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A. Introduction

The relevance of a global perspective on business operations is evident as nowadays every introduction to a major or minor text on managerial issues highlights the new challenges and risks of the globalizing world economy. It is apparent that in this paper, this opinion is shared. As globalization is evolving, all corporate activities have to cope with the influence as well as the opportunities that arise from it. Here, we will focus on the implications for business logistics and especially consider the impact on supply chain management.

We will depict the basic concept of supply chain management (SCM) as well as the phenomenon of globalization for subsequently highlighting the characteristic problems that arise for SCM in the global context. In the first part, we will treat the problems and underlying ideas of the SCM concept and its relation to logistics. Afterwards, we will have a closer look on globalization and its effects on logistics and SCM. In the last part of this section we will elucidate some aspects appearing to be of central relevance in global SCM.

B. The Concept of Supply Chain Management

The *supply chain* is commonly regarded as a sequence of material suppliers, production facilities, distribution services and customers which are linked together by the flow of goods and information (TOWILL/ NAIM / WIKNER 1992).

In this first part, we will take a look at the overall concept of supply chain management. It will become clear that besides the young logistics discipline, which has not yet definitely found its axioms and theoretical foundations, supply chain management, as an even younger concept, is less homogeneously treated. We will therefore begin to review different understandings of SCM which can be found in academic publications. We will subsequently try to distinguish SCM from logistics, as massive redundancies appear when using both terms unreflectedly, partially due to different understandings of the logistics term in Anglo-American and Continental-European regions.

1. Supply Chain Management: Schools of Thought

The roots of SCM can be localized in logistics literature The term was first mentioned by the management consultants OLIVER and WEBBER in the early 1980's to shift attention to cross-functional integration. Meanwhile an inflationary use of the term supply chain management can be observed, with authors employing the term even differently when referring to denote its underlying nature. We will not discuss the different meanings and implications which accompany the different terms here, but instead stick to view SCM as a concept. Table 1 gives a brief overview of different understandings of SCM.

Understanding (SCM is seen as ...)	**Author/s**
Approach	JOHANNSSON (1994)
Concept	BECHTEL / JAYARAM (1997), SCHARY / SKJØTT-LARSEN (1995)
Perspective	ELLRAM (1991)
Philosophy	COOPER / LAMBERT / PAGH (1997), LAMBERT / COOPER / PAGH (1998), COOPER / ELLRAM (1993)
Technique	TURNER (1993)

Table 1: Understanding of SCM

Analogous to the dissent about its nature, the specifications and definitions about contents and meaning of SCM vary widely. As HARLAND (1996, p. 63) remarks:

> "However, there is little consistency in the use of the term [SCM] and little evidence of clarity of meaning."

In an attempt to systematize definitions and understandings, BECHTEL and JAYARAM (1997) identified four generic schools of thought which so far dominate in SCM literature. We will present their findings prior to critically reviewing them. BECHTEL and JAYARAM differentiate the functional chain awareness school, the linkage / logistics school, the information school, and, finally, the integration / process school.

a) The Functional Chain Awareness School

A definition of this school is presented by HOULIHAN (1988, p. 14):

> "Supply chain management covers the flow of goods from supplier through manufacturer and distributor to the end user."

Two aspects are striking in this definition, which can be judged typical for the functional chain awareness school. Firstly, emphasis is laid on the materials flow, thus concentrating on the movement of goods. Secondly, the whole value adding process of a product is interpreted as a chain of different actors and functions, thus including suppliers and manufacturers from beginning to end of the process ("dirt to dirt").

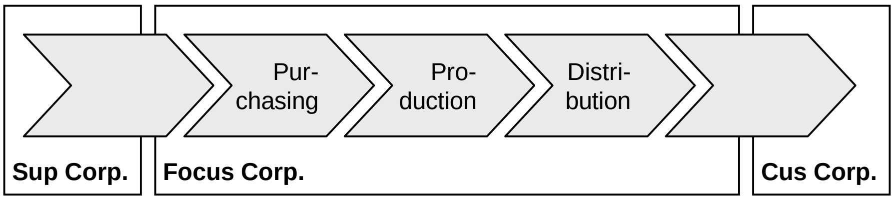


Figure 1: The Functional Chain Awareness School

The perception of authors of this school resembles closely MICHAEL E. PORTER'S concept of the value chain (PORTER 1985), which he proposes as an instrument for a firm analysing its activities. And indeed, PORTER can be judged as a key figure to give birth to the chain interpretation, although he did not primarily regard object flows. Other prominent definitions belonging to this school come from JONES and RILEY (1985), STEVENS (1989), LANGLEY and HOLCOMB (1992), and others.

b) The Linkage / Logistics School

This school of thought has a different focus: It emphasizes the links which exist between different functional areas within the chain. It therefore seeks to exploit these links in order to gain considerable competitive advantages from superior linkage management. Focus is laid on the management of the flow of goods through the different elements of the chain, and thus logistics and transportation are seen as major variables for gaining competitive advantage. A definition of SCM according to the linkage / logistics school of thought is provided by TURNER (1993, p. 52):

> "[SCM] is a technique that looks at all the links in the chain from raw material suppliers through various levels of manufacturing to warehousing and distribution to the final customer."

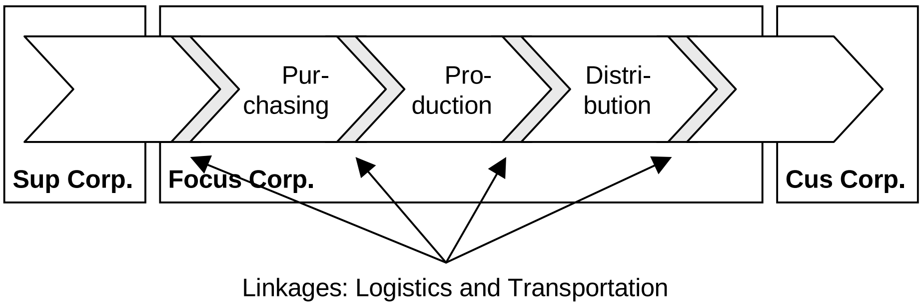


Figure 2: The Linkage / Logistics School

c) The Information School

Advocates of the information school emphasize that, besides the flow of goods through the supply chain, an information flow has to be considered according to quite similar principles as well. Thus, the information school broadens the scope relative to the two schools previously presented. A prominent definition is given by JOHANNSSON (1994, p. 525):

> "SCM [...] requires all participants of the supply chain to be properly informed. With SCM, the linkage and information flows between various members of the supply chain are critical to overall performance."

It should be noted that the information flow can move into the same direction as the flow of goods it relates to, but it can and should also move into the opposite direction. In the former case, it supports the feedforward flow of goods, in the latter it serves to inform the suppliers about status and whereabouts of their products. Accordingly, we can distinguish unidirectional and bidirectional flows of information in the supply chain. Figure 3 depicts the perspective of this school of thought.

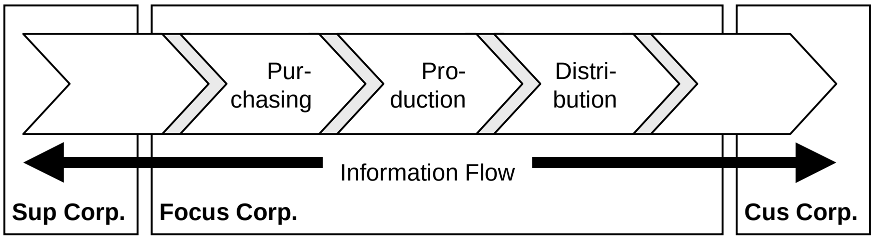


Figure 3: The Information School

Other authors, emphasizing the informational aspects of SCM are TOWILL, NAIM and WILKNER (1992).

d) The Integration / Process School

The most far-reaching school of thought is the integration school. In this school, SCM is treated as paradigm, exceeding the ideas of all previously depicted schools. It regards the supply chain not only as a collection of functional or organizational blocks which are traversed by flows of goods and information. It breaks the blocks horizontally into singular processes which are then regarded as objects of further optimization. The previously defined elements of the chain are horizontaly disassembled and might be combined in a more efficient way. Thus, a horizontal perspective is promoted here which is not confined to logistical processes. Different processes of the chain might be managed and controlled differently, even if they partly belong to the same element (logistical segmentation). A typical definition for the integration school is given by COOPER, LAMBERT and PAGH (1997, p. 2):

> "The integration of business processes across the supply chain is what we are calling supply chain management."

Further proponents of this school are ELLRAM and COOPER (1990) and HEWITT (1992). The integration perspective of SCM has also been manifested in the definition of THE GLOBAL SUPPLY CHAIN FORUM (cited in LAMBERT / COOPER / PAGH 1997, p.1), which defines SCM as

> "the integration of key business processes from end user through original suppliers that provides products, services, and information that add value for customers and other stakeholders."

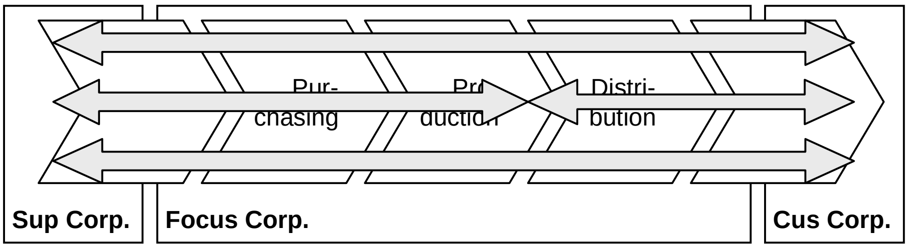


Figure 4: The Integration School

It is important to note that this school detaches from the original domain of logistics and operations, as it tries to include all kinds of important activities within the scope of supply chain management.

e) Critical review

The schools of thought depicted above show and focus on different facets of the supply chain. The supply chain is regarded as the sum of different organizational elements a product, including its components, traverses on the way to the final customer. But besides this statement, what can we draw from the different schools ? Which one is the “right“ or the “best” perspective to adopt ?

A key to understanding supply chain management is to recognize all the schools and their respective key elements. By first adopting the functional chain-perspective we are confronted with the perception of business-to-business relations as a chain of sequential tasks and / or organizational elements. The linkage / logistics school shifts attention to the management of links between the elements, aware of the fact that interfaces are the source of a variety of problems in reality. The information school adds the information flows as important aspect of the supply chain process. The integration school draws attention to the single business processes, even if it promotes a view which seems too wide. Thus, we have step by step approached a differentiated view on the supply chain. We should be aware that no single school of thought comprises all important aspects of SCM. It is clear that all schools are limited in scope and only focus on one element of the supply chain, or even SCM. Whereas the first three schools neglect certain important aspects, the integration school is extremely far-reaching. With its understanding of SCM as the integration of key business processes, totally independent of the original logistics domain, its proponents run into the omnipotence trap, as then, SCM is just synonymous for management.

There are other questions which remain. If there are trade-offs between the elements of the supply chain which are neglected right now, how can we be sure not to neglect trade-offs which occur between different processes ? Thus, a mere turn in perspective from vertical to horizontal is not sufficient. Instead, we have to adopt both perspectives in order not to trade one loss against another. Other arguments head into the same direction. In recent publications, criticism of the term *supply chain* has been uttered, since it is the demand of customers which drives the chain of activities, not the suppliers. Additionally, the illustration as a chain appears inadequate, assuming that there is only one supplier and one customer for a given product. Of course, this is not the case. Instead, when focusing on the supplier side of operations, there are many suppliers, delivering different components for one product. And these suppliers again have many different suppliers for their products. Thus, the use of the term *supply network* instead of supply chain is proposed, or, when integrating the demand focus mentioned earlier, *demand network*. Even if these comments are plausible, we will stick here to the term SCM as it is most widely accepted, but we should keep these objections in mind. However, the question remains: should all the relations to suppliers and further, to their suppliers, and the suppliers' suppliers, and so on, be managed ?

With this question we are approaching the field of interorganizational cooperation, which is very closely related to supply chain management as a fundamentally interorganizational concept. We will revisit this topic later.

