does not forward the information in good time. A poor flow of information within businesses is often a symptom of organisational or personal conflicts. Non-functional flows can lead to a loss of information and have far-reaching consequences.

It is obvious that the efficient and effective design of the material and information flows and work processes has a decisive influence upon the performance of the supply chain. At the end of the chapter is an example of how the analysis and optimisation can be carried out in practice, and which results can thereby be achieved.

## 3.2 Why and How Is Supply Chain Performance Measured?

### 3.2.1 Measurement of Cost and Performance of Supply Chains

The importance of measurement and control of supply chain costs arises directly from the objectives and tasks of supply chain management. One of these tasks is well known in the minimisation of time and costs, as the business's success largely depends on the punctual and accurate delivery of products and services.

The indicators to evaluate the performance capacity or the performance of an organisation should cover both the financial sector as well as the operations, since the aim is to achieve customer satisfaction at lower costs and ensure the long-term competitiveness. In this sense, performance indicators are not only intended to contribute to the continuous improvement of the performance of the supply chain, but also to control the business and competitive strategy.

For a comprehensive overview of the subject of supply chain costs and their measurement and control Cecere (2015), is recommended. An excellent introduction into Supply Chain Controlling can be found in Seuring and Goldbach (2010).

Performance indicators should be simple and clearly defined, easy to use and simple to understand, in order to allow the executives who use them to respond quickly and appropriately with adequate measures. Otherwise, in accordance with past experience, they will be consulted insufficiently or not all for supporting decisions.

The performance of the operations is an essential premise for the (external) customer satisfaction. The financial performance capacity however, reflects the (internal) profitability of the business and the ability to remain competitive. In the short-term period, the assessment of the financial performance capacity consists of the measurement of the *Marginal Cost* per unit (for each activity and each project), as well as the measurement of non-value-adding costs. In the medium and long terms a realistic assessment is more difficult. This is due to a number of causes, such as the inclusion of costs of research and development (R & D), because R & D costs cannot be broken down and therefore not be applied to each product individually.

*Marginal cost* is defined as the production of the most recently yielded (produced) unit. As long as the total cost curve of a product or cost centre is linear, the marginal cost of each manufactured piece is equal and corresponds to the proportional costs and the product costs. The terms product costs, marginal costs and proportional costs have an equivalent meaning. Therefore, instead of the term *Marginal Cost Calculation,* the terms *Proportional Costing* or *Direct Costing* are used (see e.g. Shim and Siegel 2009, pp. 2).

The management must also bear in mind that capital investors are primarily focused on maximising the profitability of the invested capital, and are therefore interested in the maximisation of the profit margin and asset turnover. Finally, they must leave the strategic decisions sufficient financial leeway, i.e. ensure an adequate financial flow or revenue surplus (Cash Flow).

Control of the business's performance has the intention, within the context of corporate governance, to ensure that the focus is on the achievement of defined strategic and operational objectives. To this end, the performance is measured by performance indicators and

subsequently monitored. However, not all the methods of measurement and indicators are effective. Many organisations are barely able to cope with the amount of data that is either irrelevant, too detailed, poorly organised, or of little value for decision-making, or may otherwise be difficult to obtain. An "excess" of data can have a detrimental effect.

*Key Performance Indicators (KPI)* are financial and non-financial measures and also measures that are intended to determine how successful an organisation is with a view to achieving its long-term goals. The supervision and control is usually carried out by the information service of the organisation, which has the primary task of determining the current situation and helping to develop future activities on this basis. The key performance indicators depend largely upon the nature of the organisation and the business strategy, and form an integral part of the measurable targets. These factors must be distinguished from the *Critical Success Factors (CSF)*, which are compared to the conditions that must be met in order to achieve the targets (see e.g. Marr 2012; Parmenter 2015).

Furthermore, some of the indicators have only a minor relationship to that which an organisation attempts to achieve. They are therefore not relevant for target achievement. Other indicators may be misinterpreted, because their meaning is unclear or ambiguous. The potential impact may consist in incorrect decisions with potentially far-reaching consequences. This has led to the development of a special management reporting system, which is characterised by the implementation of *Key Performance Indicators (KPI)*, for example within the context of a *Balanced Scorecard*, which will be discussed in the next section.

The key performance indicators need to be seen in conjunction with the so-called *Critical Success Factors (CSF)*. These have the purpose of identifying the key to a business's success factors. The more qualitative critical success factors are quantified and measured by the key performance indicators, which are sometimes also referred to as financial ratios.

It has been confirmed by various studies that businesses which deliberately monitor and control their performance by the use of these indicators are more successful than those who do not, or who only monitor it to a limited extent. If the business's executives are well informed about the performance indicators and the factors that have an impact on this and contribute to the results, they can make better, more effective decisions. Whilst doing this, the monitoring and control of the performance indicators must be aligned with the specific objectives, problem areas and decision factors, in other words, with the critical success factors.

The resulting benefits can be summarised as follows:

- Improved goal achievement.
- Improved and accelerated decision making.
- Alignment of the relevant workforce with the common objectives.
- Increased confidence and increased motivation amongst executives and personnel.

The problems associated with the general performance indicators have led to the development of special performance metrics and ratios to support the business's decision making process in specific areas, such as supply chain management. One possibility in this direction exists in the measurement of the performance capability using performance metrics, which are based upon related logistics activities. These logistic activities can thereby, for example, include the following sub-processes of the supply chain: purchasing, delivery, inspection, warehousing, manufacturing, intermediate delivery, order processing, shipping, logistics design, and strategic planning. For this purpose it is possible to apply, for example, the following performance measures: product availability, order cycle time, response time, and service quality.

An excellent and comprehensive overview of operational metrics can be found in Dimon (2013). For exemplary studies on the importance and the impact of the measurement of performance indicators, see e.g. Hofmann (2004), PMG (2002), and SAP (2004).

Another possibility is the application of process performance indicators and similar methods for the measurement of these indicators. Firstly, the process performance indicators can contain customer satisfaction, which can be evaluated or measured for example by carrying out and analysing customer complaints and customer surveys, or by the involvement of customers in product- and process-orientated performance appraisals. An additional potential indicator is the quality of customer deliveries, which focuses on the successful delivery of a product or service to a client and fulfilling his expectations. The customer expectations typically include perfect order fulfilment rates and the supply of products or services in the right place, in good quality and at the right time.

Another indicator which often is used, is the time from order placement to delivery or payment (order-to-cash). It measures, evaluates and compares the amount of time that elapses between the customer placing an order and the supplier side payment.

One method which is used to measure the cost is *Activity Based Costing*. In addition to the classic allocation of costs to cost centres, activity based costing has gained particular popularity for logistics services in the past few years. Due to the fact that the tasks performed within the supply chain are often comprehensive and cross-cutting, a cost allocation to internal cost centres proves itself to be difficult.

*Activity Based Costing (ABC)* is characterised by the fact that the allocation of product overheads of the indirect activity areas to the manufactured products is not carried out on the basis of value-based references. Rather, this is done according to the activities necessary for production (processes, activities), and taking into account the processes benchmarks (cost drivers). On this subject, see for instance Mocciaro Li Destri et al. (2012) and Velmurugan (2010); a specific reference to the subject matter on Supply Chain Management can be found e.g. in Askarany et al. (2010), pp. 238.

In addition, the transparency of the allocation of costs is often not present at the intra- and inter-enterprise levels. It is therefore necessary, as part of the process cost calculation, to identify the most cost-relevant factors. These factors are also known as *Cost Drivers*. These are divided into volume- and performance-based cost drivers. The aim is to determine the cost per process execution. The relevant basic data is obtained from the individual activities of the relevant processes.

### 3.2.2 Balanced Scorecard and Supply Chain Scorecard

The problems described in terms of a uniform procedure for the measurement of key performance indicators, as well as the assumption that the majority of existing approaches to measure performance are primarily based upon financial ratios, triggered a study with the title *Performance Measurement in Businesses of the Future* which was carried out by the Nolan Norton Institute at the beginning of 1990. The Nolan Norton Institute was, at that time, the research branch of the auditing and consulting company KPMG (www.kpmg.com). The study confirmed that in addition to the problems of redundant effort and lack of comparability, conventional approaches to performance measurement were too limited to monetary values. Conversely, the value-adding and pioneering process aspects were only given limited consideration. This was especially true with regards to the supply chain processes.

The study also laid the foundations for modification of the operational performance measurement by means of the development of the so-called *Balanced Scorecard (BSC)*. The further development lay mainly in the fact, that not only the optimisation of existing processes, structures and procedures was addressed, but also new processes, structures and procedures were included. Due to this, the method gained dynamic momentum and innovative capacity.

For reference to the study *Performance Measurement in Businesses of the Future*, and for an introduction into the subject of the *Balanced Scorecard (BSC)*, the standard work by Kaplan and Norton (1996), is particularly highlighted. Recommended furthermore are Gardiner and Simmons (2006) and Lawrie et al. (2005).

The concept of BSC was introduced by David Kaplan and Robert Norton with the intention of contributing to the development of business objectives, basing upon this the support for the definition of strategic initiatives in order to achieve these goals, and finally enabling the measurement of the results over the duration of time.

> If one tries to systematise possible objectives that may influence the target functions of a business, it helps to offer a fundamental distinction between monetary and non-monetary objectives. Under monetary or financial goals we understand those goals which can be measured in monetary terms, such as the striving for profit and sales. Any additional monetary objectives are for example, securing the solvency and capital preservation. Conversely, the non-monetary objectives include values such as achieving certain growth or productivity goals, the pursuit of market share expansion, and ensuring certain quality requirements (cp. e.g. Dimon 2013, pp. 1).

The method of BSC was, at the time it was developed (early 1990s), not entirely new, as businesses were already using a number of financial, non-financial, and tactical and operational indicators. It was, however, a relatively new practice to apply them in a composite and structured way, with the aim of measuring the operational performance as comprehensively and accurately as possible, and to determine whether the objectives had been achieved. A number of businesses were already using databases (so-called Data Warehouses), and spreadsheets to translate and implement the indicators. However, these were firstly not necessarily geared to the success-critical business processes and systems in general, or the supply chain processes and systems in particular. And secondly, collecting, aggregating and analysing the (correct) data often proved itself to be difficult and sometimes even impossible, because the required data material was not always or only insufficiently available.

The BSC contains two basic elements: the equilibrium (Balance) and the visualisation of indicators by means of an evaluation list (Scorecard). The balance is aimed at an indemnity, amongst other things, between the following components: strategic vs. operational

indicators, long-term vs. short-term positions, historical vs. future performance, hard vs. soft factors, monetary vs. non-monetary terms, cost drivers vs. performance drivers, internal vs. external processes.

The core *Strategic Vision* describes the purpose of a business, its core competencies and current competitive spirit to achieve a competitive advantage, the desired future competitive positioning and product range, as well as the financial goals (return on sales, etc.). One can derive from this the areas in which an organisation wishes to achieve excellence. Successful implementation can be seen in the evaluation of the corresponding power in the market (see e.g. Kotler et al. 2010, pp. 12).

In the visualisation of the indicators by means of a Scorecard, the *Strategic Vision* of a business, which is dictated by its management, forms a focal-point. This core vision must be made operational by means of strategies and activities and is considered, in conjunction with those, from four different perspectives:

- The financial perspective, which includes the return flow of funds and the value added.
- The customer perspective, which is characterised by customer satisfaction, customer preservation, market share, etc.
- The business process perspective, which contains the cost, quality, response time and new product launches.
- The learning and growth perspective, which includes employee satisfaction and availability of information systems.

Each of these perspectives within the limits specified by the BSC is in turn determined by four characteristics, which are of a business-specific nature: strategic intentions, performance indicators, targets and initiatives. In this way, BSC figuratively guarantees a balanced perspective of the selected financial and non-financial indicators which are necessary to advance the strategic plan and to monitor the business's performance. It can also be used as a tool for assessing value creation strategies for monitoring the success of the value-oriented processes and, finally, to check whether the involved groups

of interest (stakeholders), actually receive the value they expect in terms of return on capital.

For a detailed overview on the strategic and operational management and controlling approach to measuring the performance of supply chains, the book by Botta-Genoulaz et al. (2010), should be particularly emphasised. For use of the Balanced Scorecard in Supply Chain Management and the related *Supply Chain Scorecard*, Gleissner and Femerling (2014) and Gudehus and Kotzab (2012), are recommended.

Over time, BSC has evolved, due to its special possibilities, into one of the most widely used and accepted methods of defining and controlling the corporate strategy. The use of BSC is typically funded mainly by the Chief Executive Officer (CEO) or the Chief Financial Officer (CFO). BSC has therefore also become the preferred method of the largest management consulting businesses, such as McKinsey & Company (www.mckinsey.com), and The Boston Consulting Group (www.bcg.com).

The precise design of the scorecard depends largely upon the particular division being examined. Consequently, a special Supply Chain Scorecard was specifically developed for the area of the supply chain. The specific indicators which are required to measure and control the performance of the supply chain vary depending on the type of customer, the product line, the industrial sector and other factors. As the supply chain is ultimately aimed at the end user, it is important to include the perspective of the end user in the development of a Supply Chain Scorecard and the identification of specific indicators. This inclusion of the end user perspective consequently embraces aspects which are relevant, in terms of the capabilities of the supply chain in satisfying end-user requirements cost-effectively and in accordance with their wishes, as represented as an example in Fig. 3.2.

The development of a Scorecard specifically aligned to the supply chain inevitably requires the disclosure of corporate objectives and data between supply chain partners. Therefore, the design is not practical when there is no sufficient confidence between the

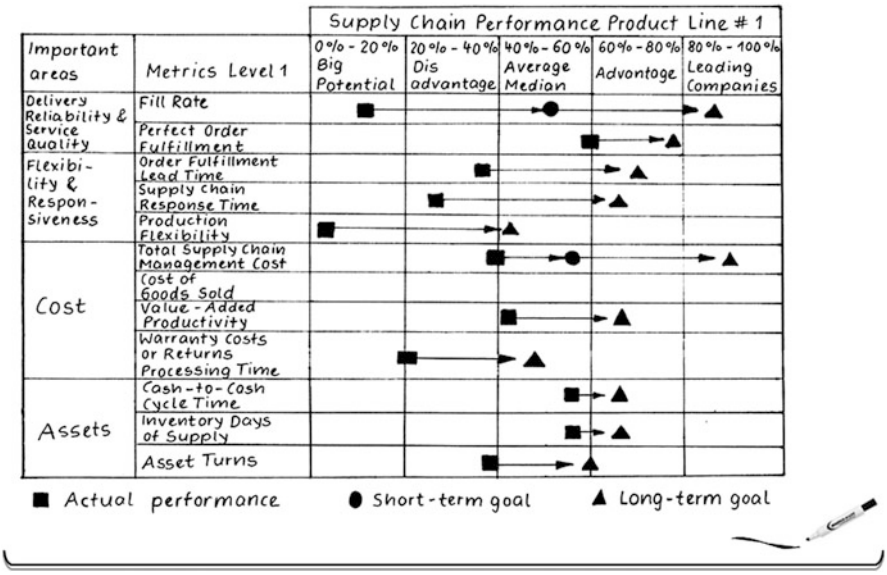



**Fig. 3.2** Supply chain scorecard (cp. Zimmermann 2010, pp. 399)

cooperating businesses within the supply chain. Thus, a Supply Chain Scorecard, which is shared by all parties in the supply chain, requires a relatively wide-ranging confidence. At the same time, however, the joint development of the Supply Chain Scorecard and the related exchange of data can enhance mutual trust and partnership. Nevertheless, the introduction of a scorecard focused on the entire supply chain appears, although theoretically desirable, relatively difficult in practice, due to the "conflict in interests" between manufacturers and suppliers.

The aforementioned SCOR model is another unified approach in order to, amongst other things, measure the supply chain performance. Since the approach extends to cover the entire supply chain, the workflows are configurable and there is the possibility of illustrating various alternatives of a same process. This as it were, creates a standardised language for the corporate and cross-business or business-integrated communication, which in turn is an essential

prerequisite for the performance comparison between the supply chain partners. The performance of the respective processes in the standardised supply chains is measured by means of specific performance indicators. We will go deeper into this subject in the next section.

## 3.3 What Is a Supply Chain Reference Model?

The *Supply Chain Council (SCC)* was established in 1996 in the United States. With the *Supply Chain Operations Reference (SCOR) model*, this organisation created a means of support for the standardisation and normalisation of supply chains, both within a single business as well as between several businesses. The primary objective of the SCC is to promote a common understanding of the processes and activities amongst the various partners that participate in a network.