2. Logistics vs. Supply Chain Management. Where is the difference ?

As already noted above, there are some irritations concerning the wording within and between logistics and SCM. In regarding this discussion from a Continental European point of view, another difficulty is added, as logistics here is differently understood and defined than in the Anglo-American area. This cultural difference complicates the discussion about the SCM term. We will therefore firstly depict the evolution and the understanding of the terms in both (continental) Europe and the United States (and the UK) for subsequently providing a way of combining both interpretations.

a) The Continental-European Understanding of Logistics

In continental Europe the logistics concept has experienced a fargoing evolution. It was originally used to denote physical transfer activities, thus comprising all structures and processes which served the purpose of transferring objects through space and time. This mainly included transportation, consolidation, and warehousing, thus contrasting to the transformation processes which dominate in the production function. So far there is no dissent to the Anglo-Saxon understanding of the logistics term.

Its meaning was then stepwise expanded in scope, ultimately leading to an overall logistics concept which is seen as a specification of the meta-theoretical systemic approach (DELFMANN 1999). The systemic perspective on organizations, as opposed to the concepts of individualism and holism, emphasizes interdependencies between the organizations' elements as well as the interdependencies between the organization and its elements (BUNGE 1996, pp. 241ff. and pp. 264ff.). We thus arrive at a network perspective on organizations and are able to interpret activities as flows through these networks. As logistics has always tried to cope with networks (e.g. vehicle routing), this perspective is a generalization of the original logistics domain. Within this logistics concept, a three-level differentiation of the logistics term has been elaborated, which can be regarded as generally accepted (see Figure 6).

According to this understanding, the original logistics domain is interpreted as the first level of logistics, labeled *logistics systems*. Here the term logistics denotes all structures and processes which serve to transfer objects in space and time. The traditional logistics activities, such as warehousing, transport and inventory management, belong into this category. The second level, called *logistics management*, is regarded as efficiently and effectively planning, controlling and implementing the first level logistics systems. Finally, on the third level, logistics is understood as a specific manner of designing and implementing logistics management. It is therefore called *logistics philosophy*. According to this understanding, logistics is no longer confined to its specific function within the company, but becomes an overall guideline or even a management approach which includes the following principles.

- *Systemic perspective and total cost approach*: The systemic perspective is used to describe the matter that fragmented management and judgement regularly leads to suboptimal decisions because interdependencies to related or linked activities are ignored. Thus, before arriving at decisions, its potential implications for other activities have to be considered. These interdependencies on the cost side of activities are frequently associated with the total cost approach. It can be regarded as a specification of the systemic perspective with special emphasis on occurring cost-cost trade-offs. Therefore, a systemic view is proposed in order to prevent the realization of sub-optima for the benefit of a global optimum.
- *Flow-orientation:* Derived from the flow of goods as used in the logistics domain, flow orientation on a more general level serves to illustrate a change in perspective from a vertical, hierarchy- and functions-oriented to a horizontal, process-oriented point of view, where functional and organizational boundaries should not matter. It is in this context that the term supply chain (syn.: logistics chain, value chain) is introduced in Continental-European texts.
- *Customer- and service-orientation:* The aspect of customer- and service-orientation illustrates that by regarding the whole supply chain not only the final customer is relevant for the overall performance of the chain. Instead, the relations between the supplier and his supplier must also be regarded as customer-relations which are critical to the overall performance.

As most of these characteristics are widely associated with SCM in the Anglo-American context, Continental-European authors were seen to have difficulties in coping with SCM. Compared with the understanding of logistics depicted above, it does not appear to bear anything originally new. A solution widely accepted so far is to view logistics as having an intra-organizational focus while SCM is focussing on inter-organizational relationships. Figure 5 illustrates this understanding.

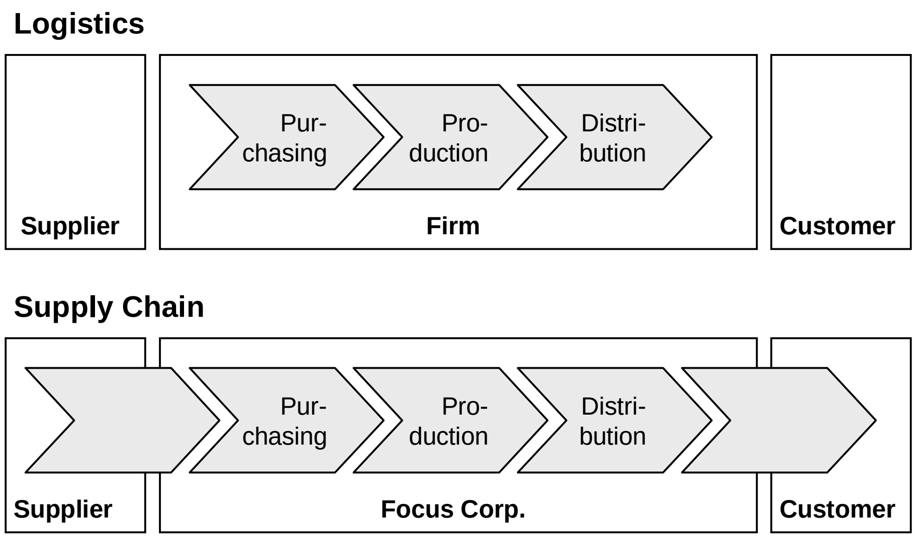


Figure 5: Logistics and Supply Chain Management

Although this seems to be a quite logical differentiation at first sight, we can only agree with it under severe restrictions. As the main characteristic of both, logistics from the Continental-European and SCM from the Anglo-American perception, is a systemic perspective which does explicitely not attribute any importance to organizational boundaries, it appears artificial to draw the line between two apparently flow-oriented concepts at the boundaries of a given organization. We will revisit this problem later.

b) The American Understanding of Logistics

In America, a different development of the logistics discipline could be observed. There, logistics and operations have always been limited to the operational logistics level, comprising essentially transportation, warehouse management and inventory control. In 1956, a study about air freight (LEWIS / CULLITON / STEELE 1956) introduced the total cost perspective to logistics because air freight was judged to be more efficient if the relatively higher transport costs were offset by savings in inventory costs. In 1963, the Council of Physical Distribution Management was founded, which is known today as the Council of Logistics Management (see http://www.clm1.org). The period of 1960 to 1980 produced a great variety of publications, ranging from articles to textbooks discussing the subject of logistics management. But besides the term of logistics management, a multitude of similar titles is in use. See for example COYLE / BARDI / LANGLEY (1988) who give an extensive overview of alternative terms which circle within logistics and which all apparently overlap in their meaning: physical distribution, marketing logistics, materials management, logistics engineering, business logistics, logistics management, integrated logistics management, supply management, distribution management, etc.

A widely accepted definition of logistics was provided in 1986 by the COUNCIL OF LOGISTICS MANAGEMENT:

> "Logistics is the process of planning, implementing and controlling the efficient, cost-effective flow and storage of raw materials, in-process inventory, finished goods, and related information from point-of-origin to point-of-consumption for the purpose of conforming to customer requirements."

Note that already this definition of logistics management traverses organizational boundaries. It reflects about the same understanding of logistics as the level one and two Continental-European interpretation, but a further evolution of the logistics term did not occur. Instead the SCM concept evolved from the logistics discipline. In the early 1980s, the idea of supply chain management was introduced by OLIVER and WEBBER. They interpret SCM as an enlargement of their (quite narrow) understanding of the logistics term (OLIVER / WEBBER 1992, p. 64):

> "What were hitherto considered 'mere' logistics problems have now emerged as much more significant issues of strategic management ... We needed a new perspective and, following from it, a new approach: supply chain-management."

They thus proposed an integration of *internal* business functions, such as purchasing, manufacturing, sales and distribution. But the concept underwent a broadening of its original understanding. This happened firstly by widening the focus to interorganizational relations, as shown in the schools of thought presented above, finally reaching the level of the integration school. This understanding of SCM partially filled the gap which was in Europe occupied by the third level of logistics understanding. Under the influence of the SCM debate, the COUNCIL OF LOGISTICS MANAGEMENT revised its definition in 1998, clearly subordinating logistics under the banner of SCM:

> "Logistics is that part of the supply chain process that plans, implements, and controls the efficient, effective flow and storage of goods, services, and related information from the point of origin to the point of consumption in order to meet customers' requirements."

But the gap to the European logistics philosophy still remains on the theoretical level, as SCM can neither be derived from meta-theoretical concepts nor does it provide a coherent conceptual framework.

Thus, we have seen a quite similar development of underlying concepts which took place nearly independently from each other and resulting in different understandings and different terms. Figure 6 illustrates the different cultural associations and differentiation.

c) Synthesis and Proposal

As we have elaborated above, there are surprising parallels in research concerning SCM and logistics and the development of these displines. We identify massive parallels between European first and second level logistics understanding and the Anglo-American logistics term, as formulated by the CLM definitions and promoted by several authors. The basic SCM schools as a whole, apart from the integration school, can also be judged as equivalent to the European first and second level logistics understanding. When regarding the European third level understanding of logistics, we track parallels to the integration school understanding of SCM, but also identify significant differences. The European logistics concept is theoretically more sophisticated, but remains somewhat vague and of moderate practical value. The Anglo-American SCM-concept is a more pragmatic one, which might be regarded as specifying the European logistics philosophy in a certain manner.

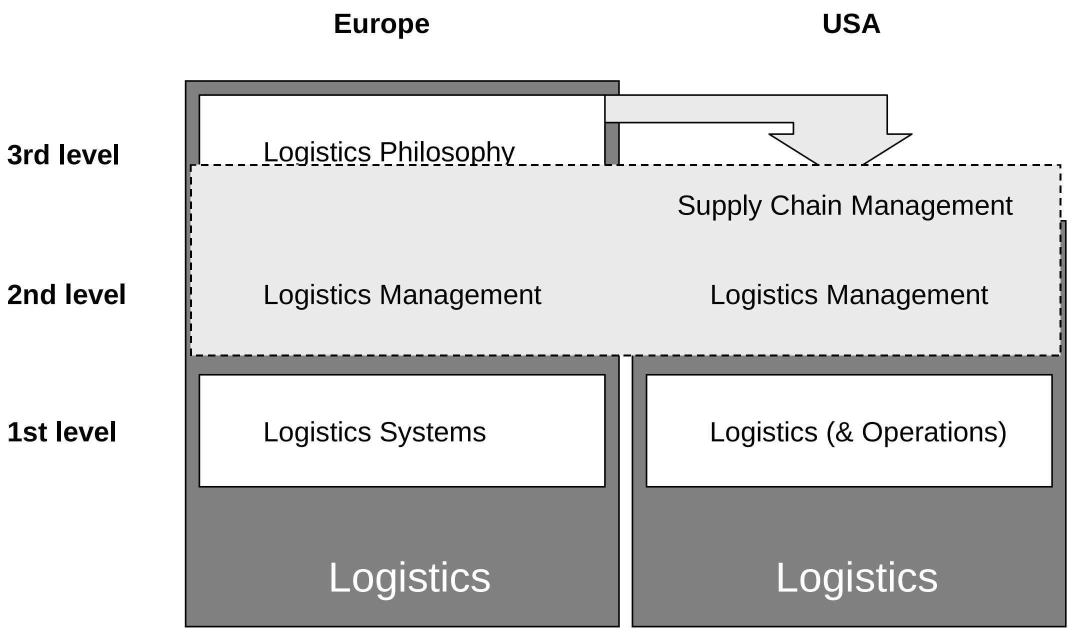


Figure 6: Differentiation of Logistics and SCM

From this perspective we can understand why there has been (and still is) some confusion about the terms of SCM and logistics. Some American authors regard logistics as part of SCM (LAMBERT / COOPER / PAGH 1998), European authors argue the other way around. When we regard the American proponents belonging to the integration school and the Europeans adopting the third level logistics understanding, we might admit that both are right.

Above, we have elaborated a differentiated understanding of the terms logistics and SCM. In this paper, we will therefore conclude the following. Logistics management (2nd level) is the management, that is planning, implementing and controlling of logistics systems (1st level) according to specific logistical principles (3rd level). Principally, supply chain management is a synonym for the term logistics management. We say principally here because the two terms highlight different aspects of the same domain. Only when adopting this understanding, we might agree to primarily associate intra-organizational matters with logistics management and inter-organizational matters with SCM, but they do not fundamentally differ. We thus arrive at an understanding of supply chain management as an applicable concept which specifies the overall logistics concept. It is still related to the original logistics domain and thus focuses on the active management of the flow of goods and related information, but emphasizes inter-organizational aspects as well as co-operative relationships among the members of the entire supply chain. Nevertheless, the SCM concept is frequently promoted as applicable by one company which should manage its supply chain(s) rather than as an overall concept with a differentiated view on its members. We will revisit this point later and confine ourselves to the predominant position, where one company appears in the center of analysis.

3. Goals and Objectives of Supply Chain Management

The goals associated with SCM are mannifold. Frequently mentioned are the reduction of inventory investment in the chain, or more generally, the reduction of costs. Furthermore, increasing customer service or higher customer satisfaction, as well as building a competitive advantage (COOPER / ELLRAM 1993, p. 14; BHATTACHARYA / COLEMAN / BRACE 1996, p. 39; ELLRAM 1991, p.17), are regarded as essential aims of SCM. The latter comprises the former mentioned goals. Again we encounter an unsystematized mixture of different goals which are related to the SCM concept. We will therefore try to systematically deduct and specify goals and objectives attributable to the SCM concept.

a) Competitive Advantage as Major Goal of an SCM Implementation

Unsurprisingly, it is widely accepted that SCM should contribute to ensuring the competitive position of the implementing company. As we have already mentioned above, the SCM concept is remarkably congruent with MICHAEL E. PORTER'S (1985) concept of the *value system*, which was his term to denote the company's economic environment. The main difference is that PORTER focused on the intra-company *value chain* as part of the value system, whereas the SCM concept attributes comparable importance to the inter-company relations. We will therefore relate to PORTERS differentiaton of sources of competitive advantage for then examining the potential contributions of the SCM concept to the realization of these advantages. PORTER argues that competitive advantage arises from superior products either with respect to the company's costs (cost leadership) or the product's features which differentiate them from competitors' offers in the eyes of the customer (differentiation). As SCM stresses the inter-organizational aspects, we will widen the focus of PORTER'S instruments and specify the two types of competitive advantage for the entire supply chain. From this perspective, not only the single companies compete, but the supply chains they are in as well. As in the intra-company case all parts of the value chain within the company have to be aligned to the overall company strategy, the companies in the supply chain have to assure that they head into the same direction.

b) Drivers

PORTER (1985, pp. 70ff. and pp. 124ff.) identifies ten major driving variables which are of significant importance to the company's ability to gain either cost or differentiation advantages. We will depict the basic drivers in the following section for subsequently specifying them according to cost and differentiation aspects. With respect to our focus on supply chains, we will specify the significance of these drivers for the entire supply chain and show the advantages which can arise when a systemic view on the whole chain is adopted. The ten drivers which represent the major variables for exploiting costs and differentiation potentials are: linkages, economies of scale, learning, the pattern of capacity utilization, interrelationships, integration, timing, discretionary policies, location and institutional factors.

The *linkage* driver is of outstanding importance for the SCM concept, as it is likewise based on the perception that inter-organizational relations are of major significance for company performance nowadays. We will thus treat this driver beforehand. PORTER uses the linkage driver to express the interdependence of activities. As one activity might severely be affected by the performance of another activity, this point shifts attention to interdependencies among them. PORTER differentiates *linkages within the value chain*, thus, within the company, and *vertical linkages*, which in his vocabulary denotes the linkages of the focal company to its suppliers and distribution channels. Naturally, the SCM concept focusses on both, but as elaborated above, pays particular attention to the inter-organizational aspects. As PORTER (1985, p. 77) remarks:

> "Managing supplier linkages can lower the total cost through coordination or joint optimization. [...] The typical linkages [with channels] mirror those with suppliers."

We will closely examine the remaining nine drivers with regard to their potential contributions to cost and differentiation advantages when applying the SCM concept.

i. Scale

On the cost side, the scale of performing an activity might be of relevance for the inflicted costs. *Economies of scale* occur if the costs of performing an activity decline per unit with increasing volume. Alternatively we can say that the related costs of an activity increase less than proportional to the volume of output. If the contrary effect is achieved, we speak of diseconomies of scale.

Economies of scale can represent a remarkable source of *cost advantages*, especially in the interorganizational focus. If similar activities which are subject to economies of scale are pooled within the supply chain, the costs for several supply chain members might be reduced, thus resulting in lower costs for the final customer. Examples might be found when regarding warehousing or inventory management. Instead of each supplier building and managing its own warehouse, a single location, used by several members of the chain, helps to reduce fixed costs which would otherwise occur for each individual warehouse. The same might appear when procurement activities are pooled, as increased purchasing power typically results in lower prices per purchased unit.

The scale on which an activity is performed might as well be regarded as source of *differentiation advantage*. When performing processes at large scale, the service level might be significantly higher than for low scale producers. An example for this effect might be a large volume telecommunications infrastructure provider, which can provide a network of service stations all over Europe. This allows him to provide faster service and higher service levels to all of his customers, whereas smaller providers must rely on third parties or are not able to provide the same high service level. When including the scope of the whole supply chain, the telecommunications equipment provider might even further enhance his competitive position. The service levels might be improved when information about sold items are directly forwarded to suppliers in order to ensure rapid refillment of inventories.

ii. Learning and Spillovers

The effects of learning are apparent when activities are performed more efficiently. This can simply happen when certain problems are already known and have been coped with before. Learning can further be the result of spillovers from one industry to the other or from and to other companies. This point seems to be of considerable relevance for the SCM concept.

Learning and spillovers might enable activities to be performed with lower costs, which may result in *cost advantages*. Sophisticated methods or techniques of one firm may find their way to other firms, reducing overall costs.

The adaptation of new techniques might as well result in *differentiation advantages*, if new features or higher service levels can be provided. The implication of bar coding in international air freight or parcel service has empowered the implementing companies to offer their customers tracking and tracing information, which gave the first movers considerable differentiation advantages. Most frequently, both effects appear simultaneously.

iii. Pattern of Capacity Utilization

When substantial fixed costs have to be coped with, the *pattern of capacity utilization* is of major importance for the distribution of *costs* among the products to be sold. Within the interorganizational focus, a harmonization of orders or a less cyclic procurement policy of a customer can considerably contribute to a less expensive capacity utilization of suppliers and thus reduce inventory as well as costs of underutilizing existing capacities. The so-called *bullwhip-*, *whiplash-* or *Forrester-effect* in supply chains illustrates the effect that demand order variabilities are amplified as they move up the supply chain, causing tremendous variances for upstream suppliers even if the demand is steady. This effect can be partly encountered by giving information about upcoming orders early enough to suppliers in order to give them a chance to react in time. The bullwhip effect will be treated extensively in a subsequent part of this paper.

Indirectly, this might as well serve as *differentiation advantage*, as the supplier can provide better information on timeliness to his customer, resulting in higher reliablity for the whole supply chain in the eyes of the final customer.

iv. Interrelationships

The interrelationship driver is closely connected to the driver depicted above. In fact, it implies sharing of resources and can be regarded as a means to achieve economies of scale, learning and a better capacity utilization pattern (PORTER 1985, p. 78). PORTER uses the interrelationship-driver in order to capture relationships between business units within a company, which can jointly perform several activities or share know-how. The latter might as well be interpreted as learning from each other, which was already treated above. However, the sharing of singular activities is of central relevance, also in the interorganizational focus, as it can be regarded as an essential source of synergies for the companies involved.

For example, a dispatch or vehicle routing department may as well engage in the planning of fleets of two companies, an interorganizational inventory management can contribute to better service levels and lower inventory costs, as well as combined distribution organizations or order processing.

v. Integration

The level of vertical integration denotes the state of performing activities within the company's boundaries, or within its organizational hierarchy system. When arguing from a transaction cost theory perspective, the performance of an activitiy within an organization avoids the costs of using the market but causes costs of using the organizational system of the company. Integration can as well contribute to differentiation aspects of a company, as the company might better control certain aspects of its offering. When regarding the level of vertical integration we approach a sensible point in supply chain management. The SCM concept does not recommend a certain level of integration as it takes as fix the organizational configuration of the supply chain and proposes an integration of processes or activities, notwithstanding the organizational status of the parties involved. SCM is commonly regarded as interorganizational concept with tribute to exactly this fact.

Thus, we cannot draw recommendations for competitive advantage from the integration driver, PORTER correctly regards with respect to his mono-organizational persective.

vi. Timing

Timing can be of considerable importance to the competitive position of a company and the supply chain. Being the first in a market can result in *differentiation advantages* (image of a pioneer) as well as *cost advantages*, e.g. with regard to learning effects. Disadvantages can arise if followers take advantage of marketing efforts of first movers, or can simply use more sophisticated production technologies.

Supply chain management can play an important role with respect to the timing of market entries or product improvements. As discussed above, spillovers and learning as well as the joint performance of certain activities may lead to better information flows and an overall superior performance of the supply chain members. Sharing of knowledge may result in a shorter time to market, joint optimization of production processes may result in a greater flexibility with regard to market changes.

vii. Discretionary policies

Discretionary policy choices comprise decisions of companies which are not directly related to the other cost and differentiation drivers of activities, but reflect strategic aspects of a company's, or in our focus, a supply chain's, behavior. The greatest policy choices with regard to their impact on *costs* as well as *differentiation* matters are, for example, product configuration, performance and features, mix and variety of products offered, level of service, delivery time, channels employed, etc. (PORTER 1985, p. 81 and pp. 124ff.).

These choices are of central importance to the configuration of the supply chain(s) a company is in. An independent allocation of tasks and activities within the supply chain results in suboptimal overall performance of the supply chain and thus not in competitive advantage for the employing companies. Therefore, the discrete policy choices have to be coordinated among suppply chain members, which is a central aspect of the supply chain management concept.

viii. Location and Institutional factors

The location of production sites, service points, etc. affects *costs* as well as *differentiation* matters of a company as well as a supply chain. Commonly, labor costs, prevailing infrastructure, energy costs, educated personel, among others, are regarded as determinants of location decisions of a company.

Coordinated location decisions within the supply chain can provide competitive advantages for two reasons. On the one hand, the location of activities can be chosen without the confinement of a company's own locations, as locations of suppliers or distributors might as well be taken into account. If an overall improvement in costs or a differentiation advantage accompanies the outsourcing of an activity to another member of the supply chain, the overall competitive position of the whole supply chain is improved as well. On the other hand, location decisions for new activities can be chosen with respect to already existing capacities. The location of an additional production site of a supplier next to the production plant of the buyer can result in savings of transportation costs, inventory and increase the service level.

With the institutional factors driver PORTER associates external factors, such as governement regulation and tax laws. Differences in these factors can be exploited similarly to location decisions when decisions are coordinated among supply chain members.

c) Conclusion

Above, we have depicted the two sources of competitive advantage as well as the major variables with the greatest impact on achieving these advantages for a company. By extending the scope of PORTERS original value chain concept onto the inter-organzational level, we have provided an overview of the potential benefits of supply chain management as a concept and have specified the overly general aim of achieving competitive advantages which is commonly associated with this concept.

C. From Domestic to Global Supply Chains: Added Complexities and Uncertainties

In the following section we will closely examine the impact of the so called globalization phenomenon on supply chain management. We will draw a clear picture of the globalization process for then relating it to the companies' internationalization and, as we are in the context of business logistics, logistics strategies. After depicting the characteristics of supply chains in the global context, we will point out the main problems which are posed in the global context for supply chain mangement.

1. The Global Market

As already noted in the introduction, globalization is *en vogue*. The term globalization appears everywhere, but is seldomly defined prior to its application. It is highly disputed if globalization is something originally new as it is commonly employed synonymously for internationalization - and internationalization processes and international trade have ever since occured in world business. As PETER DICKEN, a pioneer in globalization literature, (1998, p. 1) observes:

> " The internationalization of economic activities is nothing new. Some commodities have had an international character for centuries; an obvious example being the long-established trading patterns in spices and other exotic goods."

We will try to circumvent the pitfall of emloying undefined terms and again refer to DICKEN (1998, p. 5), who defines and differentiates internationalization and globalization.