The *Supply Chain Council (SCC)* was founded in 1996 in the U.S. by the two organisations Pittiglio, Rabin, Todd & McGrath (PRTM) (www.pwc.com), and AMR Research (www.amr-research.com). It initially included 69 voluntary member businesses and had expanded to over 1000 members worldwide, with global operations in North America, Europe, Japan, Australia/New Zealand, Southeast Asia and South Africa by the end of 2013. In 2014 APICS Supply Chain Council (APICS SCC), was formed through the merger between APICS, a leading professional association for the supply chain and operations management, and the Supply Chain Council. Today, APICS SCC advances supply chains through research, benchmarking, and publications and maintains the Supply Chain Operations Reference (SCOR) model (www.apics.org).

The process categories of the SCOR model are differentiated by the dimensions *Production Concept* and *Orientation of Product Structure*. With regards to this, the expression *discrete* corresponds to the focus on the assembly, i.e. a *convergent* product structure, whilst the

expression *process* literally corresponds to the process of alignment to the flow, i.e. a *divergent* product structure.

The primary task of the previously illustrated SCM concept is the continuous synchronisation of the value creation along the entire supply chain and its permanent coordination with consumer demand. It is this that the underlying supply chain of the SCOR model is based upon, which extends across the SCOR control processes in all businesses involved on the supplier and customer side. All conditions and opportunities to meet the necessary process steps are carried as a whole by the participants in the network and jointly agreed. The planning and control methods which are necessary to make this possible coincide logically with the methods that are used for internal planning and control. Other measures include methods to access data from the various businesses involved, in particular data pertaining to storage and capacity.

One great benefit of the SCOR model is to define a common language for communication between the various internal functional areas and, in addition to this, with the external supply chain partners. Only with a common understanding of the relevant processes does an optimised design of the customer-supplier relationships across the supply chain no longer represent a problem. The inclusion of performance indicators creates the conditions for a continuous evaluation and optimisation. Furthermore, these indicators provide the basis to enable the comparison of the performance of supply chains by means of a process known as *Benchmarking*.

*Benchmarking* denotes a comparative analysis of processes using specific performance indicators. In the operating economic doctrine this is a systematic and continuous process of comparing products, services and processes within the business (internal benchmarking), meant as compared to a comparison with businesses in the same sector (competitive benchmark level), or with businesses from other sectors (generic benchmarking). The relevant processes are compared using specific performance indicators (see for example Zhu 2014; Bogetoft 2012).

Since about the late 1990s, increasing and widespread acceptance of the SCOR model in the United States and the rapidly growing number of members in the SCC are a clear and present indication that a "de facto" standard for the description and analysis of supply chains has developed. With the intensified efforts of the SCC to create a user base by the establishment of a *European Chapter* in Europe, the SCOR model distribution is also expected to be increasingly found in European countries.

The term *best (business) practice* can be defined as exemplary solutions or procedural methods that lead to top performance, or as the approach carried out to determine such procedures and to take advantage of improving one's own processes, often as a continuation of Benchmarking. This is a pragmatic approach, which compares, in systematised form, the experiences of successful organisations and often also competitors and users, etc. It also evaluates various solutions which are used in practice, based upon operational objectives and upon this basis, specifies which designs and procedural methods best contribute to goal achievement (see e.g. Bogan and English 2014; Watson 2007).

In view of the standardisation aspect, SCOR may also be referred to as a *normative model*. A normative model consists of a predefined set of alternatives. It describes how an object of the model can be viewed and described, and how it should behave. The value of normative models lies primarily in the following areas:

- Simplification of the modelling by a higher level of abstraction.
- Compilation of an exchange of models above and beyond business areas and organisations by means of standardisation.
- Description of universally common problems and metrics by means of standardisation.
- Exchange of industrial norms for performance comparisons.
- Application of leading business practices *(Best Practices)*.

### 3.3.1 Origin and Evolution of the SCOR Model

In the case of SCOR one specifically understands a model which combines process elements, performance indicators, leading business practices and the specifics relating to the execution of supply chain activities in a very special way. The uniqueness and effectiveness of the model and its successful use are based mainly upon the concerted and coordinated implementation of these elements.

Basically, reference models are used in order to systematise business processes and uniformly represent them. SCOR builds upon the input, throughput and output scheme, which is used within the framework of process control. The model is used, amongst other things, to illustrate the processes at the various levels and to gradually formulate them.

A *Business Process Reference Information Model* (or in short: *Reference Model*), is a specific information model for an organisation, which is used on an individual case and abstracted to represent a standardised section of "reality". Reference models are thus attributable to the normative models and support the development of an individual information model of an organisation. For the practical implementation of supply chain management, enterprise-wide information systems which enable a rapid exchange of information are required, in addition to the willingness of businesses to cooperate and disclose the relevant processes. For more information on this subject, see for example Sherry (2012), and Geneva et al. (2011); a comprehensive overview of the operational reference models may be found in the standard work by Scheer (1994).

Reference models are based upon the aforementioned work processes (*Workflows*), and the control of these technological processes (*Workflow Management*). These reference models refer to the interfaces within the workflow structure which allow the individual processes to interact at various levels. All systems to control the workflows include a number of universal blocks that interact and influence each other within a defined set of scenarios. Depending upon their development, various products typically have different

performance levels within the specified and universally valid modules.

In order to achieve interoperability between the different workflows, it is necessary to establish a standardised number of interfaces and formats for the exchange of information. This can be achieved by setting up unique interaction scenarios with reference to these interfaces. These interaction scenarios in turn serve to identify various levels of functional conformity, which are in line with the range of products that are on the market.

A reference model also represents a model of the supply chain which can support the introduction of application systems. In conjunction with this, the advantages of a reference model result from the ability to provide the detailing of several levels of observation and methods of questioning. On the one hand this includes the description of the process conditions and process results, i.e. to answer the questions: which data, information and resources are to be used and which objects are to be processed? On the other hand, it embraces a description of the contiguous sequence from a process point of view, i.e. to answer the questions: which sub-processes and results control the process, and which organisational areas are thereby involved?

> On the subject of design, implementation and execution of business rules defining the business transactions within and between businesses and within the framework of supply chain management, as well as on various aspects of implementation of these business regulations in business information systems to support supply chain management, the book by Krichen and Jouida (2015), is to be particularly recommended.

Process decomposition models are clearly distinguishable from process reference models, whose intention is significantly different from the former. SCOR provides a language for communication between supply chain partners. Process decomposition models, however, are meant to observe a special configuration of process elements. They therefore lack the integrative character, both in terms of the business-internal supply chain, as well as the business-spanning supply chain.

As a new application domain associated with the reference models the aforementioned Electronic Business has, in recent years, become increasingly important. These reference models for E-business can be simply described as *those models which support the design of E-business systems*. The SCOR model can thus also be understood as an E-business reference model, since its use may require, amongst other things, an extensive use of information technology.

An interesting method of the classification and observation of reference models in the context of E-business can be found in Fettke and Loos (2003 & 2006).

### 3.3.2 Objectives and Structure of SCOR

The main objective of the Supply Chain Council is the creation of an "ideal type" model of the supply chain, so to speak. For this purpose the members of the SCC defined the SCOR model as a standardised process reference model of the supply chain and continued its further development. In 2012, the SCC released the latest version, SCOR version 11.0 (cp. SCC 2012a, 2012b & 2012c).

The application of SCOR is meant to enable a uniform description, analysis and evaluation of supply chains, across both businesses and industries. The model's application lies in three basic tasks:

- To evaluate and compare the performance capacity of (internal) supply chains.
- To analyse integrated supply chains above and beyond the involved partners and, if necessary, proactively optimise them.
- To determine the appropriate locations for the implementation of application solutions and their functionality along the supply chain.

The SCOR model has been developed and promoted by the Supply Chain Council as an industry-spanning standard for the management of supply chains. The SCC is significantly interested in the widest possible dissemination of SCOR in order to improve customer/supplier relationships as well as software systems, which can optimally support the members by means of the usage of common indicators and criteria. In addition to this, the SCC strives to achieve the early

recognition and adoption of leading business practices, regardless of their origin.

For further information on the SCOR model and its application, Bolstorff and Rosenbaum (2011) and Poluha (2007), are particularly recommended. The detailed description of the SCOR model, as well as an overview and a brief description of the SCOR model are available on the website of the APICS Supply Chain Council: www.apics.org/sites/apics-supply-chain-council.

Whilst a large part of the model's underlying content has been successfully used and tested for many years by practitioners, it also provides a flexible framework of business processes, performance indicators, leading business practices and system technologies, which are interlinked in accordance with the respective requirements. The result is a unified structure to support communication amongst supply chain partners, as well as to improve the effectiveness and efficiency of the supply chain planning and control.

All users that implement SCOR are requested to refer to the SCC in documents or illustrations of the model, and in the case of its application. In addition to this, members are encouraged to regularly visit the website of the APICS Supply Chain Council (www.apics.org/sites/apics-supply-chain-council), familiarise themselves with the latest information, and ensure they are working with the most current version of SCOR. With this the SCOR model represents, so to speak, the consensus of the SCC with regards to the management of the supply chain.

The assumption underlying the model is that each supply chain can, in principle, be identified by five fundamental processes, which are also known as *Chevrons*: in each of the four executive main processes—Procurement (Source), Manufacturing (Make), Delivery (Deliver), and Redelivery (Return)—materials or products are processed or transported. By combining these processes into a chain, customer/supplier relationships, amongst other things, are defined. These have supply and demand balanced out for them by the fifth fundamental process, namely Planning *(Plan)*. Putting all the

main processes together is intended to result in a holistic model of the supply chain.

In addition to these five main processes which make up the organisational structure of the SCOR model, the following three *Process Types* can be distinguished:

- *Planning:* a planning element is a process which aligns the expected resource requirements with the expected demand conditions. Consequently, the planning processes balance out the aggregate demand over a given planning horizon and can contribute to the response time of the supply chain. They usually take place at regular intervals. This process type refers to the aforementioned basic process of planning.
- *Execution:* execution processes are triggered by planned or actual demand and change the condition of a product. They include scheduling and sequencing, the change of materials and services and the movement of products. This type of process therefore includes the aforementioned four main processes.
- *Enable*, formerly *Infrastructure*: enabling processes are responsible for the preparation, care and control of information or relationships upon which the aforementioned planning and execution processes are based.

The diagram below (Fig. 3.3), summarises the model structure in pictorial form.

According to the diagram the first model includes a business's own supply chain and its five basic processes. In addition, it can also

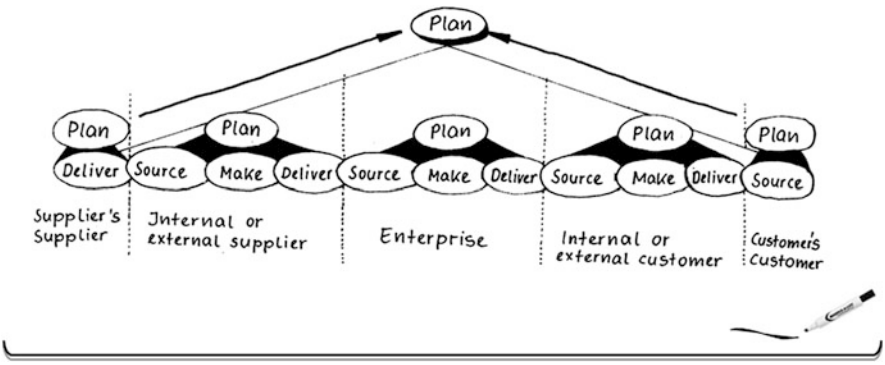



**Fig. 3.3** Structure of the SCOR Model (cp. SCC 2008, p. 1.2.1)

embrace the customer's supply chains on the one hand as well as the supplier's on the other. Finally, the supplier's own suppliers and customer's own customers can be included. In this sense, the model includes all interactions with customers, from order entry through to the paid invoice. Furthermore, it can include all products, materials and services, from the suppliers of the suppliers to the customers of the customer, including equipment, accessories, spare parts, and software. Finally, it covers all interactions with the market, beginning with the understanding of the total demand up to the fulfilment of the order.

The notation of the model is firmly defined and follows consistent naming conventions for the basic processes:

- The letter P stands for planning elements (*Plan*).
- The letter S stands for procurement elements (*Source*).
- The letter M represents the manufacturing elements (*Make*).
- The letter D stands for delivery elements (*Deliver*).
- The letter R represents redelivery elements (*Return*).

The basic processes can be configured as enabling processes. In this case the respective process is preceded by the letter E, indicating that it is an enabling element (*Enable*). Example: EP represents an enabling element within the planning process. Within the basic processes a universal structure also exists, whereby the model focusses upon the "product environment", so to speak, as shown below and using the example of the manufacturing process (*Make*):

- Stock production (*Make-to-Stock*)—M1.
- Contract manufacturing (*Make-to-Order*)—M2.
- Custom Built (*Engineer-to-Order*)—M3.
- Merchandise (*Retail Product*)—M4.

The terms procurement process (*Source*), and delivery process (*Deliver*), are classified accordingly. Only the return delivery process (*Return*), differs from this and is inevitably characterised by the following sub-processes:

- *Return Defective Product*—R1.
- *Return Maintenance, Repair or Overhaul*—R2.
- *Return Excess Product*—R3.

Within each section for the description of the planning and implementation processes, the associated enabling elements are also described. These will also have the same format as set out above for their description and graphical presentation.

In addition to this and in SCOR's case, we are dealing with a hierarchical model with several levels. The business's supply chain itself represents the output level (level 1). The subsequent main process level, e.g. *Plan—P*, represents the second level. Beneath this so to speak, follows the target object of the original main process, symbolised by a single digit. For example: P1—*(Plan Supply Chain)*. The exact number is derived from the respective position within the model structure. Level 1 metrics included in SCOR are:

- Perfect Order Fulfilment.
- Order Fulfilment Cycle Time.
- Upside Supply Chain Flexibility.
- Upside Supply Chain Adaptability.
- Downside Supply Chain Adaptability.
- Overall Value at Risk.
- Total Cost to Serve.
- Cash-to-Cash Cycle Time.
- Return on Supply Chain Fixed Assets.
- Return on Working Capital.

A level lower, that is, on the third level, there are the corresponding specific process steps, for example, *P1.1—Identify, Prioritise, and Aggregate supply chain requirements*.

Further levels, that is below the third level, are however, not included due to their specialised nature and would contradict the idea of the SCOR model being independent of any particular branch of industry.

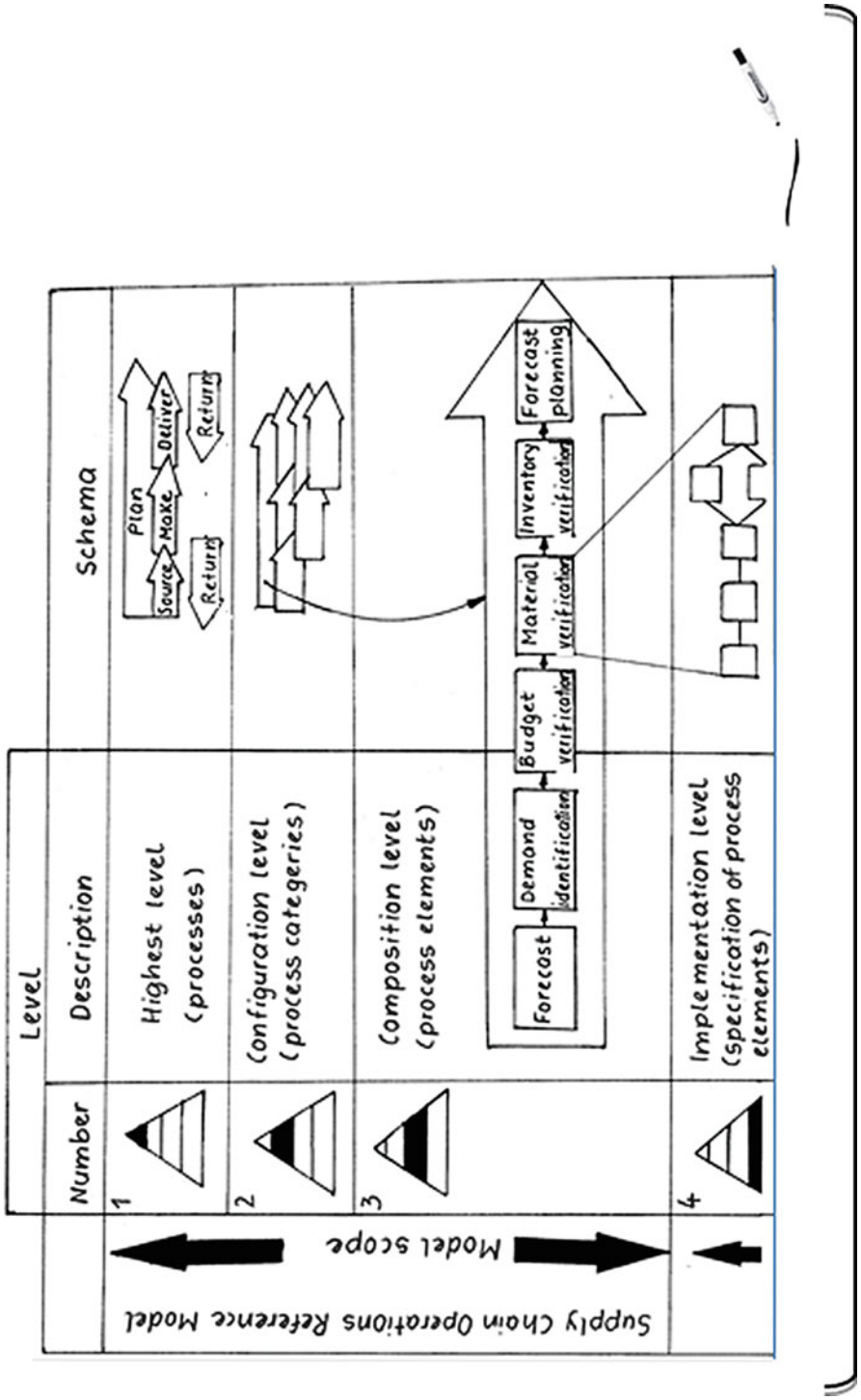



**Fig. 3.4** SCOR as a hierarchical business process reference model (cp. SCC 2008, p. 1.2.2)

The processes from the fourth level onwards prove themselves to be so extremely industry-specific and with increasing levels even business-specific, that standardisation would not be sensible or practical, and hardly possible. Therefore, the fourth and all subsequent levels represent the subject of operational implementation projects, whereby the fourth level refers to *Tasks*, the fifth to *Activities* and the sixth to *Instructions*. The diagram above gives a summarising overview of the relationships and the range of model coverage (see Fig. 3.4).