> "*Internationalization processes* involve the simple extension of economic activities across national boundaries. It is, essentially, a *quantitative* process which leads to a more extensive geographical pattern of economic activity. *Globalization processes* are *qualitatively* different from internationalization processes. They involve not merely the geographical extension of economic activities across national boundaries but also - and more importantly - the *functional integration* of such internationally dispersed activities."

From this definition we can essentially draw two dimensions of globalization: The *geographic* and the *qualitative* dimension (see also DELFMANN 1998, p. 63). The geographic dimension is used to describe the increased geographic scope of activities of international companies in the last decade. Parallely, location and dispersion of production facilities have considerably increased as well. Supply and production chains have become more international - but increasingly integrated and thus increasingly interdependent than in earlier years as well. This is refered to as the qualitative dimension of globalization. Rising international competition among more and more internationally operating companies, new possibilities of optimizing the production and supply chains also belong to the qualitative dimension. Whereas both dimensions are of major importance for logistics, the qualitative dimension nowadays becomes the driving force of global supply chain management. When introducing the terms configuration and coordination we might alternatively formulate: Increasing globally configured supply chains demand increasing coordinational efforts with regard to their activities.

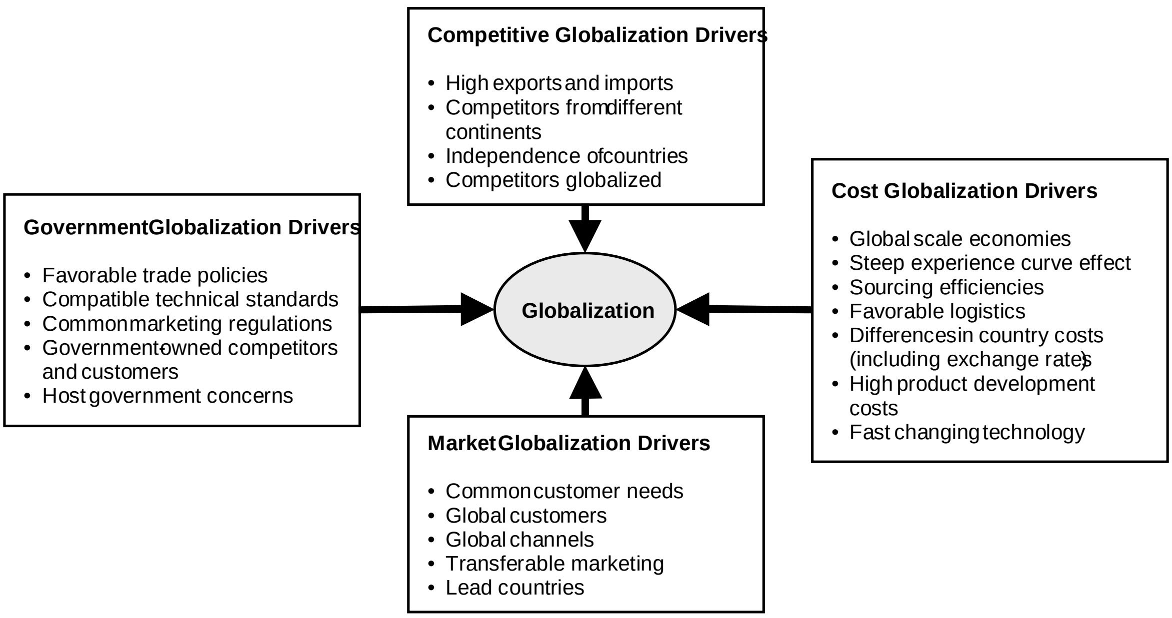


Figure 7: Globalization drivers according to YIP (1992)

But anyway, why does globalization occur and what is its impact on SCM ? Parallel to PORTER's drivers of competitive advantage we have depicted above, YIP (1992, pp. 31) identifies four clusters of industry globalization drivers: market, cost, government and competition.

These drivers can be regarded as explanatory variables for the ongoing globalization process. We will subsequently try to depict the most relevant for the logistics and supply chain focus we promote here.

a) Market Forces

On the market side, the *homogenization of customer needs* is most frequently mentioned when discussing the globalization process. As a result, for example, dispersed production facilities which take into account a multitude of regional specifities are no longer obligatory and instead replaced by fewer and larger production sites which take advantage of economies of scale.

The rise of multinational corporations and their success has been noted above. It is clear that these companies in the role of *customers* are globally present as well. A typical trait of the global customer is the coordinated or even centralized purchasing of material or services for decentralized use (YIP 1992, p. 37). Take the example of the world advertising industry. Most of their customers grow internationally and concentrate their advertising budgets on one or two globally present agencies. This trend can also be observed when regarding logistical service providers. As logistics activities are increasingly outsourced, companies prefer dealing with only few partners. Thus, globally present logistics service providers are preferred partners of globally operating companies. The globalization of customers is mirrored on the distribution side by the globalization of *channels*.

b) Cost Drivers

Additional to the drivers on the market side which favor the globalization processes there are variables on the cost side as well. The *scale economies* we have already depicted are the most apparent of these drivers. Production processes which are geographically concentrated for worldwide delivery require sophisticated logistics operations.

Apparently, *global sourcing*, *favorable logistics* and *differences in country costs* are essential for the supply chain focus. Global sourcing focusses on the upstream side of the supply chain and denotes the globally dispersed supplier locations of a company. Due to liberalized trade agreements, companies are no longer restrained to local suppliers but are free to select their suppliers on a global scale. Consequently, goods and information flows become increasingly international with severe consequences for logistics. We will refer to this point in the subsequent part of this paper. The term favorable logistics is employed by YIP to denote mainly transport costs, which reflects a too narrow understanding of the logistics term. But undisputably, the decline of transport costs, the increasing productivity due to technical progress of this industry has considerable impact on the capablilty to globalize operations. Differences in country costs are seen as driving force as well. These differences can be used in supply chain management in order to increase the overall competitiveness of the supply chain.

c) Government Regulation

Favorable *trade policy* has doubtlessly promoted international trade, as already mentioned. The GATT and WTO agreements have considerably pushed world trade and wellfare. Without the emergence of liberal regulatory environments and protective policies, the globalization of corporate activities such as production sites, research and development would not have occured.

The compatibility of *technical standards* is of major importance for our subject as well. This applies firstly to the transparency and compatibility of information systems which are essential components of every flow of goods (see above). Secondly, it applies to the efficient and effective handling of transported goods. The example of incompatibility of bar codes from Singapore Airlines and Lufthansa may illustrate this point (see above).

d) Competition

High *exports and imports* are by their very nature of essential importance for global supply chain management as they represent flows of goods across national borders. They are the result of liberalized trade policies and reflect the increasing global pattern of economic activities.

The *interdependencies of country activities* reflect the increasing functional integration of economic activities across national boundaries. In globally configured supply chains, product components have to cross a multitude of national boundaries before a finished product can be handed over to the final customer.

Above we have depicted the globalization process as well as the underlying drivers which explain this phenomenon. It is important to note that this is certainly true for a general trend in international business - but the significance of the single drivers will vary among industries which implies that industries are globalizing in different speeds.

2. International Logistics Strategy

Until now we have implied that globalization is a mainly external process for the company, pressing the single organization to react to its forces. But this can only be regarded as one side of the medal. On the other side, the single organization contributes to this ever accelerating process by the specific configuration and coordination of its own supply and production chain. This is reflected by the organization's logistics strategy, which we will relate to in this chapter.

a) Internationalization Strategy and Logistics Strategy

When examining configurations of internationally operating firms, a typology by BARTLETT and GHOSHAL (1989) is commonly referred to. According to a multitude of dimensions, they differentiate four types of internationally acting organizations: the multinational organization, the international organization, the classic global organization and the complex global organization (see Table 2).

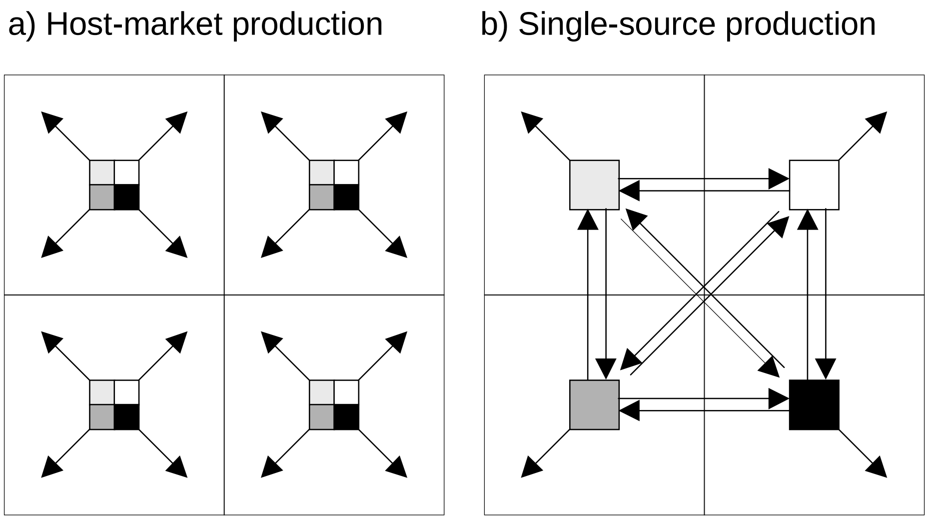
We will refrain from a detailed presentation of these types and instead confine ourselves to the presentation of two configurations which clarify our point and show the increasing significance of logistics strategy in the era of globalization. The following image shows alternative configurations of production sites for a company, but can also be interpreted as the location of a company's suppliers or distributors. We will refer to it as an reductionist view on the geographical configuration of a company's supply chain. Figure 8a illustrates the configuration of a typical multinational organization, whereas Figure 8b depicts the interdependencies in the network of a transnational company.

Characteristics	\`Multinational´	\`International´	\`Classic global´	\`Complex global´
Structural configuration	Decentralized federation. Many key assets, responsibilities, decisions decentralized	Co-ordinated federation. Many assets, responsibilities, resources, decisions decentralized but controlled by HQ	Centralized hub. Most strategic assets, resources, responsibilities and decisions centralized	Distributed network of specialized resources and capabilities
Administrative control	Informal HQ-subsidiary relationship; simple financial control	Formal management planning and control systems allow tighter HQ-subsidiary linkage	Tight central control of decisions, resources and information	Complex process of co-ordination and co-operation in an environment of shared decision making
Management attitude towards overseas operations	Overseas operations seen as portfolio of independent businesses	Overseas operations seen as appendages to a central domestic corporation	Overseas operations treated as \`delivery pipelines´ to a unified global market	Overseas operations seen as integral part of complex network of flows of components, products, resources, people, information among inter-dependent units
Role of overseas operations	Sensing and exploiting local opportunities	Adapting and leveraging parent company competencies	Implementing parent company strategies	Differentiated contributions by national units to integrated worldwide operations
Development and diffusion of knowledge	Knowledge developed and retained within each unit	Knowledge developed at the center and transferred to overseas units	Knowledge developed and retained at the central	Knowledge developed jointly and shared worldwide

Source: DICKEN (1998, p. 204)

Table 2: Types of Internationally Operating Companies

As can easily be seen, the transnational configuration appears more complex since more relations have to be handled and the single locations are interdependent. This configuration reflects some of the globalization drivers we have elaborated above, such as the necessity of big scale and specialized production. The geographic configuration of logistical networks will be treated further in part D.2 of this paper. But does globalization mean that all supply chains will sooner or later have to be configured in such a transnational manner ? And, if not, how can we arrive at a coherent judgement on how to configure the supply chain ? As we have illustrated above, the speed of globalization varies from industry to industry according to the relevance of the globalization drivers. In response to this observation, a company's logistics strategy differs as well according to the product(s) it sells or the industry it is in. JAMES C. COOPER identifies several product variables which have considerable effect on a company's logistics strategy. We will subsequently depict these variables for then arriving at four generic logistics strategies which result in different requirements for supply chain management. The following part is essentially based on COOPER's (1993) treatise on logistics strategies for global business.



Adapted from DICKEN (1998), p. 215

Figure 8: Alternatives for International Production and Distribution

b) Product Variables Which Determine Logistics Strategy

The value of a product in relation to its weight and volume is referred to as the product's *value density*. It is assumed that the value density is of considerable importance to the overall logistics strategy of a company. Take for example a product with a significantly high value density, such as microchips. These are usually produced centrally at a few manufacturing plants for the whole world. The transportation costs for these chips are negligible in relation to the costs of building inventories or multiple production sites (this, in fact, is of considerable importance for the world air freight industry). In contrast, products with low value density, such as cement, are usually produced next to their markets. Thus, the value density is mirrored in the logistics reach of a product and can be attributed considerable importance for the decision of logistics network design (see also part D.2).

But there are other variables to consider as well. Products with the same value density can be subject to different logistics strategies due to differing secondary product characteristics such as *brand, formulation* and *peripheral requirements*.

The *brand* of a product denotes its name and several marketing attributes. We can distinguish global from regional brands. Global brands are those which are present in the most parts of the world, whereas regional brands are confined to certain geographical regions. Global brands are such as Coca Cola, Mercedes-Benz or Sony. There are cases in which companies promote different regional brands for an identical global product. In this case, we might nevertheless refer to them as global branded. Unilever's ice-cream manufacturing might serve as an example for this: In Germany it is known as Langnese, but is sold under different brands in other countries.

The *formulation* of a product refers to its ingredients and their composition. Even well-known global brands are not identically formulated in different parts of the globe. Coca Cola differs the level of sweetness of its beverages according to regional preferences, as does Pizza Hut with its pizza recipe. Other product attributes which are adapted to regional requirements are more obvious. The position of the steering wheel in automobiles in the UK, Japan, Australia, etc. differs from that in other parts of the world, no matter if we regard global brands such as Mercedes-Benz or local brands.

Peripherals are accompanying aspects of a product, such as labels, manuals, but also customer service elements, such as hotlines, etc. In certain industries, such as food production, regional laws require different information policies or formulate alternative packaging restrictions. In these cases, the producers have to consider these differences in their logistics strategy: a fully centralized production will not be appropriate then.

c) Global Logistics Strategy

When combining these characteristics on the global scale, only relating to global branded products, we arrive at four global logistics strategies based on different kinds of postponement within the supply chain. (COOPER 1993, pp. 16): Unicentric, bundled manufacturing, deferred assembly, deferred packaging.

The *unicentric strategy* denotes a fully centralized configuration of the production process. In the idealized configuration, only one production plant manufactures the whole output of the product, taking advantage of economies of scale in production as well as distribution. As formulation and peripherals do not have to be adapted to local market needs, the allocation of the product to the final customer can be ultimately postponed.

The *bundled manufacturing* strategy differs from the unicentric strategy in that certain elements of product formulation vary in different markets. This aspect has to be considered in the production process. As COOPER (1993, p. 17) explains

> "The [...] aim is to retain production commonality as long as possible in the production process. Only at the last possible opportunity should the product be configured to meet the needs of a particular market."

Both remaining strategy options *deferred assembly* and *deferred packaging* denote a shift in the final product configuration from the production site to regional warehouses. The former is used to describe the fact that the ultimate assembly of the product takes place at the warehouse. The latter strategy is employed if the formulation of the product is identical in all markets, but peripherals vary regionally. The formerly described food industry might serve as example.

Table 3 summarizes our findings.

	Global logistics strategy			
	Unicentric	**Bundled manufacturing**	**Deferred assembly**	**Deferred packaging**
	Fully centralized production and distribution	Design product so that customization can take place at latest possible stage of production process	Final configuration of product at theatre warehouse	Labelling and packaging at theatre warehouse
Product variables				
Global brand ?	Yes	Yes	Yes	Yes
Common formulation in all markets ?	Yes	No	No	Yes
Common peripherals in all markets ?	Yes	Yes	No	No
Potential strategy benefits	Economies of scale in production and distribution	Rationalization of components range simplifies inbound logistics and contributes to improved quality	Economies of scale in production and distribution, savings in inventory with high levels of customer service	Economies of scale in production, savings in inventory with high levels of customer service
Examples	Marlboro duty-free cigarettes	Sony television receivers (due to different national colour systems and electrical standards)	Compaq computers (due to different keyboard requirements, esp. symbols; manuals)	Wash & Go Shampoo (economies of scale in the bottling process limit the extent to which deferred packaging can be applied for products of this kind)

Adapted from COOPER (1993), p. 16.

Table 3: Logistics Strategies for Global Products

Up to now we have focused on the outbound logistics of a company, thus confining our view to the downstream part of the supply chain. But as we have elaborated above, the SCM concept presses us to take a systemic perspective on the whole chain, from raw materials supplier to the end customer. Therefore, we will have to add the supplier side to our strategic considerations here. Similar to our differentiation on the production side, we might as well distinguish the supplier side into local and global sourcing for a given production plant.

Again, COOPER (1993, pp. 17ff.) helps us with his identification of five generic clusters of globally operating companies. He distinguishes invaders, settlers, cloners, barons and outreachers. According to the cluster a company belongs to, different requirements for the management of its supply chain arise. We will therefore start to depict the five company clusters COOPER describes.

Companies which try to enter new markets often agressively pursue offensive logistics strategies. The term *invader* is used to describe the installation of new production plants in potential new markets in order to circumvent tariffs on finished goods but to supply them with components from original markets. It is characterized by a dispersed configuration of production plants, but a concentrated supplier basis. The Japanese car manufacturers employed this strategy when they tried to conquer European or American regional markets. Nevertheless, this strategy is judged unsustainable as in the longer term local suppliers as well are considered, turning the invaders to the settler type of company.

The *settler* is characterized by sourcing its components in a variety of countries as well as serving a variety of countries with his manufactured goods. In this case, the markets to serve do not have to be conquered, but instead a reliable and competitive production site for several countries is established. These patterns can be observed in the world automobile industry.

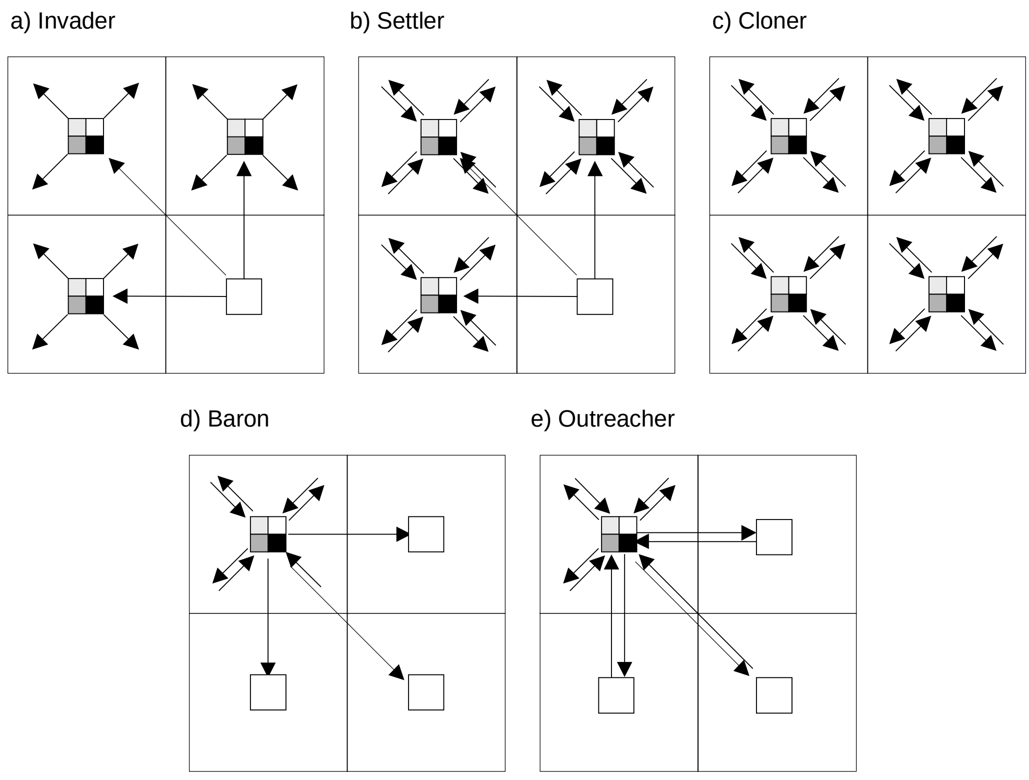


Figure 9: COOPERs generic company clusters according to their logistics strategy

Companies which are confronted with limited logistics requirements due to their products' characteristics (e.g. low value density, local ingredients) tend to duplicate their local or regional logistics strategies in order to cover several markets. COOPER calls these companies *cloners*. As an example for this kind of configuration the case of Coca Cola or McDonald's might serve.

Finally, there are companies which concentrate their manufacturing activities but serve all global markets from one or at least a very limited number of production plants. These are called *barons* or *outreachers*. The difference between the latter and the former is that outreachers source their components from all over the world whereas the barons tend to buy their components from more local suppliers. Examples for barons are premium car manufacturers such as Mercedes-Benz, whereas aircraft manufacturers such as Airbus or Boeing might serve as examples for the outreacher type of companies. Note that due to the ongoing globalization processes the baron and the outreacher types of companies are melting together, as the outreachers disperse their production facilities whereas the barons "globalize" their sourcing and production operations. Figure 9 illustrates our findings.

d) Scope of the Supply Chain

Apparently, the different company clusters have different requirements in managing their supply chains. As already pointed out earlier, information management is of major importance for supply chain management. COOPER (1993, pp. 19ff.) identifies three additional key factors which are significant for international logistics strategy. These are diffusion of best practice, partnershipping and flexibility.

Diffusion of best practice denotes the spread of new and more efficient methods and techniques among the different locations and sites of the company, but also among the supply chain. *Partnershipping* is used to express the changing relationships of different elements in the supply chain, implying a shift from lose arms length and singular transactions to more cooperative forms. *Flexibility* is used to describe the capability of a company to adapt logistical strategy and configuration to changing environmental factors.

When combining these factors with our generic company clusters, some corelations become visible. On the one hand, the diffusion of best practice appears to be of central relevance for cloners as their operations are duplicated around the world. Thus, an improvement identified in one location should rapidly be diffused to all other similar locations of the company in order to profit from the innovation. On the other hand, cloners seem to have the least requirements with regard to the geographic scope of their supply chain, as they operate duplicate systems within national boundaries which are only marginally intertwined. Therefore they tend to operate several regionally bounded supply chains for their national or regional markets instead of "the" global supply chain.

Partnershipping appears to be of special relevance for the cluster of outreachers as they have both strong and dispersed inbound and outbound logistics operations, due to their global sourcing and concentrated production sites. Outreachers need to coordinate and control extensive supplier and distribution networks and are thus predestined for implementing global supply chain management. It is not surprising that the cooperative element was earlier identified as crucial in supply chain management.

Flexibility in switching between global logistics systems is, as the other two factors, important for all companies. But invaders, settlers and barons will attribute even more importance to the flexibility aspect. This is because of the evolutionary trail most companies pursue according to COOPER, as they most frequently start as invaders, then become settlers and perhaps barons later on. They need to switch smoothly from one logistical configuration to another. When regarding their supply chain, invaders do not differ considerably from national or regional operating companies, as their international locations are predominantly served by components from their home production sites. Therefore only transport relations to the new market have to be established, but a considerable shift of complexity of their supply chain does not yet appear. When evolving into a settler, this shift partially becomes reality, as local suppliers have to be considered as well.

3. Characteristics of Global Supply Chains

Above we have elaborated different strategies a company may adopt in order to compete in the global marketplace. We have therefore already stressed different configurations of global supply chains. Whereas the explanations above concentrated on more strategic issues of global SCM, which underlay the influence of the company in focus, we will now shift to other, external aspects which distinguish operations in a global setting from purely national considerations. We will therefore turn to external as well as operational aspects, which add even more difficulties to global SCM. These are: substantial geographic distances, added forecasting difficulties and inaccuracies, exchange rates and other macroeconomic uncertainties and, finally, infrastructural inadequacies (DORNIER / ERNST ET AL. 1998, pp. 224ff.).

a) Substantial Geographic Distances

Crossing national borders does not necessarily imply increased geographical distances as the comparison of the huge American domestic market and the multitude of smaller European domestic markets illustrates. Nevertheless, international operations are frequently associated with larger geographic distances, which implies longer transportation lead times. Additionally and perhaps even more important is the fact that goods are longer exposed to inpredictable disturbances. When regarding national boundaries, customs procedures might be only one cause.