In addition to this there is the definition of indicators (Performance Indicators), which allow the basis for a performance comparison (Benchmarking), with businesses or supply chains within the same industry or from other industrial branches. The members of the SCC established the most effective business procedures for the main processes in order to achieve a high performance capacity, namely the aforementioned Best Practices, and integrated them into the model. Finally, the requirements of IT application systems were added, which are known from experience to be helpful in implementing these practices.

The performance indicators are, analogue to the process elements, also built up hierarchically. Although not explicitly shown in the model, they are typically allocated to the first level of the respective control process, (e.g. *P1—Plan Supply Chain*), and stemming from there and following the hierarchy they are collated and assigned to the respective Planning, Execution and Enabling Elements.

### 3.3.3 Practical Application

In summary it can be stated that the SCOR model has been developed with the intention of describing the business activities of organisations which refer to the supply chain, and which are connected with all phases that are traversed in order to satisfy customer requirements. By using the above-mentioned Process Modules and also by the use of universally valid definitions the model can serve to describe supply chains which are of a very simple or a very complicated nature. This allows disparate industrial branches to be linked, in order to reproduce the "depth" and the "width" of any given supply chain. The model has, in multiple practical applications, successfully contributed to the provision of a valuable basis for the

improvement of the supply chain, both within a location-specific as well as a global perspective.

One of the biggest strengths during the implementation of the SCOR model within the framework of projects to analyse the supply chain (hereinafter simply referred to as SCOR Projects), is the reliability and predictability of temporal duration and costs. The initiation of SCOR projects depends primarily on the particular objective. Thereby the following operational factors form the particularly important focal points:

- Improvement in the share price.
- Increasing the financial resources available for the implementation of investment (e.g. IT investment).
- Cost reductions.
- Increasing profits and margins.
- Optimising industrial planning by using an *Enterprise Resource Planning system* (ERP system in short).

*Operational planning and inventory management systems,* or Enterprise Resource Planning (ERP) systems pursue the primary objective, which is to integrate the often functionally aligned solutions for the diverse business areas existing within this business, i.e. procurement, production, retail along with the associated data into a system and to make it centrally available. ERP systems represent, in this sense, transaction systems which mainly reflect the actual status and manage historical data (see for example Magal and Word 2012).

In addition to qualitative improvements such as improved communication between the operational and functional areas, a sequence of quantitative results were able to be achieved and proven (cp. Bolstorff and Rosenbaum 2011, pp. 15):

- Improvement in operating profit by an average of 3 % in the initial phase of the project by reducing costs and improving customer service.

- Two to sixfold return on the project investment costs within the first 12 months, often associated with improvements which were able to compensate for the costs within the first 6 months.
- Reduction in expenditure on information technology by minimising business-specific system adaptations ("customisation"), and the better use of available standard functionality.
- Improvement to the business results by an average of 3 % in the initial project phase by means of cost reduction and an improvement in customer service.

Another not directly quantifiable benefit is the industry-independent character of the SCOR model. This enables, amongst other things, a comparison of the processes of businesses within various industrial branches and the resulting process optimisation.

In a review, the technology group Intel describes the benefits that have arisen within the context of the SCOR Initiative (cp. Intel 2002). The advantages described are mainly qualitative in nature. The project team, which was originally responsible for the SCOR project, strongly encouraged the spread of the SCOR model for implementation across all areas of Intel's supply chain. In this, a clear indication is seen that the team was convinced by the experience gained from the performance capability and the advantages of the model. Although difficult to measure, but still detectable and of great benefit, was the increase in knowledge of the project team members regarding the business and supply chain processes, as well as relationships and contexts within the supply chain.

The application of the SCOR model is also considered by Intel to be positive in order to understand the basic connections with regards to a generally valid language convention, and the orientation towards a continuous structure to internalise them. The involvement of representatives from the business areas is quoted by Intel as another big advantage. This enabled the risks associated with the unilateral implementation of projects for analysing and optimising the supply chain by the IT sector to be confronted.

Finally, Intel quotes the central knowledge database which has arisen within the course of the project and is now an integral part of the corporate *Knowledge Management (KM)* of the Intel business, to be a further significant advantage. The part of the knowledge base,

which was created and used for the SCOR projects, was also subsequently used for several cross-border projects. This included, amongst other things, an initiative for business process modelling in conjunction with the introduction of operational planning and the Enterprise Resource Planning system (ERP system).

For a general introduction into the subject of *Knowledge Management (KM),* refer to Pasher and Ronen (2011) and Dalkir und Liebowitz (2011); for a specific reference to KM in conjunction with Supply Chain Management, Gattorna (2015), is particularly recommended.

The view of the leading research firms such as the META Group (www.meta-group.com), extends in the same direction: the SCOR-based performance comparison of supply chains is viewed as a good opportunity to provide businesses with valuable information in order to analyse and optimise their business processes. In particular, the usefulness of indicators is highlighted, which make it possible to compare the performance capacity of the supply chain with that of its competitors.

In conjunction with this, Research companies highlight the special benefit in comparison to the aforementioned Supply Chain Scorecard, which has been used up until now, whereby they categorise the latter as being rather one-dimensional and insufficiently integrated. Thus, the advantages and strengths of the indicators applied within the framework of the SCOR model gain a strong and clear emphasis.

## 3.4 Practical Examples: Analysis and Optimisation of Material Flows

As stated at the beginning of the chapter, the material and information flows and work processes are of crucial importance in supply chain management and integration within the concept for the design of business processes at the outset. An analysis and optimisation based upon them should therefore be carried out at regular intervals to ensure the desired effectiveness and efficiency of related processes in procurement, manufacturing, warehousing and logistics.

The following shows an example of how an analysis and improvement of material flows can be carried out in practice (see Bolstorff and Rosenbaum 2011, pp. 17). There are similar approaches for the work processes and information flows. As was made clear in connection with the integration concept, it is necessary to consider and include all relevant factors for the optimal design of business processes, and thus on how best to achieve the business objectives.

### 3.4.1 Creating an Inventory of Existing Material Flows

In the analysis and description of the current actual material flows three points should mainly be noted:

- Compliance with the required precision in the presentation of details, i.e. ensuring the required level of detail.
- Realistic representation of the physical locations in geographical charts, for example, based on the types of processes on the second SCOR level.
- Creation of a table to illustrate the performance of the material flows.

The first task whilst analysing material flows consists of determining the level of detail in order to identify potential inefficiencies. Some factors that may assist in determining the reasonable accuracy are:

- In the case of actual values, it is often easier to define material flows in the form of a supply chain matrix, and carried out from a product perspective (usually in columns), and not from the customer's perspective (usually presented in rows). The reason for this is that physical locations, raw materials and major suppliers are listed mainly for products, not for customers.
- The level of the products which are to be cartographically represented during this procedure plays an important role. A cartographic representation of the material flows at the level of inventory of stock is more labour-intensive than the ones on the level of the product group or product family. In order to emphasise the tactical and operational inefficiencies in services, transport costs, lead time and inventory range as widely as possible, the highest possible level should be used.

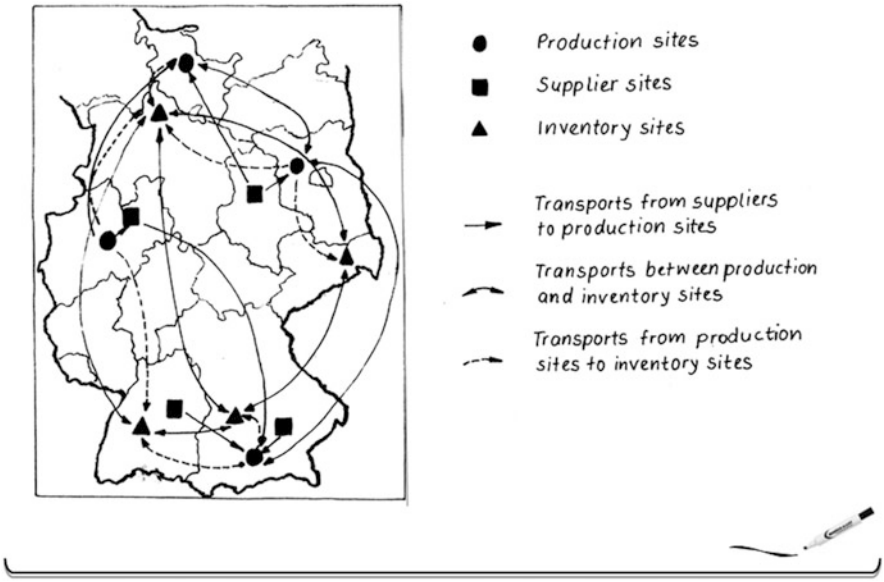



**Fig. 3.5** Example of a geographical chart based upon material flow types (cp. Bolstorff and Rosenbaum 2011, p. 253)

After the definition of the details the cartographic representation can be created. Usually, the physical locations and then the links of product families between these sites are drawn first, as shown in the figure above. There are two basic approaches to the creation of a cartographic representation:

- By type of material movement (input supplies, internal deliveries between production sites or warehouses, initial deliveries and return deliveries).
- Along the processes of the supply chain.

For many businesses, the creation of geographical charts to represent the material flows is the first in-depth examination of the efficiency of its material movements. The performance summary of the material flows therefore possibly represents the first attempt to quantify these efficiencies and attach their real value. Experience has shown that during this task the support of the transport department and the logistics services is of great assistance (Fig. 3.5).

A geographical chart with highlighted start and finish points for the deliveries from the distribution centres to the places of customer

fulfilment should include, for example, a list of its existing inefficiencies. Such a chart can provide valuable information to managers. Other charts can be developed for internal business deliveries between the personal storage or manufacturing sites and for inbound shipments. However, they are not able to provide a deeper understanding of the details which are necessary to answer the ultimate question: *what would be the (desired and undesired), consequences if the problems identified by, and represented in, the charts could be solved?*

Most project teams would probably prefer to make their material flow assessment based upon the established geographical charts. This rather superior view would, however, restrict the ability to make individual events or problems transparent and compare them. Another frequently observed preference is to wish to try and solve all material flow problems individually. This detailed view, however, severely limits the possibilities for observing the efficiency of the entire supply network. It is therefore important to ensure that neither of these two perspectives is neglected.

When the geographical chart is complete, it is followed by the creation of the performance summary of the material flows in tabular form. The aim is to conduct a comprehensive analysis of possible performance indicators for each site. Frequently used indicators in terms of the procurement process include:

- Punctuality and completeness of deliveries by the product supplier.
- Supply of raw materials to storage and production sites, and in transit.
- Transport costs will be calculated and charged in accordance with incoming deliveries.
- Duration of order backlogs.
- Cycle time for procurement due to current contractual agreements.

To align a supply chain strategy to effective material flows, knowledge and experience as well as collated and compiled facts are necessary. This knowledge and experience for the observation of material flows is implemented from a superior perspective in order to understand to which extent they are consistent with the supply chain strategy and business practices. Contrarily, however, the facts are used in order to focus upon details and to examine, for example,

how effective and efficient means of transport and capital are used to replenish the inventory in order to meet customer requirements. This part is inherently linked to working through large amounts of data.

The main components of the table for the performance summary of the material flows are usually place names, profits, warehouse management costs, transportation costs, inventory value, punctual order fulfilment, throughput times and return delivery quotas. The diagram illustrates an exemplary table for a product group and three locations.

The table in Fig. 3.6 expressively represents a summary. Each component is, however, supported by detailed information. The actual sales value of the deliveries for a particular delivery location is represented by the relevant sales data. Other possible details for inclusion in the analysis are the number of deliveries and the number of customers, for example, to represent places of fulfilment.

The storage costs result from the materials and products that can be stored and moved. The two inventory categories that are shown in the table are raw materials or semi-finished and finished products. Transport costs are usually aggregated into three categories:

- Freight costs for inbound deliveries from suppliers.
- Freight costs between own locations, that is, the transportation of goods between storage and/or production sites.
- Freight costs for outbound deliveries to customers.

For each category the cost, weight and number of deliveries represent relevant information in order to assess the efficiency of freight movements. The cost per delivery and the number of deliveries which are necessary to fulfil a customer order in this case are critical factors for the performance measurement. The inventory level data can be categorised in accordance with the product type—raw materials, semi-finished and finished products. The annual cost of the products sold by product type (i.e. direct as well as indirect costs that occur whilst manufacturing end products), which are partially referred to as sales costs (i.e. direct and indirect costs incurred by a business to produce finished products), must be known in order to allow the calculation of the inventory coverage.

The on-time performance rate is calculated for both inbound and outbound deliveries. Many businesses identify both the timely order

| Inventory Cost (m $) | | | | Transportation Cost (m $) | | | | Stock Level (m $) | | | | On-time Delivery (%) | | Lead time (Days) | | | Returns (m $) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Location | Revenue | Raw material & unfinished goods | Finished goods | | Inbound deliveries | company-internal | Outbound deliveries | | Raw material | Inventory in production | Finished goods | Goods receipts | Outbound deliveries | Inbound deliveries | internal orders | Customer orders | Volume ($) | Stock level | Freight charges |
| Dallas | 61.5 | 0 | 0.87 | $ | 2.28 | 0.85 | 2.1 | Stock Level $ | 0 | 0 | 22 | 0.67 | 0.69 | 62 | 3 | 5 | 19 | 20 | 0.25 |
| | | | | kg | 5.4 | 4.3 | 5.5 | Cost of goods sold $ | 0 | 0 | 86.1 | | | | | | | 86.1 | 1.2 |
| | | | | $/kg | 0.42 | 0.2 | 0.38 | Days | - | - | 93 | | | | | | | 85 | 0.21 |
| Atlanta | 52.5 | 0 | 1.04 | $ | 1.92 | 0.72 | 0.38 | Stock Level $ | 0 | 0 | 20 | 0.59 | 0.75 | 59 | 4 | 4 | 16 | 16.8 | 0.24 |
| | | | | kg | 4.5 | 3.6 | 4.6 | Cost of goods sold $ | 0 | 0 | 73.5 | | | | | | | 73.5 | 1 |
| | | | | $/kg | 0.43 | 0.2 | 0.38 | Days | - | - | 99 | | | | | | | 83 | 0.24 |
| Chicago | 56.2 | 0 | 0.97 | $ | 2.07 | 0.77 | 1.9 | Stock Level $ | 0 | 0 | 18.5 | 0.61 | 0.77 | 72 | 3 | 5 | 17 | 17.9 | 0.23 |
| | | | | kg | 4.9 | 4 | 5 | Cost of goods sold $ | 0 | 0 | 78.8 | | | | | | | 78.8 | 1.1 |
| | | | | $/kg | 0.42 | 0.19 | 0.38 | Days | - | - | 86 | | | | | | | 83 | 0.21 |
| Total | 170.2 | 0 | 2.88 | | 22.34 | 14.83 | 20.62 | | 0 | 0 | 576.9 | | | | | | 52 | 544.1 | 4.68 |

**Fig. 3.6** Performance overview of material flows (cp. Bolstorff and Rosenbaum 2011, p. 246 ff)

fulfilment (i.e. the complete and punctual performance of the sales order request), as well as the timely fulfilment of customer order items (i.e. the correct delivery of each respective item belonging to a single order). In this case they calculate the delivery time for all incoming purchase orders, internal transfer orders and outgoing sales orders.