The consequences from this extended period of uncertainty are mainly higher levels of inventory as customers seldom want to risk the missing of a components shipment. This factor contributes to the bullwhip effect we will subsequently illustrate in full length.

b) Forecasting Difficulties and Inaccuracies

Increased geographical distances result in forecasting difficulties as well. This is not only the effect of longer transportation times and longer exposure to risks, but has its reasons in communication difficulties as well. The crossing of national boundaries implies the involvement of different cultures which employ different languages and mentalities which may lead to different judgements. As the exactitude of demand forecast has considerable impact on the level of inventory, operating in the global context tends to raise inventories.

c) Exchange Rates and other Macroeconomic Uncertainties

Principally, macroeceonomic uncertainties arise in the national and the international setting. But in the international context, the problem is magnified as the company deals with as many national macroeconomic settings as the markets it operates in. The same effect can be observed with regard to the number of currencies the single company has to consider. Beneficiary effects on the input (output) side can be neutralized - or worse – even aggravated by the output (input) side of a company's operations. Thus, risk management has to be seen as integral part of supply chain management and will be treated in an special part of this paper.

d) Infrastructural Inadequacies

Especially with regard to developing countries, deficiencies in infrastructural resources can hinder a company's operations. Lack of skilled workers, suppliers which cannot provide requested products and / or adequate quality deficiencies in transportation and telecommunications infrastructure are only some problems which are frequently encountered when operating on the global scale.

4. The Bullwhip Effect in Supply Chains

From the difficulties depicted above one special problem in international supply chains arises: The bullwhip effect.

a) Concept

Executives at Procter & Gamble once took a closer look at the order patterns for their famous Pampers disposable diapers. They noticed that, although the demand of their end consumers (the babies) was steady, sales at retail stores were slightly fluctuating. When they broadened the scope of their examination and regarded the distributors' orders, they were, to their surprise, varying at a much heavier rate. As they subsequently surveyed their own (P&G's) orders to suppliers, the variance was even greater. This effect is typical for supply chains and is commonly referred to as the bullwhip effect.

The *bullwhip effect* refers to the phenomenon that an originally steady demand for a finished product is turned into increasingly fluctuating demands for its components further up in the supply chain (see Figure 10)

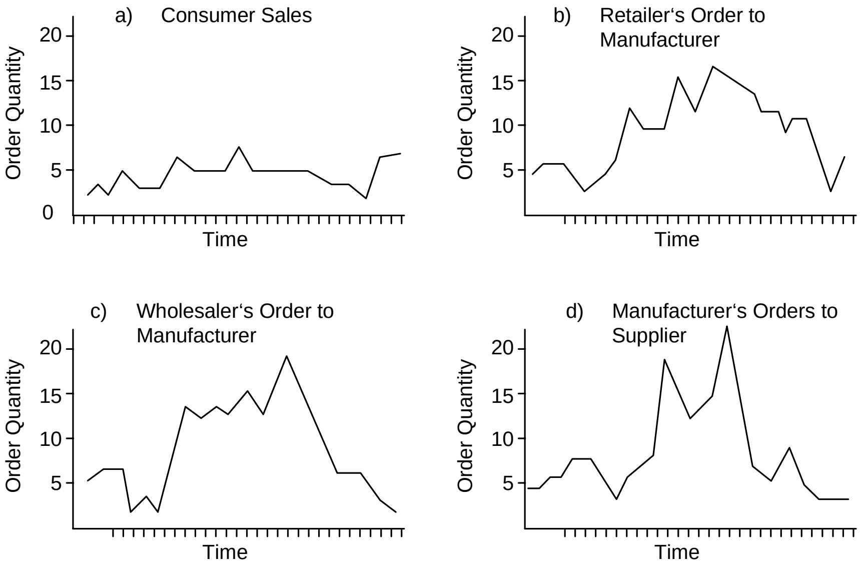


Figure 10: Increasing Variability of Orders up the Supply Chain
(Source: LEE et al. 1997, p.94)

The following example (HAYES / WHEELWRIGHT 1984, p. 279) shall illustrate the effect. *Bullwhip Corp.* serves the consumer market with its product Y. Y consists of three identical components which are bought from the supplier *Sup Corp*. Bullwhip serves a very competitive market and tries desperately to avoid missed deliveries. It therefore pursues the following inventory policy: one month's supply of Y and two weeks demand of the component are stored in the plant's warehouse. Bullwhip's inventory manager promotes a monthly adjustion of inventory according to Y's sales. Table 4 illustrates Bullwhip's policy assuming a steady demand of 100 units of Y per month.

Month	Consumer demand during month	Beginning of month finished goods inventory		Production rate during month	End of Month		
					Parts inventory		Parts order to supplier
		Actual	Desired		Actual	Desired	
1	100	100	100	100	150	150	300
2	100	100	100	100	150	150	300
3	100	100	100	100	150	150	300

Table 4: Bullwhip's policy with steady demand

The consumer demand in month 1 is exactly 100 units and thus matches the production output. We assume that the inventory level was already 100 units in the month before, so that inventory does not have to be filled up this month. As three components are needed to produce one unit of Y, we need 300 components for the month. As Bullwhip's inventory management policy requires the storage of only two weeks' components demand, inventory is kept to 150 units. Nevertheless, as we are regarding the process monthwise, we have to order the whole supply contingent for the next month and arrive at 300 parts which are ordered at Sup Corp.

We will now assume a sudden decrease in demand. Let us assume that demand drops by 10% to 90 units per month in month 5. At the beginning of the month, this decline is not foreseeable for Bullwhip's executives, thus all policy decisions remain untouched. It is not earlier than the beginning of month 6 that the decline results in consequences for

Bullwhip's procurement and production decisions. As 100 units of Y were stored, another 100 were produced whereas only 90 Ys were sold the inventory level rises to 110 Ys. This is 20 units more than Bullwhip's inventory policy requires, thus the company reduces its production and, consequently, its orders to suppliers.

The parts inventory shows a too high level as well. When regarding the actual demand, we observe that 20 units of Y were not produced, resulting in 60 units of the components remaining in the warehouse. To these 60 we have to add the security stock of 150 units, resulting in 210 units of actual inventory at the end of month 6. Compared with the desired inventory level of 120 units (240 units of the component are needed to produce 80 units of Y, divided by 2) the company is confronted with excess stock of 90 units. Bullwhip therefore cuts back its orders to Sup Corp. in order to adjust inventory levels. But how much will it order ? Clearly, if the warehouse would contain only the required safety stock, Bullwhip would order 240 units of the component, reflecting the forecasted production of 80 Ys. As there are still 90 units of the components in the warehouse, the company only orders 150 units. This means a decrease of 50% in orders for Sup Corp. ! Remember that Bullwhip was only confronted with a decline of 10% of its own sales.

Month	Consumer demand during month	Beginning of month finished goods inventory		Production rate during month	End of Month		
					Parts inventory		Parts order to supplier
		Actual	Desired		Actual	Desired	
4	100	100	100	100	150	150	300
5	90	100	100	100	150	150	300
6	90	110	90	80	210	120	150
7	90	100	90	80	120	120	240
8	90	90	90	90	90	135	315
9	90	90	90	90	135	135	270
10	90	90	90	90	135	135	270

Table 5: Bullwhip's policy after demand variation

But let us go on with month 7. Consumer demand stays at a steady 90 units per month. Inventory of Y has only decreased by 10 to 100 units and is still above the desired level of 90 units. This results from an inventory level of 110 plus a production output of 80 minus this months demand of 90. Thus, production is maintained at 80 untits per month, resulting in the desired inventory level of 120 units. Surprisingly, the actual inventory level arrives exactly at the desired 120. 210 units which remained in the warehouse from last month were replenished by the ordered additional 150 items, but simultaneously 240 items were consumed in the companies production, resulting in 120 items in the warehouse. Therefore, no adaptions have to be considered and 240 items of the component are ordered for the next month. Again, Sup Corp. is confronted with a dramatic variation in orders by its customer. From one month to the other, orders go up again from 150 to 240 items.

In month 8 the desired inventory of Y is finally achieved. Thus, production is adapted to the actual consumer demand of 90 units. According to Bullwhip's inventory policy for components, this results in a desired inventory level of 135 units. As in month 7 components were ordered to satisfy a demand of 80 units of Y whereas 90 units were produced, inventory is reduced by 30 units of components. Thus, the actual inventory level at the end of month 8 is 90 units, whereas the desired level is 135. This again results in a variance in orders for Sup Corp. 270 units would be ordered at Sup Corp. to serve the forecasted demand of month 9, but an additional 45 units are ordered to replenish inventories. Bullwhip places an order of 315 components at Sup Corp. It is not before month 9 that a balance is reached in orders from Bullwhip to its supplier. The differences in variances are illustrated in Figure 11.

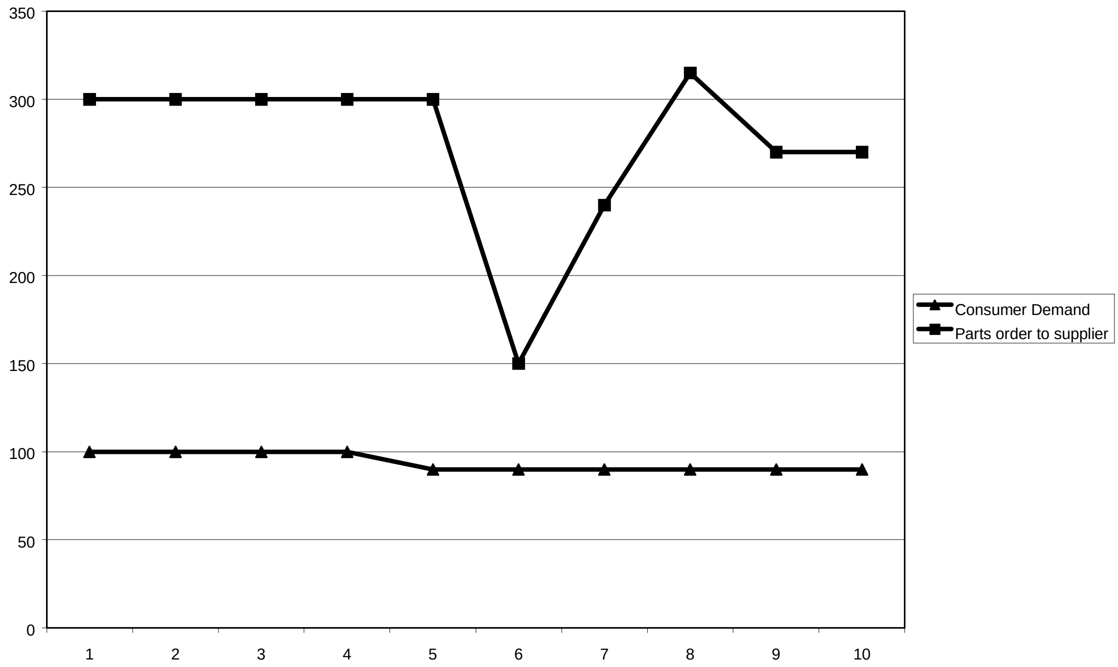


Figure 11: Illustration of the Bullwhip-Example

The example presented above was confined to two elements of a supply chain and only one modest variation in demand. We might assume that the bullwhip effect is considerably magnified when multiple elements of the supply chain are examined and when demand varies more frequently and with greater amplitude. We will examine this problem by utilzing a simulation game, called the "Beer Distribution Game", which was introduced by the Sloan School of Management at the Massachusetts Institute of Technology (MIT).

b) The Beer Distribution Game

The Beer Distribution Game is originally a simulation of a supply chain with three to four stages. Each stage of the chain is represented by a student who, in the four stage chain, plays the role of retailer, wholesaler, distributor and factory of a brand of beer. The part of the consumer is taken over by the teacher or the supervisor of the game, who draws a card representing consumer demand. The retailer satisfies demand out of his inventory and orders new beer from the wholesaler, and so on until the order reaches the factory. At each stage, delays for transportation and ordering procedures are implemented. Additionaly, inventory holding costs are set to $0,50 per case per week and stockout costs are $1,00 per case per week. The costs are assessed at each link of the chain. The aim for the players is to minimize total company costs during the game. In the original version, the single groups cannot communicate with each others, taking decisions only according to their limited perceptions.