The data compiled for this part of the table includes both the duration of the on-time order fulfilment as well as the duration of any backorders. The return delivery data embraces the total cost of returned products, the value of the inventory, the inventory coverage based on the annual cost of sales, as well as the cargo weight of redelivery and the resulting shipping costs.

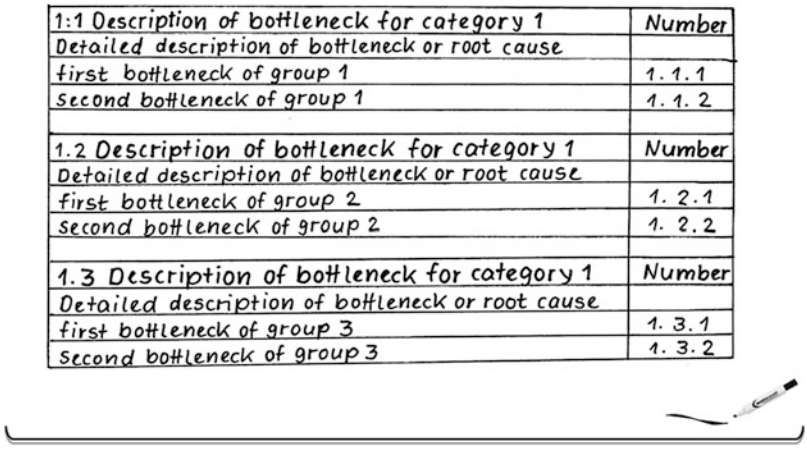
### 3.4.2 Performing a Material Flow Bottleneck Analysis

The analysis of material flow bottlenecks concentrates upon the identification of events, inefficiencies and problems with regards to the movement of goods—from suppliers through the business and up to the customer, in other words: throughout the complete supply chain.

For a thorough and useful representation of a bottleneck it is necessary to describe one in a complete and easily understandable sentence, create a direct reference to current and real-world examples (designation of a product, suppliers, customers, etc.), and to assess the frequency of the occurrence. A good problem representation usually includes three sentences: one to describe the problem, another to describe the effects by means of an example, and a third listing the indicator/s of the performance summary of the relevant material flow, upon which the problem could possibly have an effect.

An effective and simple system within this task consists of the allocation of a number to each problem category (1, 2, etc.), a second number for each sub-category (e.g. 1.1, 1.2, etc.), and a third number for each bottleneck (1.1.1, 1.1.2), and so on. The table in Fig. 3.7 below shows an exemplary template for the documentation options of the data collected.

Listed below are two examples to illustrate the possible material flow bottleneck categories, including problem descriptions and associated metrics:



| 1:1 Description of bottleneck for category 1 | Number |
|---|---|
| Detailed description of bottleneck or root cause | |
| first bottleneck of group 1 | 1.1.1 |
| second bottleneck of group 1 | 1.1.2 |
| | |
| 1.2 Description of bottleneck for category 1 | Number |
| Detailed description of bottleneck or root cause | |
| first bottleneck of group 2 | 1.2.1 |
| second bottleneck of group 2 | 1.2.2 |
| | |
| 1.3 Description of bottleneck for category 1 | Number |
| Detailed description of bottleneck or root cause | |
| first bottleneck of group 3 | 1.3.1 |
| second bottleneck of group 3 | 1.3.2 |

**Fig. 3.7** Template for summary of bottlenecks (cp. Bolstorff and Rosenbaum 2011, p. 73 ff)

- Bottleneck category 1.1: *inaccurate forecasts of operations due to a lack of reliable market information, weak demand signals for many product variants and inadequate data integrity*.

  The results are excess inventories and lost sales opportunities. For example, a product is forecast too low, although a higher demand for it exists, whilst another article is forecast too high, although only a small demand is present for it.

  The relevant indicators in this case being: forecast accuracy, delivery performance (date, etc.), sales, transportation costs, and inventory.
- Bottleneck category 1.2: *inefficient goods transfer between warehouses and/or incorrect adjustment to the inventory*. The results are longer lead times and inefficient use of existing stocks.

  Thus, for example, finished products are transported from one location to another in order to allow the recovery of the local inventory in response to reported backlogs. The products in question may actually already be present in large quantities, and the backlogs relate, in actual fact, to other articles.

  The relevant indicators in this case being: sales, inventory, transportation costs and warehouse management costs.

Many individual bottlenecks are conceivable under each bottleneck or problem category. Listed below are several examples of possible individual bottlenecks.

With reference to bottleneck Category 1.1—inaccurate forecasts of the business units:

- Bottleneck 1.1.1: the forecasts for new products are often inaccurate and result in lost sales.
- Bottleneck 1.1.2: incorrect forecasts for new products.
- Bottleneck 1.1.3: inadequate market information for forecasting new products.
- Bottleneck 1.1.4: a forecast at product-family level offers insufficient support, given the variety of available inventory products.
- Bottleneck 1.1.5: the growth rate of new products is not included in the sales plans and forecasts.
- Bottleneck 1.1.6: too much dependence upon the forecasts of the distribution function for new products and lack of involvement of strategic market forecasting.
- Bottleneck 1.1.7: discrepancies between the sales forecasting, marketing forecasts, and forecasts of the relevant business areas.
- Bottleneck 1.1.8: errors in data processing, leading to further errors in the planning and procurement to production (for manufactured products), or suppliers (for related articles).
- Bottleneck 1.1.9: spare parts are not forecast as a separate product demand, but there is an assumption that these are covered by the existing forecasts.
- Bottleneck 1.1.10: lack of transparency with regard to the influence of return shipments to the (adjusted) sales to end customers and intermediaries.

### 3.4.3 Creating Cause and Effect Diagrams

At the next stage, the above bottleneck categories are to be consolidated into unique and unambiguous problem statements. The following statements could arise from the previously listed bottleneck categories 1.1 and 1.2:

- Poor inventory planning: the problem lies in a purely operational and reactive management of inventories and replenishment orders.
- Inaccurate forecasts: this problem lies in insufficiently defined business practices, non-optimised forecasting methods, and the lack of personnel knowledge in the fields of marketing and sales planning.

One method which may be used for structuring the problem causes and their consequences is, for example, a method named after its inventor, Kaoru Ishikawa, which is also known as *cause-and-effect diagram*. It is based upon the visualisation of a problem-solving process, with the help of which the primary causes of a particular problem are sought after, and which is often quoted as one of the so-called seven quality tools.

For a comprehensive and current introduction into the topic of quality management and related topics, such as Total Quality Management (TQM), amongst others Goetsch and Davis (2014), and Pyzdek and Keller (2013), can be recommended.

The starting point is a horizontal arrow pointing to the right and which has, at its end, a problem, which should be as concisely formulated as possible (e.g. a high rate of error during a certain operation). From above and below this arrow, other diagonal "cause" arrows are aimed at it, which are also responsible for the alternative and widely spread name given to the diagram, namely the *Fishbone Diagram*. The main arrows usually refer to the basic categories of *material, machine, method and man*. Other typical categories are the *environment, business, measurement* and *processes*.

Horizontal arrows now point at these main arrows, upon which the uncovered problem areas are marked. Within the diagonal and horizontal arrows one is, in stages, able to search for gradually deepening causes. As a general rule, the technique of the *five consecutive questions* is applicable here, whereby based upon experience it is assumed that under certain circumstances one must pose up to five selective questions asking *why*, in order to reach the actual root of the problem.

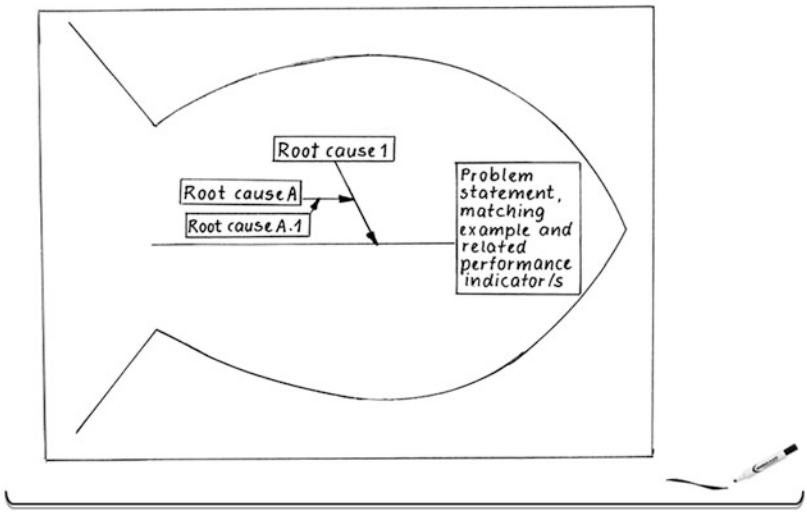



**Fig. 3.8** Template for cause and effect diagrams

The Fig. 3.8 above shows a template representing the starting point for a cause-and-effect diagram. The individual problem statements, i.e. the effects, form the starting point in this case (right side of the chart). In the first stage, the cause on a higher level is named (*Cause 1* in the diagram), and then a deeper level follows (*Cause A*). One should try, in every case, to attain the second level of the cause-hierarchy (e.g. *Cause A.1*).

### 3.4.4 Developing Concrete Improvement Proposals

The final step is to quantify the potential for improvement. The quantification procedures used for this may be based, for example, upon the following five fundamental principles:

- Whilst dealing with the level of improvements, realistic assumptions should be used with regards to the actual level of improvement, so that unrealistic expectations may be avoided.
- The assessment of the impact of projected growth is based upon the assumption that sales remain constant in the relevant financial period. The improvements can be approximately calculated upon

an annual basis and the profit growth may be illustrated by the use of the sales growth (i.e. a linear profit development is presumed).
- The assessment of the quantitative value for the elimination of a problem statement should take place, with the inclusion of the locations and measurements from the table for the performance summary of the material flows.
- Before publication of the figures and assumptions, all employees who may contribute to a conscientious examination and objective validation should be identified and involved. The resulting benefit aspects concern both the content substance and the change process. On the one hand, the quality is improved with regards to the validity and reliability of the figures, and on the other, the involvement of all relevant employees of the organisation is made possible, which also provides an insight into the project activities.
- All presumptions with respect to the estimated values should be clearly documented. This principle is of great importance, because doubts about the potential improvements are known to be far more common due to missing or unclear assumptions, than to the actual number of the values.

The possibilities to document the improvements vary from sophisticated tools for supply chain modelling and simulation, to simple spreadsheets. The real challenge is rather to determine which financial implications a value possesses upon the profit and loss accounting and the balance sheet, as a result of the elimination of a problem statement, and regardless of the application used. It is therefore understandable that employees often have difficulties with these assessments. To make this task easier, a rounding-up or rounding-down to whole $50,000 or $100,000, may take place.

An additional assistance during this task may be to determine a value for every cause on the lowest level, and then to calculate a grand total of the individual values for the respective cause-and-effect diagram, and associated problem statement. In other cases, however, it may be advantageous to directly determine an overall value for the entire chart or problem statement. Provided the assumptions are documented in detail for this purpose, both approaches are acceptable.

For many businesses it is often the first time that the skills and methods for management of their supply chain are studied in detail.

This approach has the primary purpose of providing a reference base, which can later be used to measure the achieved improvements. The degree of difficulty in the assessment of opportunities for improvement depends to a large extent upon the experience of the project members, as far as their cost accounting is concerned. Because the performance within the supply chain often involves widely embracing as well as cross-sectioning tasks, a cost allocation to internal cost centres proves itself difficult. In addition to this, a transparency of the allocation of costs at intra- and inter-enterprise level is not always given.

Due to this, and as well as the classic assignment of costs to cost centres, the previously mentioned activity-based costing has gained in importance in recent years. This fact applies particularly to logistic services. The focal point of activity-based costing is the attempt to identify cost-relevant factors and cost drivers. During this process, a distinction is made between volume-based and performance-based cost drivers. The allocation of the product overheads of indirect activity areas to the manufactured products takes place, not on the basis of value-based reference figures, but according to the activities required for manufacturing (processes and activities), and taking into account the reference figures that influence the processes (cost drivers). The goal is to ultimately determine the cost per process execution, whereby the relevant basic data stems from the individual activities of the respective processes.

Despite their progressive status, techniques such as activity-based costing are, at best, an approximate assessment of the opportunities for improvement. Using the bottleneck category presented at the beginning of Sect. 3.4.3 (*poor inventory planning*), the following could, for example, be identified as possibilities to increase profits, which result from the elimination of the associated problem statement by improving the relevant material flows:

- Reduction of the inactive inventory by a certain percentage. Based upon inventory write-offs, the resulting cost savings within the first year mainly have to do with the working capital. In the second year, however, the cost savings affect the profits in the majority of cases, because write-offs do not take place.

- Reduction of inactive stocks in the warehouses by optimising the sales and production planning processes, in order to comply with the requirements of the competition with regards to inventories and to reduce the inventory range by a certain number of days.
- Permanent and immediate availability of accurate inventory figures. This allows time for the multiple processing of an order, the shipment of inventory transfer orders, and the reduction in the notification of field service employees.

It is frequently possible to eliminate a large number of problem statements and cause-effect-diagrams by the introduction of relatively few, but therefore far-reaching, changes. However, there are no general rules for the duration of the development and implementation of future solutions. This depends largely upon the scope and complexity of the relevant problems.

From experience, the use of leading business practices (Best Practices) provides great assistance in the development of solution approaches. With regards to the above-mentioned bottleneck category or problem statement (*poor inventory planning*), such a solution proposal could consist of the implementation of the aforementioned concept of *Collaborative Planning, Forecasting and Replenishment (CPFR)*, in order to improve the material flows (please refer to Sect. 2.2). This in turn can result in the following potential measures for shaping future material flows:

- Shortening lead times by means of improvements to inventory aggregation and storage techniques. The aims are to increase the reliability of supply and to reduce transport costs.
- Conduct an increased number of direct deliveries from the suppliers to the warehouses of certain retail customers. This would mean a change in the connecting lines in the geographical charts. In future charts, the respective materials would be transported directly from the supplier to a regional warehouse of a final customer (i.e. the parent business is no longer directly involved in the flow of materials). This would replace the prior approach of using several warehouses and only delivering to the location of the end customer at the final stage.
- Optimising the material flow for returned goods. Before the changes, all return deliveries were transported from the sites of

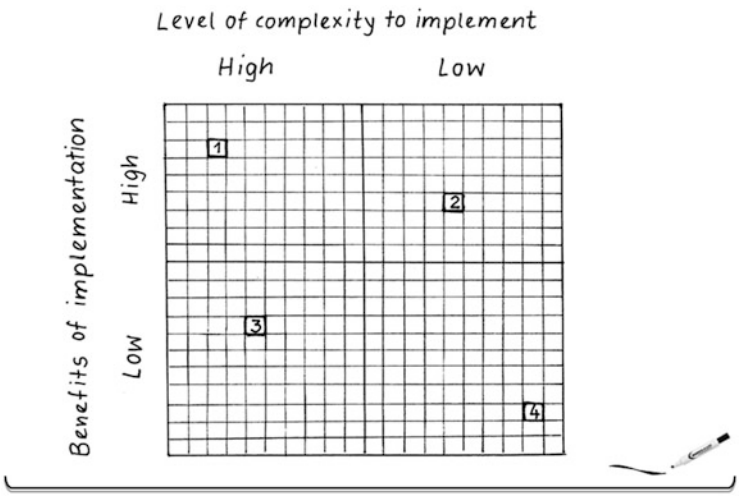



**Fig. 3.9** Example of bottleneck-potential-matrix (cp. Bolstorff and Rosenbaum 2011, p. 129 ff)

the customer to the closest warehouse of the parent business. In future charts, the returned goods would at first be consolidated in a regional warehouse of the customer, in order to then be transported to a central warehousing facility of the parent business, which functions as a focal point for the acceptance of all return deliveries.

Since there can be a variety of solutions for each bottleneck category and problem statement, and experience has furthermore shown that a variety of bottleneck categories and problem statements exist, the solution proposals must be conclusively prioritised. For this purpose, the creation of a *Bottleneck-Potential-Matrix* can prove itself to be of ideal assistance.

This matrix typically consists of four quadrants or areas in which the projects are positioned based upon the level of difficulty of their implementation and their expected benefits, as illustrated in Fig. 3.9 above. It is recommended to first tackle projects whose benefits are high and whose level of difficulty is low—in the illustrated example, these projects are the number 2.