STERMAN (1989) surveyed 48 trials over a period of four years and reports average total costs after 36 rounds of about $2000. As in our example, he changed demand only once from 4 to 8 cases of beer in week 5. After examination of order patterns in his sample, he arrives at several regularities. All trials were marked by considerable instability and *oscillation*. Additionally, the variance of orders are *magnified* with every stage upstream the supply chain, with the peak order rate at the factory, which is the end of the chain in our case, being more than double the peak order rate at the retail level. Furthermore, the peaks tend to appear with certain *time lags* as one moves up the chain. This effect is not surprising, as the change in customer demand pass through the different levels with the indicated delays and communication among the different stages was prohibited.

Since we have now depicted the concept of the Bullwhip effect, we will subsequently turn to its causes.

c) Causes of the Bullwhip Effect

DORNIER / ERNST ET AL. (1998) distinguish in behavioral and non-behavioral causes of the bullwhip effect and attribute its appearance partially to irrational behavior of the persons involved. We will not follow this differentiation as the bullwhip effect naturally has its causes in the behavior of persons in organizations, or at least, in rules which are fixed by persons behaving in a certain way within organizations. The causes these authors group to the non-behavioral cluster reflect this understanding and are identical to the four causes we present here: demand forecast updating, order batching, price fluctuation and shortage gaming (LEE ET AL. 1997).

i. Demand Forecast Updating

Usually, a company employs product forecasting in order to plan production schedules, capacity utilization, etc. The forecasts are most frequently based on historical data of earlier periods and are adapted according to changing environmental factors. These forecasts are frequently updated with actual orders coming in from customers. Thus, a downstream company's order is utilized by the upstream company for forecasting purposes. If a sudden upswing in demand occurs, demand forecasts are updated and adjusted, as well as the resulting orders for suppliers. These peaks are forwarded upstream and are magnified by adjustments of safety stock. When we take long transportation and order lead times into account, a further dramatization is likely, as with increasing horizon the forecasting's exactitude decreases, resulting in adjustments in following orders.

It seems clear that sharing information among supply chain members becomes a success factor in fighting the bullwhip effect. If the supplier is informed in time about decreasing sales volume of the end customer, he might adjust his production in accordance with the other supply chain members smoothly and straightforward, without heavy variations in his order pattern. End consumers' demand should be the raw data for forecasts of all supply chain members. EDI and ECR are techniques which are employed in order to enhance information and communication along the supply chain.

Another variable can be identified in lead time length. A reduction of lead time results in more appropriate forecasts, as the time period which has to be predicted shortens. Within our global focus, however, this becomes a difficult task. With geographic locations of raw materials suppliers and producers held constantly, only transport modes can be altered. Alternatively, suppliers have to move to geographically nearby locations of their customer.

ii. Order Batching

Even if demand occurs with a steady rate, companies tend to order in discrete time intervals - they accumulate or *batch* the demand before issuing their orders.

Periodic ordering, for example, refers to the fact that a company's order activities are performed in fix intervals, e.g. weekly or monthly. The cause for this might on the one hand be the result of high fixed ordering costs or of discrete controlling activities. LEE ET AL. (1997, p. 96) hint to the fact that companies tend to place their orders after running their MRP (Materials Requirements Planning) systems, which are often run monthly.

Furthermore, push ordering amplifies variations in demand. Sales persons are measured with regard to certain deadlines. In order to fill sales quota, they have incentives to place orders prematurely. Additionally, transportation costs press companies to accumulate demand before issuing their order as economies of scale apply.

If these different peaks which are the result of customer order cycles occured evenly spread over time, their effect would be marginal. Regrettably, order cycles partially overlap and thus amplify the initial peak, resulting in ever inceased variations.

More frequent ordering would be an apparent cure for these causes of the bullwhip effect, but the periodic ordering as well has its causes. Therefore, the reduction of fixed ordering costs might help and seems realistic with the rise of information technology and appropriate communications systems. Alternatives in transportation management as well have to be considered. As we are regarding the global supply chain, transportation costs are of major importance. Consolidation of shipments therefore come into focus, implying increased involvement of third party logistics.

iii. Price Fluctuation

In consumer products, promotions are a marketing instrument which is frequently applied. Rebates and special price and/or quantity discounts are granted in order to attract customers, i.e. in supermarkets. If we take a look at the implications for the supply chain, we observe that during a price reduction for, say coffee, consumers react with high demand and buy larger quantities as they actually need. When the promotion is over, consumers retain from buying as they speculate for the next promotion and, for the moment, seem to have enough coffee to bridge the gap. For suppliers in the supply chain this means that, while the promotion is going on, demand rises whereas at the end demand drops significantly. As the buying pattern of the consumer in this case is already fluctuating considerably, we can imagine the impact on upstream suppliers in the supply chain.

The most efficient method to counteract this source of the bullwhip effect obviously is the reduction of promotions. As this is very unprobable to happen, the sharing of information and communication among supply chain members might help as well.

iv. Rationing and Shortage Gaming

If a product is surprisingly successful in the market and demand exceeds supply, companies usually ration the product to customers. Commonly, the product is allocated according to the amount the customer ordered. If customers become aware of this policy, they might react by placing exaggerated orders as this raises the chance for them to aquire the amount they really desire ("gaming"). In this case, the manufacturer of the product is in this case confronted with a considerable increase in demand whereas later on, when "real" demand decreases, many orders will suddenly be cancelled. This leaves the manufacturer in a dilemma, as incoming orders do not reveal any information about the real demand for the product.

LEE ET AL. (1997, p. 98) present the case of Hewlett-Packard (HP) to illustrate this point. HP rationed the LaserJet III printer due to unforeseen order volumes. As orders accumulated, HP could not distinguish real orders from phantom orders. When allocation restrictions were liberalized, many resellers cancelled their orders, leaving HP with excess inventory which cost millions of dollar.

Whereas rationing can only be avoided by more sophisticated forecasting methods, which is not quite probable, the gaming of customers can be corrected by intelligent allocation rules. Instead of rationing according to actual orders, allocation could also be based on the dealers' past sales records .

D. Establishing and Managing the Global Supply Chain

In the following section we will try to elucidate the essential problems which arise when the SCM concept is introduced. Due to the introductory character of this paper we will present only rough overviews of the topics. We will begin with the overall problem of planning tasks only within the supply chain.

1. Planning the Global Supply Chain

Prior to its implementation, certain aspects of supply chain management have to be thoroughly considered. We will subsequently highlight these aspects and depict their relevance for SCM.

Up to now we, have implicitly assumed two aspects for illustration purposes, which have to be specified when considering an SCM implementation. These issues are supply chain topology and the perspective we adopt when implementing supply chain management. After covering these topics, we will turn to the specific questions which arise when approaching the planning task.

a) Supply Chain Topology: Interorganizational Chain versus Network Structure

One of the first aspects to look upon is the question whether we are dealing with a linear sequence of elements or if we are considering a network structure. The term supply chain implies a linear structure, but, as we discussed shortly before in our theoretical reflections about the nature and content of SCM, the term is misleading. Nevertheless, for real planning purposes it is of considerable importance to become aware of the fact that the linear structure we have up to now dealt with was an idealized setting. Clearly, real world relations of a company show a network structure which increases the complexity of supply chain management by a considerable factor. This complexity is even magnified when we take the global focus into consideration (see chapter C.3).

Let us take a look at Henkel KGaA to illustrate the network structure. As a world specialist in applied chemistry, the Henkel Group consists of more than 340 companies in more than 70 countries. The company incorporates six business divisions, each of them consisting of several product groups. More than 54.000 Henkel employees manufacture almost 10,000 products, marketed under many familiar brands (e.g. Persil, Fa, Pritt). With regard to colorations, Dülken is the largest production site world-wide. Consequently, this production facility maintains relations to 201 supplier companies and counts about 15,000

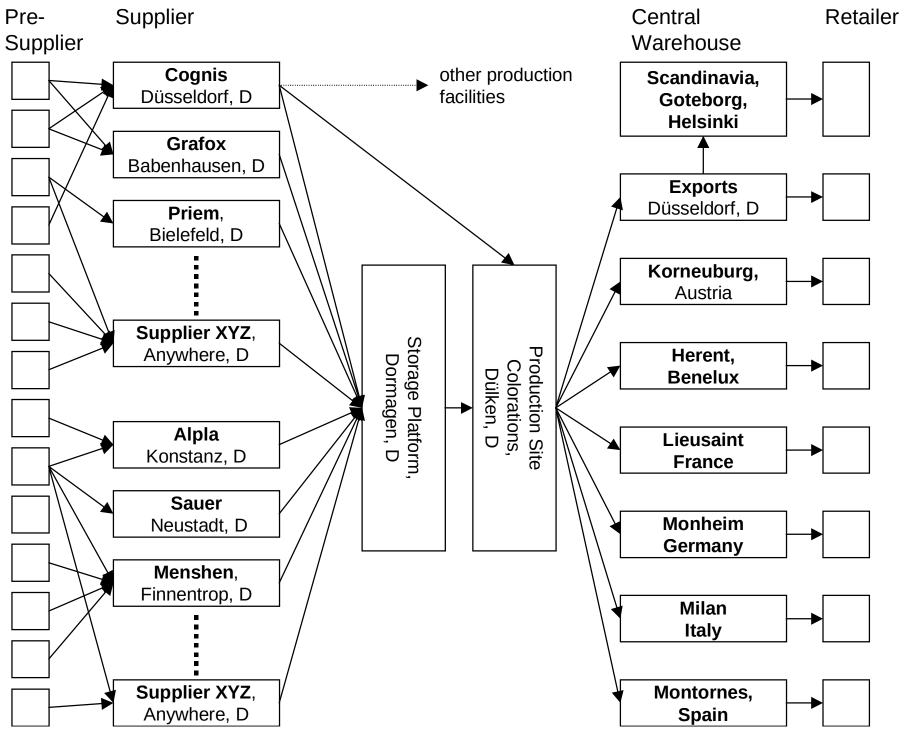


Figure 12: Henkel Colorations Supply Network

customer delivery points, notwithstanding the final consumers. However, this is only the number of immediate suppliers and customers which would be potential subjects for a direct supply chain management partnership. Nevertheless, this complete supplier and customer network can be regarded as an open network or a composition of individual supplier and customer networks *for each Henkel product*, which of course overlap to a certain extent. These overlaps are caused by suppliers which provide components for more than one product to other production sites within the Henkel Group. Cognis, for instance, supplies production facilities of Henkel as well as competing companies.

The procurement process at Henkel is presently organized as follows. The production site Dülken orders raw materials and packaging from its suppliers, which is transported to the production site in two different ways. Most of the ordered goods converge at the storage platform Dormagen before they get accumulated to the production site. As a result, the opportunity for a demand-oriented continual (Just-In-Time) supply exists. Alternatively, Cognis transports the chemical materials with bulk vehicles directly to the production site Dülken.

The produced colorations are now distributed by full trucks to the central warehouses (CWH) of the different distribution areas. For the central East European countries, delivery is performed via one CWH. Deliveries for the northern European countries and outside Europe are fulfilled by the CWH for exports in Düsseldorf. From here the colorations are delivered either directly or via an additional consolidation point to the retailers. Feedback information complete the supply chain circle. The final delivery points can be either retailer distribution centre or point-of-sales. Henkel’s supply network for colorations is illustrated in Figure 12.

b) Supply Chain Perspective: Focal Company and Bird's-eye Perspective

At this point, another fact should be stressed. When regarding a special product we are focusing on one special company as well. We are thus approaching the inter-organizational SCM concept through the lense of one particular product of one particular company. But which is the company we should be focussing on ? If we regard a supplier network as it is illustrated in Figure 13b) it is not apparent which company should be the one in focus. Every company in this network might pursue the idea to manage its supplier and customer network for its own products, a fact that appears questionable. In literature we therefore mostly find the idea of the *hub firm* or the *focal company* which seeks to implement the supply chain concept for its products. A popular example for this is the automobile industry, where the big manufacturers are usually regarded as the focal companies.