As already mentioned, consideration should really be given to including the proposals for improving the material flows into the analysis, in addition to the developed suggestions for improving

workflows and information flows. The resulting list can be used as a basis for the implementation of improvement projects with a 6 month payback period. The achievements reached herewith can then be used to launch further initiatives, with which the goal is to achieve higher returns on investment over a longer period.

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# Innovative Concepts for Supply Chain Design and Optimisation

# 4

*Supply chain design, planning and operation decisions play a significant role in the success or failure of a business. To stay competitive, supply chains must adapt to changing technology and customer expectations.*

(cp. Chopra and Meindl 2015, p. 18).

## 4.1 Flexible Business Processes Using Adaptive Supply Chains

Since about the year 2000 it has become clear for many businesses, especially those in the fields of the manufacturing industry and the wholesale/retail trade, that in the present competitive environment the performance and efficiency of the supply chain are necessary conditions for the business to succeed. To assist in ensuring that these conditions are supported, *adaptable supply chains* or *adaptive supply chains* are being discussed lately. Terms such as *adaptive networks, agile supply chains* and *adaptive business networks* may be found for this purpose.

With regards to the conditions and peculiarities of *adaptive supply chains*, the book by Claus Heinrich and Bob Betts is particularly recommended (see Heinrich and Betts 2003). In addition, there are a number of interesting articles on the subject, such as Colehower

(continued)



R.G. Poluha, *The Quintessence of Supply Chain Management*,
Quintessence Series, DOI 10.1007/978-3-662-48515-6_4

et al. (2003), Holcomb et al. (2003), Radjou et al. (2002), and Segal (2003). Although most of them are several years old, the practical implementation within businesses is still at a relatively early stage.

### 4.1.1 Combining Planning, Procurement, Manufacturing and Distribution Processes into an Integrated Business Process

The adaptive supply chains are presently in the process of replacing the originally illustrated, traditional linear supply chain concept and the further advanced, dynamic supply chains. They possess the flexibility to continuously adapt to changing market requirements and thus respond to the environmental variables in an optimal manner, i.e. with maximum efficiency and in real time.

In order to meet these requirements, they combine planning, procurement, manufacturing and distribution processes into integrated business processes and provide supply chain networks with real-time information. This feature enables faster decisions and their efficient and effective execution.

IT systems supporting SCM try, amongst other things, to display the state of the supply chain in or at least close to real-time. For this purpose, data required with regards to demand, condition, location, etc. of materials and products along the supply chain are recorded at certain pre-determined points. This can take place for instance by scanning an individual bar code or by means of identification with the aid of electromagnetic waves (so-called *Radio Frequency Identification* or *RFID*). The combination of these real-time data stored in IT systems as part of an event-driven supply chain is called *Supply Chain Event Management (SCEM)* (see for this purpose e.g. Ijioui et al. 2010, and Otto 2003).

The conversion of a traditional supply chain into an adaptive network makes it necessary to review the business processes of the supply chain and undertake changes if necessary in order to remain

competitive. The supply chain is then no longer a static system, but rather a dynamic, constantly changing and adaptive high-performance network. The changes in market conditions determined by the internet play a major role, and the result must be seen in context with the currently available internet-based options. From this the following characteristics can be derived:

- *Event driven*: in this case, the afore-mentioned principle of control by means of demand pull comes into play, which is supported by information technology
- *Business-related*: in this case, one understands the focal point which lies upon the components of the integration concept for the design of the business processes which was introduced in the first chapter. Influencing factors are: human resources, organisation and information technology, business goals, business strategies, and business guidelines, as well as the business context (industry, etc.)
- *Self-regulating*: with the use of suitable application solutions the supply chain may be continuously adapted to the actual demand in order to proactively avoid supply shortages, as well as the occurrence of surplus materials

The following diagram illustrates a simplified relationship in graphical form. All the properties mentioned must be present in order to constitute an adaptive supply chain (Fig. 4.1).

Taking into consideration the business process-orientated description of E-Business presented in Sect. 2.2.1 (cp. Poluha 2007, p. 15), the following definition of the term can be made:

*Adaptive supply chains* or *electronic business networks* are business-based, event-driven and self-regulating. They are based on a supply chain integrated by means of information technology, in which the flow of information between the various supply chain partners represents the integration factor. For this purpose, several and up to all supply chain relevant business processes within the business, between the business and its partners, as well as between the business and third parties (for example government organisations), are completely or partially implemented using electronic communications networks and supported by the use of suitable IT systems and application solutions.

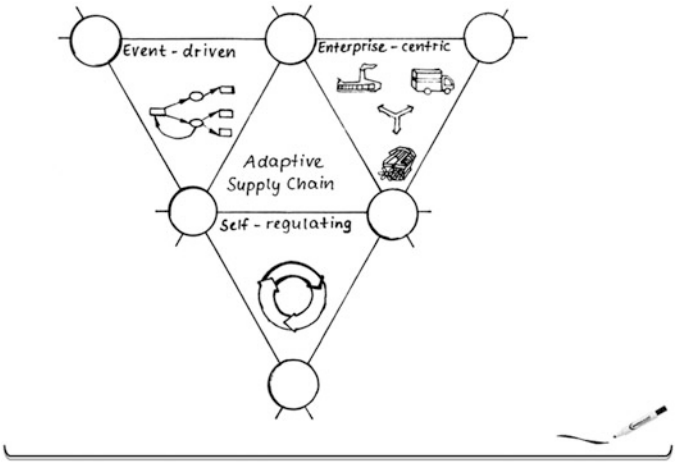


**Fig. 4.1** Characteristics of an adaptive supply chain (cp. Radjou et al. 2002, p. 3)

All represented properties stand in conjunction with the introduction of appropriate information technologies, or may even cause them to be urgently required. Section 4.1.3 will deal with these aspects in greater detail. First, however, we will study how adaptive supply chains may be put into practice.

### 4.1.2 Practical Implementation of Adaptive Supply Networks

The implementation of adaptive supply chains is based upon an existing supply chain and can be graphically presented in the form of a gradual process (cp. Heinrich and Betts 2003, pp. 79):

- First stage: *Transparency* (*Visibility):*
  The exchange of information and the handling of standard processes for routine transactions with the supply chain partners. The exchange of information by means of internet-based technology. Further insight opportunities into business process and data problems.
- Second stage: *Supply Chain Community:*
  Settlement of regularly recurring transactions by means of so-called portals (virtual marketplaces that allow users to handle electronic

transactions), introducing minimum and maximum control values (e.g. for inventory), reduction of inventory levels and increased efficiency of processes through automation.

- Third stage: *Collaboration:*
  Exchange of customer demand information amongst supply chain partners, for example, by joint order planning or Collaborative Order Planning (i.e. the exchange of order and planning data between different participants within the supply chain). Establishment of targets to rebuild stocks (e.g. by use of the aforementioned concept of Collaborative Planning, Forecasting and Replenishment). Transfer of responsibility for the replenishment of stock to the suppliers (for this purpose, the concept of Supplier Managed Inventory or Vendor Managed Inventory, abbreviated to SMI or VMI, can be applied). Using the possibility of exact inventory allocation in order to fulfill the completion of a maximum number of orders.
- Fourth stage: *Adaptability:*
  Significant shortening of the process times often eliminating stages of work. Significant reduction of inventories and working capital. Opening new market opportunities using strategic partnerships and the accelerated introduction of new products.

The concept of *Vendor Managed Inventory (VMI)* or *Supplier Managed Inventory (SMI)* are logistical means to improve the performance of the supply chain, in which the supplier has access to the inventory and demand data of customers. In this case, the supplier accepts responsibility for the inventory of his products at the location of the customer. The inventory at the customer's location will be fully managed by the supplier. For this the customer often receives the full right of return. The basis for the calculation of the supplies are, for example, usage or sales figures which are either recorded by the supplier during the regular replenishment, or electronically communicated (for these and other inventory management, principles and strategies, see e.g. Waller and Esper (2014)).

Steps one to three have already been, at least partially, developed and applied in the past within the framework of traditional supply

chain strategies. The key difference lies in the fourth step, which only then enables the development towards an adaptive network. In this step, companies begin to standardise and automate a large number of their business processes.

This entails an increasing complexity in terms of supporting information technologies, as well as a significantly higher degree of automation amongst members of the enterprise-wide and integrated supply chain. In the fourth stage the transition to Electronic Business Networks is completed. The diagram below summarises the stages in graphical form (Fig. 4.2).

The particular challenges in terms of adaptive networks stem from the requirement to exchange information both within the business as well as with the relevant supply chain partners. To make the process of creating electronic partnerships and alliances effective, businesses need to integrate different types of information systems in order to avoid inefficiencies and redundancies. The resulting supply chain environments are increasingly complex and consist of a variety of sub-processes and activities. The competitive requirements literally force revolutionary changes to be made in the existing supply chain processes. The result is the increasing conversion of traditional linear and static supply chains into dynamic, adaptive networks.

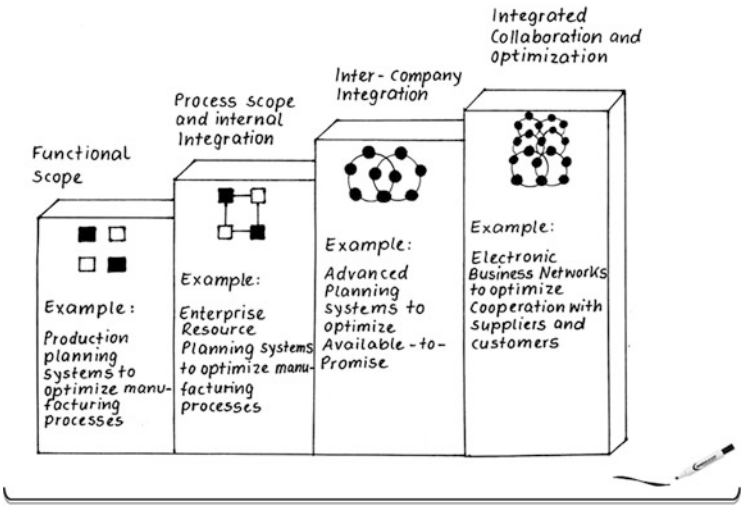


**Fig. 4.2** Development stages of electronic business networks (cp. Hofmann 2004, p. 85)

### 4.1.3 State-of-the-Art Solutions for Supply Chain Design Management

The existing tools and applications for supply chain management are often only restrictedly able to keep pace with the changes which are required to be implemented for greater supply chain effectiveness and efficiency. In some cases, it is not even possible to complete this task at all. This chapter deals with details on the new, modern tools that should offer assistance. In the case of the IT systems and IT applications that support the planning and management of the supply chain and which are illustrated in certain places in the first chapter, the term *Electronic Supply Chain Management* or abbreviated *E-SCM* is used to describe them. Similarly, the term *Supply Chain Design Management* or *SCDM* may be used to describe IT systems which support adaptive supply chains and electronic business networks.

The term Supply Chain Design Management is based upon a given supply chain model and is aimed at possibilities for the simulation and continuous optimisation of adaptive supply chains. It represents a completely new type of tool that is designed to help to identify and improve supply chain processes and supply chain performance indicators, as well as the information flows within an organisation and with other supply chain partners. It primarily pursues the following objectives:

- Validation of the current supply chain model based upon existing or actual business processes (As-Is analysis).
- Simulation and prediction of the influence of adjustments to the supply chain structures to meet the desired or target business processes with the performance of the supply chain.
- Use of performance indicators in accordance with industry standards for the analysis of alternative supply chain scenarios.
- Measurement, prediction and control of supply chain factors to identify potential improvements.
- Linking business and supply chain processes at deeper levels, which are relevant to the control of operations and application systems.

A supply chain model which is supported by Supply Chain Design Management is particularly efficient if it is recognised by both the executives responsible for decision-making (within the business), as well as by the external supply chain partners. Changes in demand and the resulting alternative scenarios, for example, may be analysed quickly to determine the impact these have on the business policy and the financial and the supply chain-specific performance indicators.

The result is a clear understanding of the options, risks and effects on the supply chain. SCDM therefore opens up new possibilities for greater flexibility and adaptability. At the strategic level it can be used both for the initial design as well as to continuously improve the entire supply chain, and thus serve to implement adaptive supply chains.

For a current and comprehensive overview of Supply Chain Design Management (SCDM), the work of Watson et al. (2014), is particularly recommended.

SCDM makes a universally accepted language convention available for the business processes in procurement, manufacturing, warehousing and logistics, for example. It also reflects the integrated (i.e. business internal and cross-business), supply chain, enables analysis of possible impacts on changes in supply and demand factors, as well as the simulation of changes in the supply structure and processes. It therefore directly contributes to the realisation of adaptable networks and to their design and continuous improvement. As a part of the electronic business concept, it has to be continually adjusted to market developments and changing requirements in a consistent manner and throughout the system lifecycle.

IT systems and applications to support SCDM are not to be confused with applications for planning, management and control of operations, into which category the aforementioned Enterprise Resource Planning systems (ERP systems) fall. The clear leaders amongst the providers of these systems are for instance SAP (www.sap.com), and Oracle (www.Oracle.com). There are also smaller

manufacturers that offer more specialised niche solutions or solutions for small and middle-sized businesses, such as IBS (www.ibs.net), Infor (www.infor.com), and Sage (www.sage.com).

They are also not to be confused with such applications that are used for initial design and possibly sporadic transformation and forward planning of the supply chain. Such cases include the aforementioned Advanced Planning Systems from specialised vendors such as jda. (www.jda.com). Furthermore, there are vendors who offer a specific line of business application, such as Salesforce.com for salesforce automation solution (www.salesforce.com), and Workday for Human Capital Management solutions (www.workday.com).

In addition to these applications, there are also specialised electronic tools for the continuous design and respective reshaping of supply chains which have only recently been developed and are therefore not very widely known. The primary goal of these applications is to create complex supply chains for strategic, tactical and operational predictions and implement them. Such cases include e-SCOR by Gensym (www.gensym.com), ADOlog by BOC Group (www.boc-group.com) and ARIS EasySCOR by Software AG (softwareag.com).

The majority of these SCDM specialised applications are based to a greater or lesser extent upon the SCOR model. They in no way supersede existing IT systems to support supply chain processes, such as the above Enterprise Resource Planning systems or Advanced Planning Systems, but rather assist in their completion and provide a complimentary component within the interactive Electronic Business concept.

The following diagram, Fig. 4.3, gives an exemplary insight into ARIS EasySCOR. The method of schematic representation highlights, above all, the principle of these applications as well as its consistency and integration with SCOR, which is reflected in the well-known constituent elements of the model (process elements, performance attributes, etc.). The current release of ARIS EasySCOR is consistent with the SCOR revised version 11.0. It is used by some well-known and global businesses such as Intel, as well as a number of large government organisations such as the United States Department of Defence (DoD).

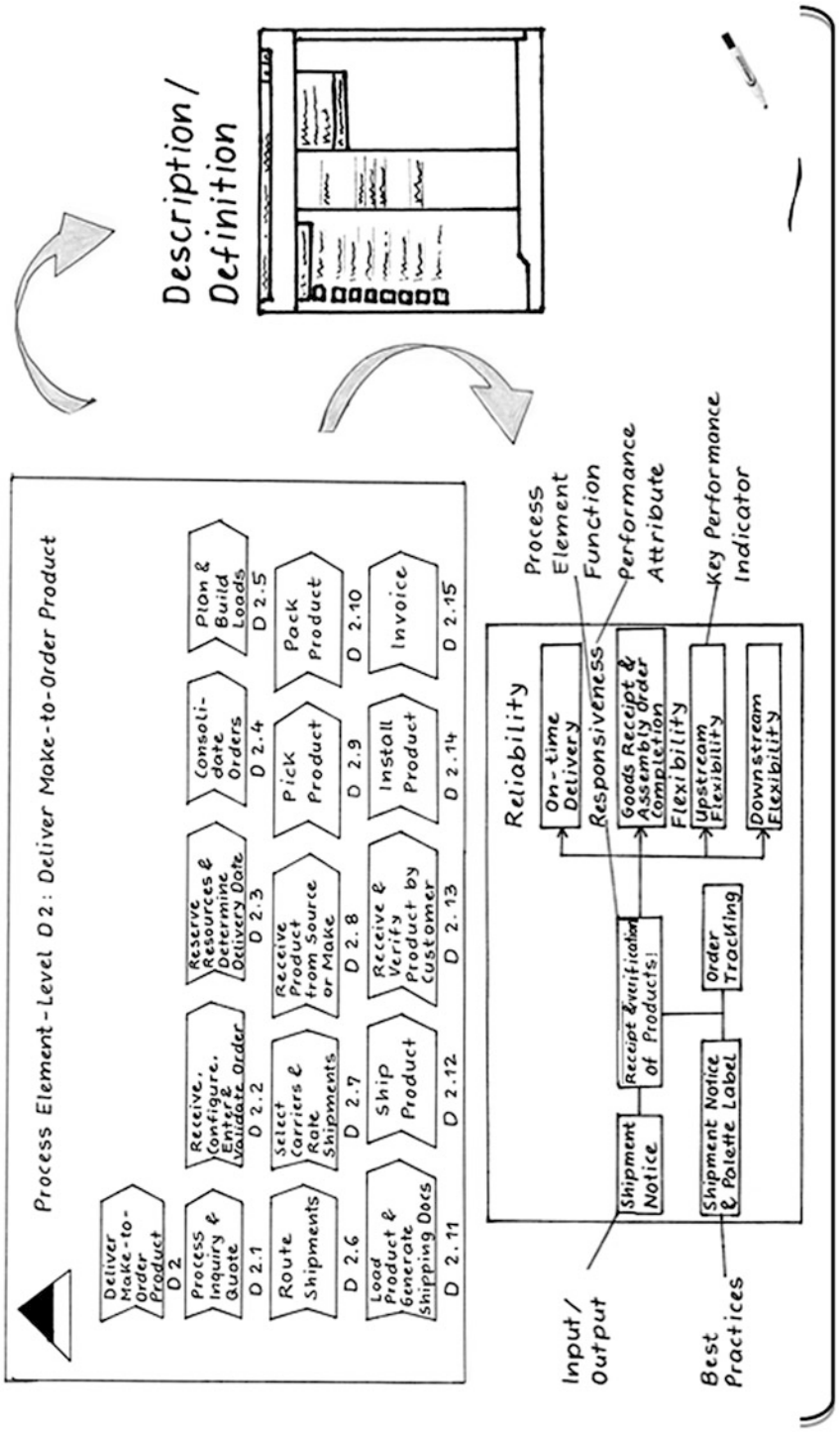


**Fig. 4.3** Graphical example of ARIS EasySCOR (cp. Gunther 2003, p. 8)

## 4.2 Business Process Optimisation in Supply Chain Management: Reducing Cost and Improving Quality

At the beginning of the first chapter, the importance of the process point of view was made clear whilst studying the supply chain. In the second chapter an introduction was given into the process-related perspective upon work processes, material flows and information flows. The following section will now deal specifically with the optimisation of processes and the related measures for the improvement of their effectiveness and efficiency.

Because the supply chain runs through the entire organisation, many changes must be managed during the optimisation of supply chain processes. These include, amongst other things, the following areas (cp. e.g. Poluha 2001, p. 312):

- Organisational Structure.
- Responsibilities.
- Planning and control processes.
- Business guidelines.
- Planning cycles.
- Material and information flows.
- Workflows.
- Communication channels.
- Information systems.

First, the related improvement measures must be analysed, quantified and prioritised, taking into account the business strategy and the derived supply chain strategy. These may be viewed from four different perspectives upon the basis of the aforementioned balanced scorecard (cp. Kaplan and Norton 1996, pp. 20):

- The *financial perspective*, which includes the benefits and the value.
- The *customer perspective*, which is characterised by customer satisfaction, customer preservation, market share, etc.

- The *business process perspective*, which comprises quality, response time, cost and new product launches.
- The *learning and development perspective* which involves, amongst other things, employee satisfaction and availability of information systems.

### 4.2.1 Business Process Reengineering vs. Continuous Improvement

One possible approach to the implementation measures for the initial improvement of the supply chain is the transformation of business processes and business process reengineering. Within this concept, the current business processes are fundamentally changed, and in some cases even entirely new business processes are introduced. This is already clearly stated and expressed in the programmatic title of a standard study on the subject by Michael Hammer and James Champy: *A Manifesto for the Business*, as well as the subtitle on the book cover: *How to Re-invent Your Business* (cp. Hammer and Champy 2006).

Basically one is dealing with the elimination of "process fractures" and the harmonisation and standardisation of processes. This is because it is assumed that the simpler and more standardised the processes, the fewer exceptions and therefore incurred costs will be present, and the intervention, control and monitoring will consequently be better. For this purpose one strives to achieve the use of time potentials to reduce lead times and buffers (e.g. waiting time), between the individual process steps, and to eliminate interfaces which are a hindrance to the process flow (organisational interfaces arise when tasks require a cross-functional cooperation, and activities with those of other operating areas overlap).

The restructuring is thus a process-orientated adjustment of the business, where existing procedures are monitored for their effectiveness and efficiency. Due to the scope of this restructuring one is typically dealing with strategic projects, within which not only a

business-internal cooperation, but also a business-external cross-cooperation with customers and suppliers takes place, and is carried out by the responsible project group. The implementation measures normally lead to a change in the organisational and operational structures.

For an introduction into *Business (Process) Reengineering*, the original work of Hammer and Champy (2006), should be especially emphasised. Furthermore for example, Johnston (2012), is recommended. For the connection with Information Technology, see e.g. Donovan (1994). For a specific reference to the subject of Supply Chain Management, Handfield and Nichols (2002), are recommended.

The organisational changes aim at beginning a conversion of the functional mindset so often associated with the "silo mentality", into a more pronounced and process-oriented mindset. The following four basic components are typically used during this conversion (cp. Hammer and Champy 2006, pp. 47):

- *Renewing* meaning improved training and organisational involvement of employees.
- *Revitalising* referring to the redesign of processes.
- *Reframing* should lead to conventional thought patterns being discarded, and new paths being taken; this component is directly related to the change process.
- *Restructuring* requires a fundamental revision of business processes and workflows.

However, it has been shown in practice that this concept meets with massive resistance from within the workforce, which can play a very special role during the monitoring of the change process. This resistance results, for example, from the fact that most employees show a function-orientated thought process, tend to consider a certain area of

responsibility to be "their own", and therefore defend it against change. According to experience, this resistance can be managed using suitable measures during the implementation of the initial improvement project, but may only be permanently overcome by means of a constant effort. Irrespective of this there is often no longer an immediate requirement for the enforcement of radical changes after the completion of the initial project. Therefore, the initial projects are often carried out as an initiative to transform business processes and then switch to an alternative approach.

An alternative approach, which offers itself as a method for the continuation of necessary improvement measures and which has been used successfully in the past in connection with strategic supply chain improvement initiatives, is the *Continuous Improvement Process (CIP)*, or in short *Continuous Improvement*. During this method, the continuous improvement of products, processes and service quality is sought in incremental steps rather than drastic, incisive changes. The method was developed in the 1980s as an essential part of the Japanese *Kaizen* concept. The terms *CIP* and *Kaizen* are sometimes used synonymously, which is not always applicable.

For a comprehensive overview on the topic of *Continuous Improvement* and *Continuous Improvement Process (CIP),* the works of Ahlstrom (2014), and Boutros and Purdie (2013), are particularly recommended.

The continuous improvement process can be broadly associated with quality management, which itself is a part of business governance. However, it does not have the same or similar meaning as, for example, related terms such as *Total Quality Management*, or *TQM*.

The primary objective of CIP is to optimise workflows and business processes, taking into account material and time constraints and ensuring certain quality requirements of products or services and their further development.

*Kaizen* comes from the Japanese and, literally translated, means "constant improvement". However, it is understood as a concept within business management which summarises all the efforts to improve operational performance standards in a comprehensive manner, and combines various methods and techniques from quality management. Kaizen includes, for example, group work, Kanban (a method of production process control according to the pick-up or call principle, which is based purely on the requirements of a consumption point in the production process), and the in-time delivery *(Just-in-Time)*, to name just a few (see e.g. Imai and Gemba 2012; Taiichi 1988, 2015). For further information on the subject of *Total Quality Management (TQM),* Goetsch and Davis (2014), and O'Mara (2013), are recommended.

In this context, for example, we are dealing with the optimisation of communication structures, the drafting of professional solution strategies, the maintenance or increase of customer satisfaction, staff motivation, and the standardisation of certain business processes and workflows. In addition to this we are also dealing with standards for products and services, documentation, training and further education measures, as well as the design and furnishing of workrooms. All significant business units (development, purchasing, production, sales, and order processing, etc.), are included.

Organisations as well as those people working in them have a tendency to retain the "Status Quo", i.e. they possess a kind of "inertia" effect. The demand for constant improvement contradicts this effect. Therefore, continuous activities are required in order to analyse problems and implement improvement measures, otherwise the change process easily loses momentum and therefore also its effectiveness. The continuous improvement process is highlighted by supporting the following activities:

- Analysis and optimisation of workflows and processes.
- Increasing productivity.
- Improvement of product quality and customer satisfaction.
- Indication of available resources and synergies.

- Lowering costs and reducing wastage.
- Enhancement of skills, creativity, and commitment of its employees.
- Improving teamwork, business culture, and employee satisfaction.

As part of the continuous improvement process within business process optimisation, employees analyse their respective workspace in special working groups and later develop concrete suggestions for improvement. For this purpose they are trained to work in groups and carry out group presentations. In addition to this they are allocated a part of their working time for related tasks. The unconditional intent of management to implement the changes resulting from the improvement process, authorise the special working groups to introduce their ideas, and if necessary make the necessary resources available, is an absolute requirement which must not be underestimated.

If it is not possible to implement certain changes—for example, by law, agreements with the works council, etc.—this should be justified to the group members in a credible and understandable way. To this end, a business culture is necessary, within which appreciation is shown for the ideas of the workforce and the group work, and the employees receive effective support and candid recognition. There will be more on this topic in the next section.

### 4.2.2 Managing Change Successfully: Change Management and the Human Factor

Experience has shown that resistance is to be expected during the implementation of improvement measures within the organisation. This is especially the case when it comes to changes within the area of supply chain management. As long as the employees involved in the change process are within their possibilities as far as knowledge and experience is concerned and are also in a position to support and react to the changes, they can make a valuable contribution. However, if the expectations can no longer be met, it may result in a negative and thus counterproductive behaviour, which can be attributed primarily to the fact that not all people have the same capacity to cope with, and accept, change.

The process of change must therefore be carefully planned, controlled and monitored as part of a targeted *Change Management*. Although the process can take a different course within each various business and according to the various circumstances involved, some typical phases can be distinguished:

- *Unfreezing*: the starting point of the first phase is the realisation, that one's expectations no longer correspond to reality. The necessity for change gradually makes its way into our consciousness in form of a possibility, and the practicality of existing behavioural tendencies and work methods is questioned. The primary objective of this phase is to strengthen and support the entities striving for change, and to create a kind of "change awareness".
- *Moving*: in this phase solutions are compiled, new processes and operations are developed, and identified problems are addressed in the form of improvement measures. One therefore moves out of the prevailing state, and a change occurs towards a new balance.
- *Freezing*: the aim of the third phase is to implement the solutions found and thus to at least temporarily complete the preliminary change process. All performed changes are integrated into the overall system of the organisation.

Within the term *Change Management,* all tasks, measures and activities may be subsumed, which may bring about a comprehensive, cross-sector, and far-reaching content change to the implementation of new strategies, structures, systems, processes and/or behavioural tendencies within an organisation (see for example the standard work of Kotter 2012). Hiatt and Creasey (2012), is also recommended for an introduction. A comprehensive review of the subject can be found in Kotter (2011).

The process of change is supported by so-called Change Agents, who are ideally from the upper hierarchical levels. These working colleagues are trained in the areas of technique which are relevant for change management, such as Conflict Management and Group Communication, and should be exclusively responsible for change

intentions. In the further development, changes are then supported by the responsible *Change Teams*.

> Very interesting and modern aspects for the integration of the management of businesses into the change process, and for the requirements asked of innovative management, can be found in Hamel (2007, 2012).

Over a period of time, all executive managers of a business should possess the competence and expertise to act responsibly during the realisation of change, so that no further colleagues are required for this purpose, and the respective experience becomes part of the knowledge basis of the organisation. It is also a prerequisite within the scope of the continuous improvement process, that it will become a natural daily component within the thoughts and areas of responsibility of managers and employees within everyday business. The related concepts and methods are closely linked to the organisational education as part of its development.

The stipulation for the significant involvement of the business's management in the improvement process results from the associated necessity for support, as shown in Fig. 4.4. As already strongly indicated, this support is an absolute prerequisite for the successful implementation. It is often shown in practice, however, that the necessity for support does not necessarily always correlate with the attention span of executive management.

It would be ideal to adjust the course of the attention span to the necessity for support, or at least attempt to match them with each other as closely as possible. As far as the economic aspect is concerned, this would also correspond to the cumulative cost of the improvement initiative, because the importance of a successful realisation naturally increases with the duration of time and in conjunction with the rising cost.

According to experience the management of change is most often only possible if the current problems have attained a level that exceeds the cost of transition to a new, improved state. To acquire the necessary information, it is recommended that an analysis of the current competitive position is carried out using common indicators

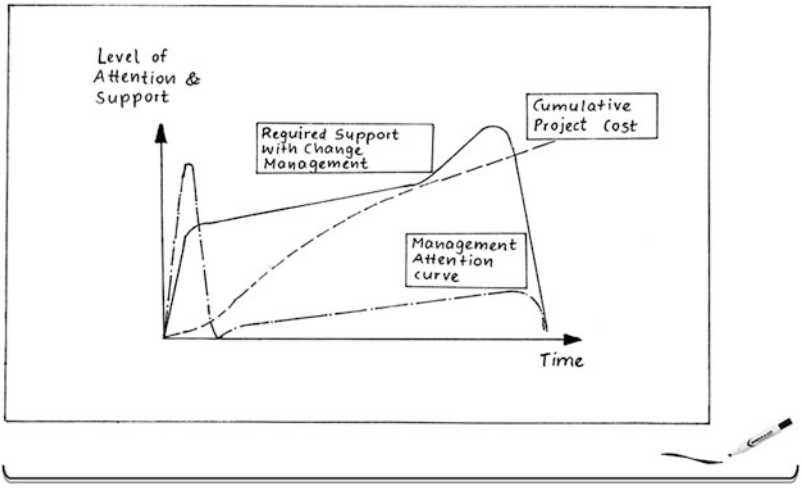


**Fig. 4.4** Required change management support in supply chain management projects (cp. Poluha 2001, p. 322)

and to identify bottlenecks within the material and information flows and work procedures (such as those which are described during the example of the material flows). Based upon this analysis, a subsequent agreement is made to proceed with striving for an improved design for the future conditions. As a possible result, for example, the key to success could lie in the strategic transition from an excellent operative performance capability within the fields of procurement and manufacturing, into a strategic customer orientation with regards to outbound logistics processes.

This in turn can result in further and more thorough investigations into problems in terms of delivery performance, order lead times, inventory levels, return delivery costs, etc., in order to prove that a transition to a new state is required, if not critical, for the long-term success. The associated discovery process can assist in dispelling the initial common reservations and resistance. The employees involved in the change process must be resolute and convinced in eliminating the bottlenecks which may have possibly existed for years. This conviction is the initial starting point so that initial resistance may give way to a clear motivation for the acceptance of further changes.

As already mentioned, there are large differences in the individual capability and willingness of employees to deal with change. It is

therefore important to identify a manageable number of relevant projects, which are aimed at the greatest number of possible results within a short to medium time-frame (ideally less than 12 months). As a result, the initial projects can constitute an important contribution to the integration of supply chain related changes into an executable supply chain strategy, with the associated business processes, material and information flows, and working procedures.

## 4.3 The Supply Chain Integration Concept and Adaptive Businesses

In order to put the newly-introduced aspects such as adaptive supply chains and supply chain design management into a framework for cross-reference, it is first necessary to define the relevant dimensions used to describe supply chains. As already mentioned, supply chain management currently represents an inherent part of the field of business governance and therefore has to be aligned with the overall business strategy and goals. One possibility of describing organisations is to group them into system variables or design dimensions. Harold J. Leavitt introduced the term *four-variable conceptions of organisations* (cp. Levitt 1965, pp. 1151):

- *Strategy, processes and tasks*: this involves the provision of goods and services including all associated operational subtasks.
- *Organisational structure*: this embraces the organisational structure, work processes, communication channels and role models.
- *People*: in the first instance this mainly entails the observation of the persons involved.
- *Technology*: this consists of all technologies used including information and communications technologies and systems, and the technologies with which to measure work performance.

If one transfers these system variables, which are now universal for an organisation, onto the area of supply chain management, the following dimensions of supply chain design may subsequently be derived (cp. Poluha 2007, pp. 235):

- *Strategy:* with this, the conceptual design of the supply chain is made possible, based upon the business goals and market requirements.
- *Processes and organisational structure:* this describes the constitution of the organisation and the processes that are necessary for the operation and management of the supply chain, including the relationships between the processes and the leading business practices.
- *Technology:* this embraces the supporting IT systems and applications for planning, execution and control of the supply chain processes, workflows, material and information flows.
- *Staff:* this describes the employees (Human Resources) required in order to handle all activities concerning the supply chain, and their impact within the context of the change process.

The input contained in the first chapter is an introduction into an integration concept for the design of business processes as a reference framework for businesses, which has acted almost like a continuous thread throughout the entire book. The intention is now to metaphorically close the circle by including the aforementioned holistic perspective of supply chain design into this reference framework. The resulting *Business Process-Orientated Supply Chain Integration Concept* is represented graphically in Fig. 4.5. Input and output variables such as material and information flows and work processes, as well as activities and process stages, are not explicitly listed in the chart, but represent an inherent part of the business processes.

The timeline is only designed to be an estimated guide. In actual fact smooth transitions are usually normal. Therefore we are not dealing purely with the spread of these technologies within business practice, but also with their availability. Their distribution and practical application will be discussed in greater depth in the following section.

The design dimensions reproduced on the right hand side of the graph figuratively represent organisational change, whilst the left hand side refers to the specific design of the associated changes, i.e. the way in which the change process manifests itself in terms of the supply chain.

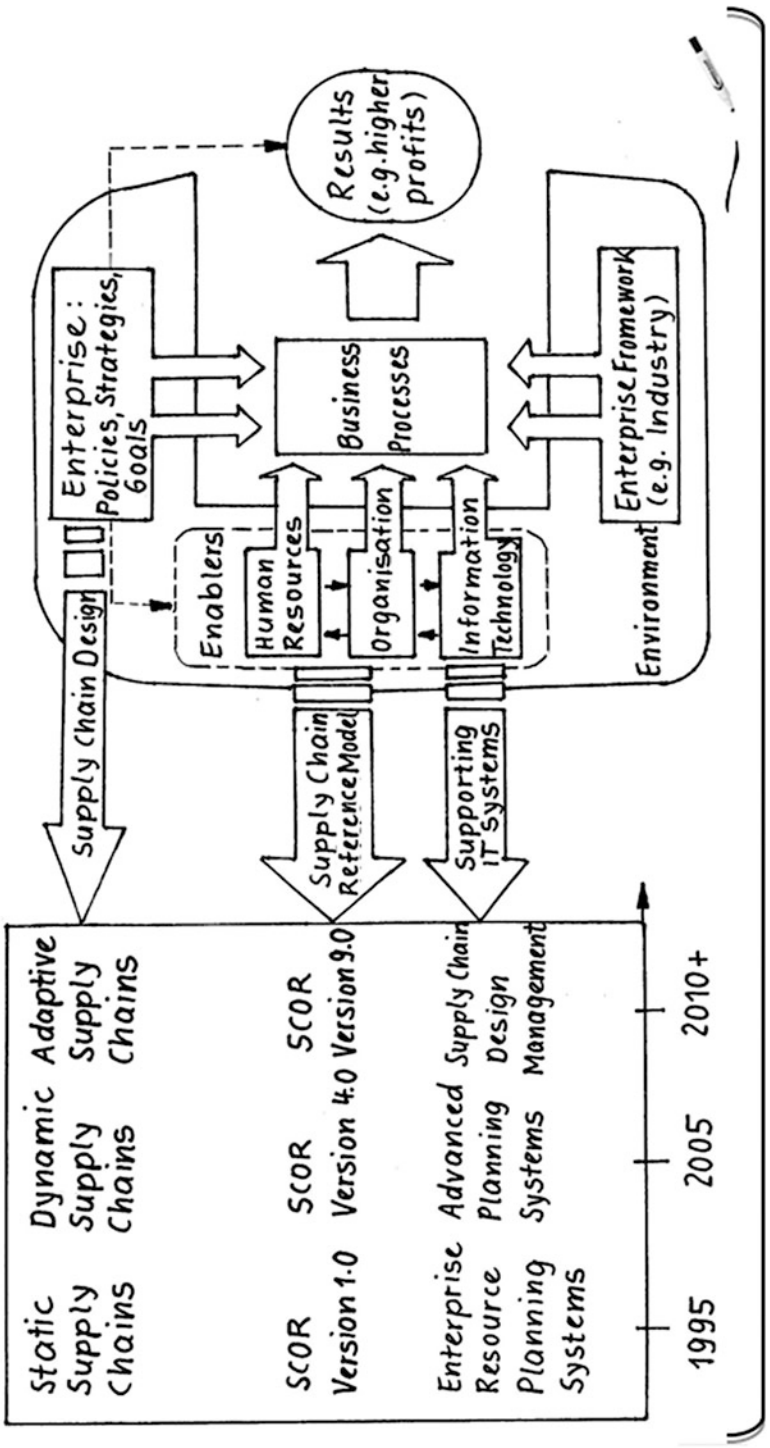


**Fig. 4.5** Integration concept for the business process-orientated design of supply chains (cp. Seibt 1997, p. 6; Poluha 2007, p. 237)

The supporting IT systems are, as already explained, of a complementary nature and accompany each other within a comprehensive E-business concept. This may be seen in similarity with the supply chain strategy, in which the contents of each previous stage of development are complemented by other aspects as well as the various versions of the SCOR model, within which the later models are all based upon their predecessors. Because of its diffusion rate and its increasing importance as a "de facto" standard, SCOR has been described as an exemplary supply chain reference model, as described in the second chapter.

The next section describes which results can be achieved, in practice, by using the correct application of the relevant components of the business process-orientated supply chain integration concept. However, an important question must be answered prior to this, namely: *how can a business be successful in attaining the transition into a process of continuous improvement in which, amongst other things, the supply chain practically and independently develops and optimises itself?* For this purpose, an equivalent to the adaptive supply chain would be required on the part of the business's operational influence factors, namely organisation and personnel—in the literal sense an adaptive organisation.

Such an organisation would require the active involvement of all employees in the continuous improvement process, and allowing them to become an integral part of the business culture. In this way, the intention is to set an organisational learning process in motion, which makes it possible for a business to acquire a previously unknown potential for change. This in turn can constitute a decisive factor for the long-term business success. Since the learning process refers to both individual employees in addition to the organisation as a whole, the term *Organisational Learning* is also used.

A *learning organisation* is, in this sense, an adaptable organisation which responds to external and internal stimuli. In general, a distinction is made between *adaptable* and *learning* organisations. This distinction results from the fact that a learning ability does not necessarily have to result in innovations, but can also lead to counterproductive behaviour such as resignation or resistance.

On the one hand, *Organisational Learning* refers to the social science topic of the so-called learning organisation, which studies the patterns of activity, conditions and investigations on both a theoretical and a practical level. It attempts to clarify questions such as how an organisation must be made up in order to learn how this knowledge can be acquired and how it can ultimately be evaluated. On the other hand, organisational learning can also refer to the pure learning process at organisational level, in which the basic principle lies in the fact that not only the individual members learn the purpose of effectiveness and efficiency, but rather the entire organisation is collectively submitted to a continuous learning process. See in particular the standard work of Peter Senge on this subject (cp. Senge 2006). Deiser (2009), may also be recommended.

The term was originally introduced around 1990 by Peter Senge, who made the concept known and significantly promoted its distribution. He identifies five development stages or disciplines which are necessary for the creation and maintenance of learning organisations. The disciplines are mutually supportive and contribute to the gradual increase in capabilities and competences of the respective organisation within a development process (cp. Senge 2006, p. 20 ff):

- *Personal Mastery*: raising the skills of the members of an organisation through personal development.
- *Mental Models*: explicit and implicit basic assumptions in order to explain and describe the surrounding (organisational) world, as well as to make the assumptions visible, discussable and thus the object of development.
- *Shared Visioning*: collective visions arise when as many members of an organisation as possible understand and have a command of their common goals, and grasp the purpose as well as the tasks for the achievement of the common objectives.
- *Team learning*: learning as a group takes place when the group members jointly understand issues.

- *Systems thinking*: by using a holistic observation of the system, the working mechanisms and the expected behavioural patterns are described in a symbolic, formal language. Typical behavioural patterns (System Archetypes) can thereby be recognised, made discussable, and worked upon. With appropriate methods, the system can then be simulated and potential behaviours can be predicted.

The term *Knowledge Base* in conjunction with Knowledge Management embraces all data and information, and all knowledge and capabilities which an organisation requires in order to solve its various tasks. Individual knowledge and skills are hereby systematically anchored into the organisation. *Organisational learning* is an integral prerequisite for the creation and maintenance of this knowledge base. Its primary tasks lie in the promotion of the knowledge base and the acquisition of competition-relevant competences, aiming at increasing the *Organisational Intelligence*, or *Systems Thinking ability* (see for example Mella 2012; Wright 2013).

A learning organisation is ideally a system that finds itself constantly in motion. Events are conceived as challenges and used for development processes in order to adapt the knowledge base and the field of manoeuver to the new requirements. The fundament for this is an open organisation marked by individuality, which allows and supports innovative methods of problem solving. The degree of learning capability of an organisation is also partially referred to as *Organisational Intelligence*. In this context, the knowledge management mentioned in the second chapter plays a central role, which serves to develop and implement knowledge within an organisation, and whose aim it is to promote the *Knowledge Base* of a business.

In order to optimally support organisational learning and knowledge management a number of important requirements must be met:

- Clear targets, common objective processes, and orientation towards the benefit of customers.
- Cooperation and conflict solving, mutual trust and team spirit.
- Process orientation and self-regulation in groups.
- Democratic and participatory management style supporting new, innovative ideas (especially by the business management), integration of personnel and organisational development.
- Reward for commitment and tolerance of errors during projects and activities with higher risks.
- Ability to monitor (oneself) and evaluate, with well-functioning and integrated IT systems which can contribute to a faster and more accurate assessment.

The type of learning in which digital media are used for the presentation and distribution of learning materials and/or for the support of interpersonal communication is known as *Electronic Learning* or *E-learning* (see for example Clark and Mayer 2011; Elkins and Pinder 2015).

Due to the importance of organisational learning and the close connection with the change process, an increasing number of businesses concentrate upon the issues related to this, such as the creation of a learning strategy, the development of educational content, and the technical support of learning processes.

With regards to the latter-mentioned point, the implementation of information technology plays an increasingly important role in supporting workplace learning in education and training, for example in the form of *Electronic Learning*, which is also simply referred to as *E-learning*. The corresponding tools supporting E-learning activities are known as the *Learning Management System (LMS)*.

## 4.4 Practical Examples: Application of Trendsetting Supply Chain Concepts

The following are examples presented from business practice which should clarify just which qualitative and quantitative benefits for an organisation can be attributed to the measurement of the performance

capability of its supply chain, the optimisation of the related business processes by means of leading business practices, and the continuous adjustment of its supply chain to changing market requirements, with the assistance and support via the usage of modern application solutions.

In other words: it should be about the advantages which may arise if as many components of the supply chain integration concept, introduced in the previous section, are put into practice.

The *Americas 'SAP Users' Group (ASUG)* was founded in 1991 by customers of the SAP AG (www.sap.com), as a non-profit association with the primary goal of sharing experiences and learning from one another. By 2015, ASUG comprised more than 100,000 individuals within 3,800 businesses and from more than 17 industries across the SAP ecosystem. The board consists of volunteers from its member businesses, which are elected by the members at regular intervals. The administrative affairs are covered by a group of full-time employees who report directly to the ASUG Board. There are about 40 local chapters and over 90 Special Interest Groups (SIGs), whose activities are supported by 400 volunteer members in the preparation and presentation of lectures, conferences, general meetings, and training courses, etc. (www.asug.com).

### 4.4.1 ASUG Study for Performance Benchmarking and Best Practices

The Americas 'SAP Users' Group (ASUG) has worked closely with the SAP AG since 2004 to measure the performance of businesses in, amongst other things, the field of supply chain management. Other areas include, for example, the financial and cost accounting, customer management and human resources.

The Americas 'SAP Users' Group (ASUG) Benchmarking and Best Practices Program, a collaborative program between ASUG and SAP, has its focus on two critical business pursuits: how to put innovative ideas into action, and help businesses measure their operational progress. Its main intention is to help identify aspects of the organisations that excel and those requiring improvement. Benchmarking allows the tracking and comparison of performance to that of one's peers and other SAP users, the determination of the value of adopting best practices, and an improved understanding of how IT drives performance. Relying on systematic surveys and studies that detect strengths and vulnerabilities, the program also explores current and emerging best practices that can be integrated into operations (www.asug.com/benchmarking).

The program runs under the name of *ASUG Benchmarking and Best Practices Study*. In total, 26 various business processes were covered and included at the time of the study, of which 10 were related to supply chain management (see Fig. 4.6). At that time more than 2,600 participants from more than 1,000 businesses in North America, Latin America, Asia and Europe, participated. Although there are no fees to be paid for the participation in the

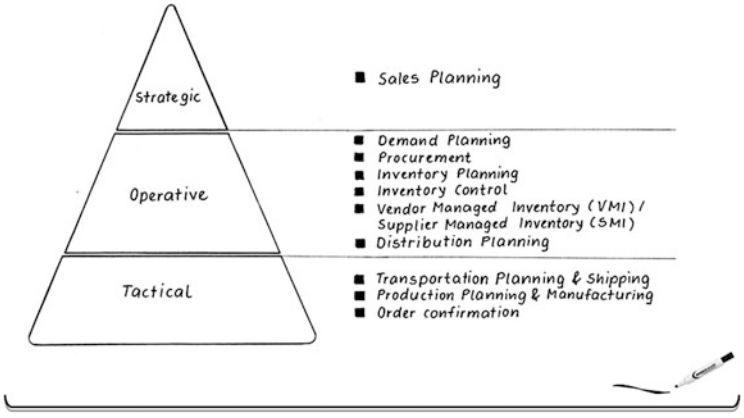


**Fig. 4.6** Supply chain processes in the ASUG study for performance benchmarking (cp. ASUG and SAP 2008/1)

study to ASUG, there is nevertheless a considerable effort in conjunction with the data collection and the completion of the respective questionnaires.

The businesses submitted the following reasons for their participation:

- Comparison of their personal performance with that of other businesses in the same industry or in other industries (for the various types of benchmarking see the comments in Sect. 3.2.1).
- Measuring their personal performance over a long period of time.
- Preparation of proposals for improvement projects.
- Proof of the success of improvement measures.

After evaluating the results, the participants receive the following information:

- Documentation of their personal performance over a period of several years.
- Detailed description of the results of the personal performance comparison with other businesses within the same industry.
- Description of the results of the personal performance comparison with businesses from other industries and regions.
- Summary and evaluation of the effectiveness and efficiency of business processes, spread across different business and process areas.
- Notices for improvement by the application of leading business practices and modern IT application solutions.

The information is treated confidentially and only in a neutral form, i.e. without mentioning names and without providing an indication of the businesses involved. Due to the content, the results are considered equally relevant for managers of the individual functional areas (in this case purchasing, manufacturing, warehousing, inbound and outbound logistics, and information technology).

### 4.4.2 Correlation Between Business Success and Performance Indicators

The data, which provides the basis for the following explanations, has been taken from the presentation material during an Internet conference (webcast), jointly organised by ASUG and SAP (see ASUG and SAP 2008/1 and 2008/2).

With its definition of supply chain performance indicators, the study follows an approach similar to that shown within the context of the SCOR Model in Chap. 2. Likewise, it distinguishes between the (internal) efficiency and (external) effectiveness (cp. SCC 2008, p. 1.2.5). The following performance indicators are specifically used:

1. Efficiency (business-internal, cost-related):

   - Employees in relation to sales.
   - Inventory range.
   - Storage costs.
   - Supply chain planning costs.

2. Effectiveness (customer-orientated, market-focused):

   - Punctual delivery.
   - Order delivery performance.
   - Delivery time.
   - Forecast accuracy.

In order to measure and quantify the performance indicators, questions have been developed which relate to the use of leading practices that have a direct or indirect impact on the respective performance indicators. In turn, these business practices result directly from the specific business processes in Fig. 4.6. Behind it lies the assumption that the use of leading business practices can contribute to an increased performance of the supply chain.

> A comprehensive description of the common supply chain performance indicators can be found, for example, in the SCOR model description by the Supply Chain Council (cp. SCC (2008, pp. 2.1.1).

An example will help to illustrate the method of procedure. Amongst others, the following criteria were used in order to measure the performance indicator known as "on-time delivery":

- Material Resource Planning: globally integrated processes—regular implementation of a formal, globally applicable requirement planning process with the inclusion of restrictions in availability.
- Production Planning: simultaneous material and production capacity plan—carrying out a planning run several times a day with availability constraints.
- Demand Planning: forecasting—initial forecast adjusted to cater for internal factors such as price changes, sales plans, special promotions, and for external factors such as customers, competitors, economic trends, legal regulations and market trends.

In the questionnaire there are a number of other questions regarding the above three business processes as well as the additional questions regarding each of the other seven SCM processes. This explains the necessary effort in data collection, which occurs in conjunction with the participation in the study.

Based on the information gathered and using statistical methods, the business will then be apportioned to one of the following categories in accordance with their performance and with regards to the above supply chain performance indicators:

- *Leading Businesses*: highly effective and efficient.
- *Innovative Businesses*: high effectiveness with simultaneous low efficiency.
- *Renovating Businesses*: high efficiency with simultaneous low effectiveness.
- *Straggling Businesses*: low effectiveness and efficiency.

The leading businesses are also innovatively inclined. But since they also operate efficiently, they succeed in achieving a higher customer focus and cost advantages. This category includes businesses which have set up electronic business networks with suppliers, wholesalers, and retailers. The straggling businesses, however, not only fail to create competitive advantages in the market and use information technologies, but also do not have their financial

situation under control. Due to the diversity of products and business processes there will continue to be a distinction between process industry, discrete industry, and consumer goods industry.

The study comes to the following exemplary results:

- Leading businesses achieve, depending on the sector, an 8 % (process industry), to almost 32 % (discrete industry), higher forecast accuracy than the straggling businesses (76.67 % vs. 69.17 %, and 69.54 % vs. 37.8 %).
- Expenditure on transport, measured as a percentage of sales, is about two-fifths lower amongst the leading businesses than amongst the straggling businesses (2.9 % vs. 1.7 %).
- The missed revenues due to non-deliverable items is on average more than two and a half times higher amongst the straggling businesses than amongst the leading businesses (6.7 % vs. 2.5 %).
- In the consumer goods industry, missed revenues amongst the straggling businesses due to non-deliverable items are even almost seven and a half times as high as those of the leading businesses, as the latter are able to succeed in almost completely avoiding supply shortages (7.5 % vs. 0.05 %).
- Leading businesses have about one-third lower sales expenses than the straggling businesses (4.3 % vs. 6.2 %).
- The duration required for re-planning is almost one third higher amongst the straggling businesses when compared with the leading businesses (80.5 h vs. 55.8 h).
- The use of available production capacity amongst the leading businesses lies at around one fifth higher than amongst the straggling businesses (process industry: 86 % vs. 68.5 %, discrete industry: 82 % vs. 67 %).
- The costs due to inventory obsolescence are nearly four times as high amongst the straggling businesses as amongst the leading businesses (3.38 % vs. 0.91 %).

In order to continue the validation of the results, the businesses were correlated in accordance with their classification with the annual sales growth and annual earnings growth (as overriding figures for the business's success). Figure 4.7 illustrates the result.

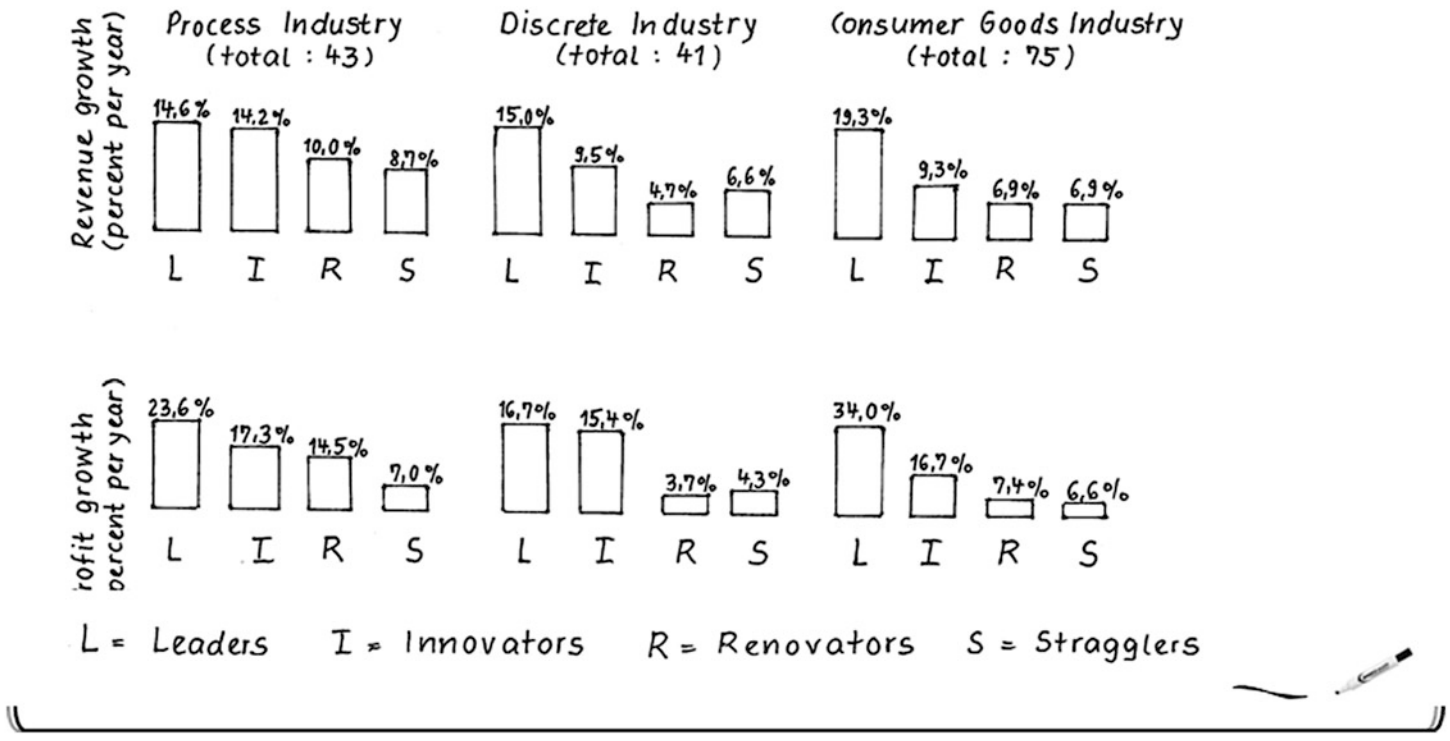


**Fig. 4.7** Correlation between business success and performance indicators of the supply chain (cp. ASUG and SAP 2008/1)

As can be seen from the diagram, the leading businesses are, without exception, clearly superior to the straggling businesses in all of the above industries, and are able to generate between 5.9 % and 12.4 % higher sales growth. Here, the better recognition and fulfilment of customer requirements is precipitated in competitive advantages. The difference in earnings growth is even more clearly evident: there, the leading businesses are between 12.4 % and 27.4 % higher. The reason is that the leading businesses are not only more effective but also more efficient, i.e. they show a better domination of the cost-related aspects. The influence upon profits seen as the difference between the sales and the cost cannot be overlooked.

As the results show, the discernible trend is clear, unambiguous, and confirms the underlying assumption, namely that the use of leading business practices actually and significantly contributes to a higher performance capability and thus to corporate success. The study highlights some of the innovative business practices as being particularly relevant:

- The previously widespread supply-push approach to managing the supply chain described in Chap. 1 is used around three to four times more often by the straggling businesses than the leading businesses (60 % vs. 18.6 % in the processing industry and 50 % vs. 11, 7 % in the consumer goods industry). The least pronounced is the difference in the discrete industry (29.8 % vs. 24.3 %).
- The more recently introduced concept of the demand-pull approach also described in the first chapter is used up to twice as frequently by leading businesses as by straggling businesses (process industry: 81.4 % vs. 40 %, consumer goods industry: 91.3 % vs. 55.6 %). Here again the difference in the discrete industry is the least pronounced (75.7 % vs. 70.3 %).
- The expenses for procurement managed by the concepts of supplier managed inventory (SMI), and vendor managed inventory (VMI), as described in Sect. 4.1.2 are more than one third higher amongst the leading businesses than amongst the straggling businesses (consumer goods industry: 80 % vs. 45.5 %). It is worth noting that the difference from the renovating businesses is far more pronounced: in the discrete industry and in comparison, the concept is used more than twice as often by leading businesses (37 % vs. 15 %).

Since the innovative businesses are ahead of the straggling businesses in terms of effectiveness and thus also customer focus, the assumption could be made that they may have higher revenue growth. However, as can be seen in the diagram above, the straggling businesses have an almost identical and in one case (discrete industry), even superior sales performance. A very similar picture emerges for the growth in earnings. The obvious conclusion is that whilst the businesses concerned actually invest in improving their customer and market focus, they do not go about this with the same level of competence as the leading businesses. In other words, whilst they must bear the cost of these investments, they are not however able to convert them into actual competitive advantage.

The use of information technology is a very important aspect in conjunction with the business practices. The reason for this is that the execution of business processes is, in most cases, supported or even made possible by IT systems. This will be discussed in the following section.

### 4.4.3 Adoption of Supply Chain Applications in Leading Businesses

The data collected can also be evaluated in terms of the use of IT systems in enabling and supporting leading business practices. Hence conclusions can be drawn with regards to the practical implementation of adaptive supply chains and e-business networks. The diagram below provides a specific overview of the results for the leading businesses. It incorporates the various development stages of supply chain application from the Supply Chain Integration Concept shown in Fig. 4.5.

As shown in the chart, only a quarter of the businesses surveyed are using a state-of-the-art SCDM application. It should also be noted that there are only leading businesses included, which are typically open to innovation. On the other hand, more than half of the businesses (55.8 %), are using other IT systems to support their supply chains. This number results from the incremental method of presentation: businesses that use Advanced Planning Systems (APS) are also probably working with Enterprise Resource Planning systems (ERP systems). The various applications, as explained in Sect. 4.1.3 are of a complementary nature—that is they build upon each other and

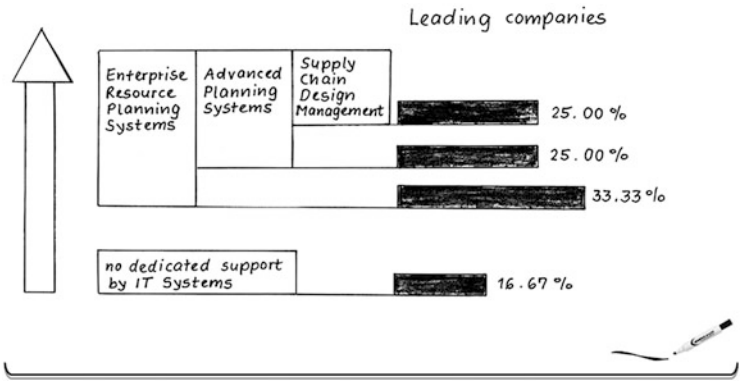


**Fig. 4.8** Support of supply chain management by IT systems in leading businesses (cp. ASUG and SAP 2008/1)

complement each other. The penetration of leading businesses by IT systems for the realisation of adaptive supply chains can therefore certainly be considered to be advanced. The same applies to the innovative businesses (Fig. 4.8).

The picture is different as far as the renovating businesses and straggling businesses are concerned: for example, more than two thirds of innovative businesses use information and communication technology systems for processing the concept of Collaborative Planning, Forecasting and Replenishment (CPFR), as described in Sect. 2.2. In comparison, the proportion amongst the renovating businesses accounts for merely 2 %.

In summary it can be stated, that based upon the results obtained in the study, the use of innovative supply chain applications verifiably helps businesses to be effective and efficient. This is consistent with the findings of a similar study, which was conducted by SAP together with PRTM, and also concludes that the use of appropriate IT solutions for supply chain management has a significant impact upon the efficiency and the financial situation of businesses (cp. Hofmann 2004, pp. 82).

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# Conclusion: What Matters Is the Right Balance

# 5

*The best supply chains aren't just fast and cost-effective. They are also agile and adaptable, and they ensure that all their company's interests stay aligned.*

(cp. Lee 2004, p. 2).

## 5.1 The Winners in the Competition of Supply Chains

The demand for a standardisation of supply chain processes and business processes, material and information flows and workflows often has an ambivalent character. On the one hand, a number of businesses see great potential for optimisation in the harmonisation and improvement of their processes. However on the other hand, there are often concerns that the standardisation of structures and processes could cause strengths that result purely from the diversity and, as a result, uniqueness is lost.

Ultimately, an over-extensive standardisation would lead to stagnation, because ultimately all competitors would have achieved the same performance level and there would be no more differentiation. In this case, Supply Chain Management would only contribute to a limited extent to the achievement of competitive advantages or, in extreme cases, could even lead to the contrary, and therefore result in competitive disadvantages.

Thomas Davenport, one of the leading experts in the field of process optimisation and standardisation, has summarised it aptly: When it comes to the standardisation of their processes, businesses



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have mixed feelings for a good reason, since this is also always connected, in some way, to certain interchangeability. This in turn can quickly lead to increased competition and pressure on prices and margins. On the other hand, standardisation is essential since it leads to benefits in many cases due to the associated efficiency and effectiveness it leads to benefits in many cases. In any case, it is better to participate early and actively in standardisation activities and to "drive" these, as opposed to becoming forced into being "driven". And it is of course always better to help shape a standard than to be put out of business by it (cp. Davenport 2005, p. 108).

Therefore, a business must find the right balance between standardisation and customisation to sustainably improve its competitive position and to enable its expansion. A great benefit of supply chain management lies undoubtedly in the definition of a standardised, common language for communication between the various internal functional areas and the partners of the supply chain network. Only with a common understanding of all parties involved does an optimised design of the customer-supplier relationships along the entire supply chain no longer represent a problem.

In conjunction with the activities related to the ongoing analysis and optimisation of the supply chain, the aspect of individualisation also comes into effect. Although this represents a major challenge, at the same time it constitutes a "larger than life" and also necessary condition in order to remain competitive. Businesses must continuously work on improving measures regarding functional, organisational and information technology levels to enable the flexible design and integration of enterprise-internal and cross-enterprise supply chain processes.

Marlon Dumas, Marcello La Rosa, Jan Mendling and Hajo Reijers, who dealt in-depth with the subject of business process management, come to the conclusion that it is crucial to find the right balance between the inward and outward views. The enterprise and supply chain strategy on the one hand and the customer perspective on the other must be properly matched. In a unilateral focus on the customer there is a risk that businesses are based too much on the short-term operational efficiency and provide insufficient contributions to the long-term development and expansion of the success potential and core competencies. Conversely, a one-sided focus on the business and

supply chain strategy can, figuratively speaking, result in "overlooking the customer" and thereby missing the actual operational objectives (cp. Dumas et al. 2013).

Consequently, it is no longer just a matter of creating surplus value, but constantly redefining this added value across the entire supply chain. The ultimate goal is to control a dynamic or evolutionary process that enables a balance between the requirements of customers on the one hand and the supply chain competencies on the other. For this purpose, it is necessary to transform static supply chains into adaptive networks that are business-related, event-driven and self-regulating. As a result, supply chain management best accomplishes its actual task: the continuous, proactive synchronisation of consumer demand and business value.

Innovative approaches to implementing and supporting adaptive supply chains, such as the presented Supply Chain Design Management, advise of potential paths to the future of continuous adaptation to changing market requirements and value-based networks. They may, however, not be considered in isolation under any circumstances. Rather, they should be seen in a holistic context along with the overall corporate strategy, the input and output variables, the corporate environment, employees, organisational structure, information technology and business processes.

Paul Hofmann, Chief Technology Officer of Space-Time Insight, sees the combination of performance measurement and comparison and the evolution towards an adaptive enterprise as an essential prerequisite, in order to enable businesses to implement and realise adaptive supply chains. He is of the opinion that supply chain design management will play an increasingly important role in the future, due to the accelerating rate of change of the supply chain in businesses (cp. Hofmann 2004, p. 86).

Again, it is about finding the right balance. This allows the coordinated and optimised interaction within a business process-orientated supply chain integration concept, supported by a continuous improvement process. You may ask: on what score? The answer is obvious: in order to make a very worthwhile contribution to increasing the value and securing the long-term success of the business, thereby enabling your business to be amongst the winners in the *competition of supply chains!*

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**Dr. Rolf G. Poluha** holds a Bachelor of Industrial Engineering from Aalen University, Germany, a Master of Business Administration from the University of Stuttgart, and a Ph.D. in Economics from the University of Cologne in Germany.

He started his career as Project Manager with SAP in Germany. Thereafter, he managed international projects in Europe, USA and Asia for Bearing Point (formerly KPMG Consulting). Since re-joining SAP in 2003, he has been responsible for managing large, global accounts in North America and Europe.

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In addition to his practical experiences with Supply Chain Management, he has studied the topic in the context of an in-service dissertation project at the University of Cologne, which was also published in the English language:

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# About the Series Editor

**Prof. Dr. Nils Bickhoff** holds an M.Sc. and a Ph.D. in business administration and began his career as a consultant with Roland Berger Strategy Consultants in 1995. He advised international clients on matters of strategy, organisation, branding, and corporate finance, and was also responsible for Roland Berger's global research & development activities. In 2005 he founded his own company and has since been advising top managers on all issues of strategic management. Nils Bickhoff has authored and published several management books, is editor of the "Quintessence" series, gives lectures and seminars, and is Professor of Business Administration and Marketing at the European Distance University in Hamburg.



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