However, the focal company analyzes and judges the importance of relations and processes according to its own subjective judgement and takes over control of subjectively important relations. Of course, in order to push its suppliers to close cooperation, there have to be advantages for them as well. Nevertheless, a subjective bias is to be assumed when tasks, that is costs and benefits, are distributed. Therefore, a *bird's eye perspective* on supply networks is promoted sometimes. The bird's eye perspective, which can be adopted by an independent organization or a common steering commitee, should provide opportunity to objectively analyze a given supply chain and identify optimization potential regardless of the position or importance of a single chain member. However, the focal company would again provide the perspective, as the supply chain for its own products is subject to surveillance. Figure 13 illustrates the different approaches to SCM.

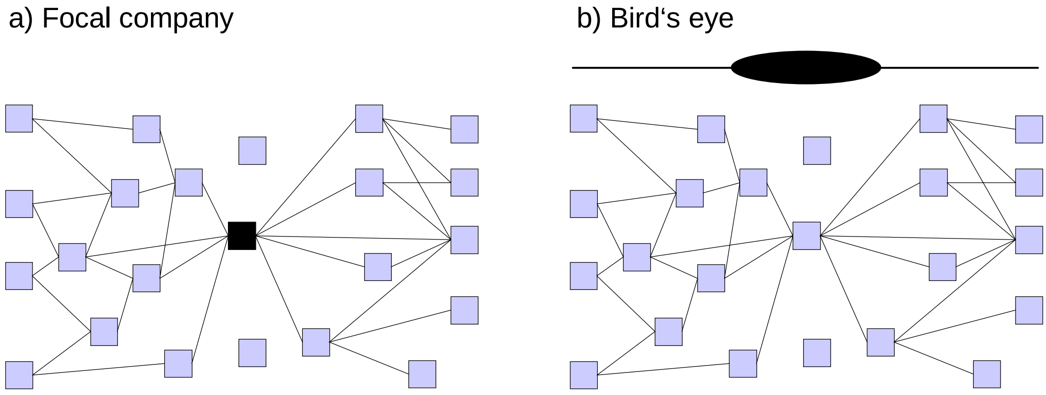


Figure 13: Supply Chain Perspectives

c) Planning Tasks

After the consideration of supply chain topology and perspective we will turn to the practical planning tasks which are related to SCM. We will first have to become aware of the members of the relevant supply chain, for then coping with complexity with the aid of logistical segmentation. We will then treat the major problem of benefit distribution among the members of the supply chain, which has to be overcome before the SCM concept can be established.

i. Members

As we have noted above, the supply chain is not a mere chain of actors or activities, it is a network. A shift in complexity arises not only from the elevated number of actors we have to cope with, but also implies another question: Do we have to manage all relations, that is, all supplier-customer relations which occur, can we neglect certain relations, or do we have to approach the management of our inter-firm relations in a more differentiated manner ? Thus, we have to find an answer for the question: Whom should we manage ?

As can easily be seen in our network-structured supply chain in Figure 14, the decision to manage all relations to suppliers, suppliers' suppliers, etc. as well as distributors and so on would result in a very complex task, which would, even in the computer age, be impossible to cope with. We therefore state that a selection process has to take place in order to separate important from less important relations within our supply network.

On a first level, LAMBERT, COOPER and PAGH (1998) propose a differentiation in primary and supporting supply chain members. This differentiation is derived from PORTER's (1985, p. 39) similar differentiation of activities within a company's value chain. It is implied that primary members are those to include in the SCM process, whereas supporting members may fall out of the managed network. For the remaining primary supply chain members the authors propose to distinguish the links, according to their importance for the focal company, into four classes: managed, monitored, not managed and non-member business links (LAMBERT / COOPER / PAGH 1998, pp. 7ff.).

The most important links are titled *managed links*, as they should be managed by the focal company itself. These links represent integrated processes of the focal company and one or more of its suppliers. LAMBERT, COOPER and PAGH attribute these links primarily to the first tier suppliers of the focal company.

The second class contains links which appear less critical to the company's success and should therefore only be *monitored* by the focal company. The responsibility for the active management of these links should be given to the partner. However, these links are important for the focal company which thus should ensure that they are managed and integrated properly. Therefore, a monitoring of these links is proposed.

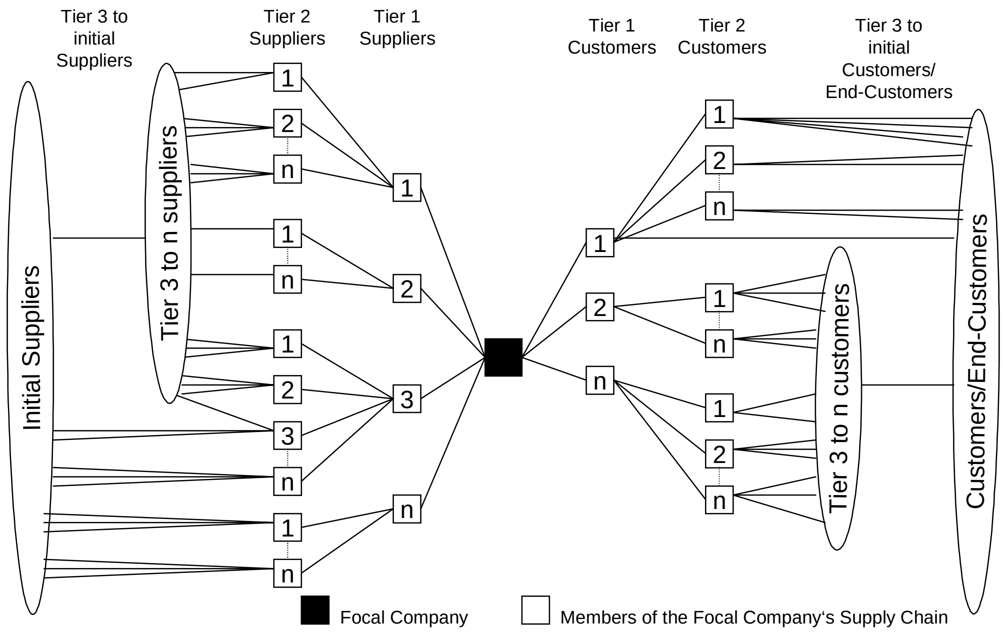


Figure 14: Supply Chain Network Structure
(Source: Lambert / Cooper / Pagh 1998, p. 3)

The third class of links the authors identify is labelled *not-managed process links*. These links are not critical to the focal company's success, it is not actively involved in these processes. Therefore, no resources should be spent by the focal company to monitor or manage these links. Other parties will have bigger stakes in this relation and should thus care for the management of this kind of links. It appears reasonable to let these links be managed by other parties trusted by the focal company.

A final class of links contains the *non-member links*. These links describe relations between members of the focal company's supply chain and members of other supply chains. LAMBERT, COOPER and PAGH introduce this class of links due to the influence of environmental factors and organizations which might as well influence supply chain performance. If a supplier does not only sell his products to the focal company we regard here, but also to a main competitor, order behavior of this competitor might easily affect deliveries to our focal company.

Figure 15 shows a map of a supply chain according to the differentiation of links.

The contribution of COOPER, LAMBERT and PAGH is helpul, although we should add one aspect to their differentiation. The company does not only have two alternatives of managing a process link, but at least three. The differentiation in managed and monitored is too strong, as it implies a central management approach. In between we can identify the possibility of a *commonly managed link*, e.g. by a steering committee which consists of representatives of both companies involved. This kind of control can be adequate for links which are of crucial importance for both parties and where, consequently, no party will rely solely on trust of proper link management by its partner.

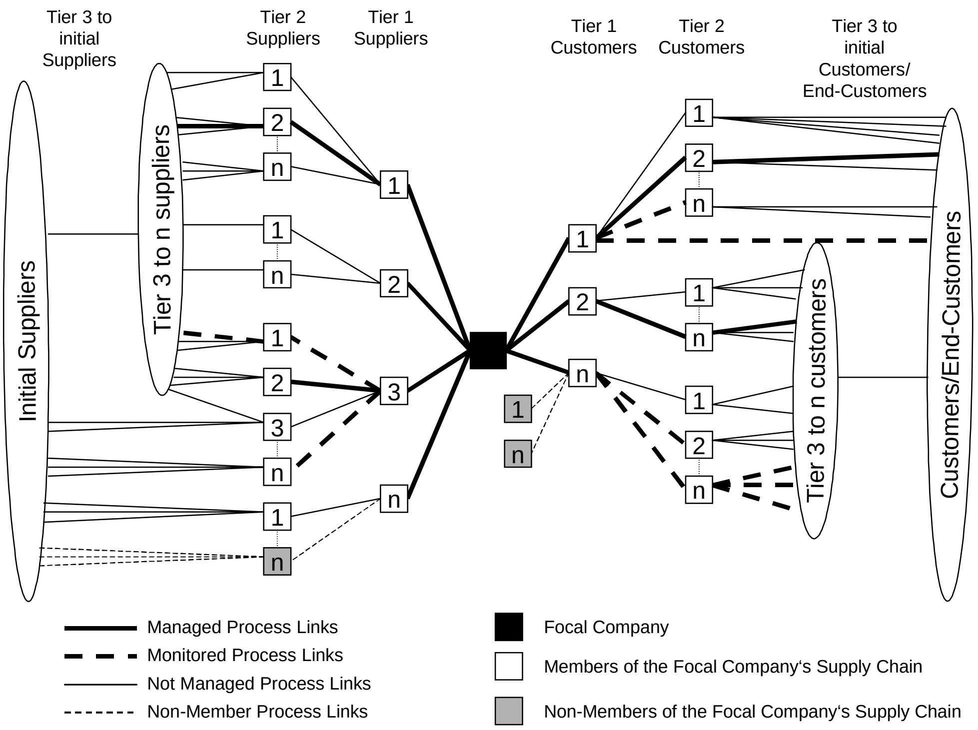


Figure 15: Types of Inter-Company Process Links
(Source: Lambert / Cooper / Pagh 1998, p. 7)

After the performance of this first step, we have identified the members of our supply chain. We should now turn to the question of how and according to which criteria the management tasks for production and information flows should be allocated among the supply chain members. This problem is commonly referred to as *logistical segmentation*.

ii. Logistical Segmentation

Logistical segmentation denotes the division of the supply chain into several integrated segments which are managed and coordinated according to similar principles under the banner of flow orientation. Thus, individual logistical segments are *decoupled*, or seperated, by intended time buffers which allow to manage single segments according to the most suitable mechanisms (DELFMANN 1995, pp. 172f.). The interpretation of logistical segmentation as an instrument within the framework of the integrated SCM concept ensures that this instrument is not misunderstood as promoting a fragmentation of the flow of goods and information. Instead, it is an instrument to ensure the manageability of the supply chain in accordance with the logistics philosophy developed earlier in this paper. But how can single logistical segments be identified ?

In order to approach this task, a thorough examination of the actual state of the supply chain should be performed. Therefore, a mapping of the supply chain is usually proposed. CHARLES SCOTT and ROY WESTBROOK (1991), for example, propose a pipeline map which represents processes and stock holding points by horizontal and vertical lines. The horizontal lines show the average time a product needs in a specific process, whereas the vertical lines show waiting times in stockholding points. Figure 16 illustrates such a *pipeline map* from the textiles industry.

Three dimensions can be identified within our supply chain map. The first is the total *pipeline length*, which consists of the sum of all horizontal lines. This number shows the time which is needed to pull (or push) a product through the whole supply chain with constant inventory levels. The second dimension is the total *stocking time*, which is derived by an addition of all vertical lines. By this number we can identify the average time product components are stocked. The last dimension is *pipeline volume* which is the sum of all vertical and horizontal lines, thus representing the time to market for a given product.

Whereas the pipeline length can be important to show how the supply chain can react to increases in demand, pipeline volume might be seen as important when decreases in demand occur.

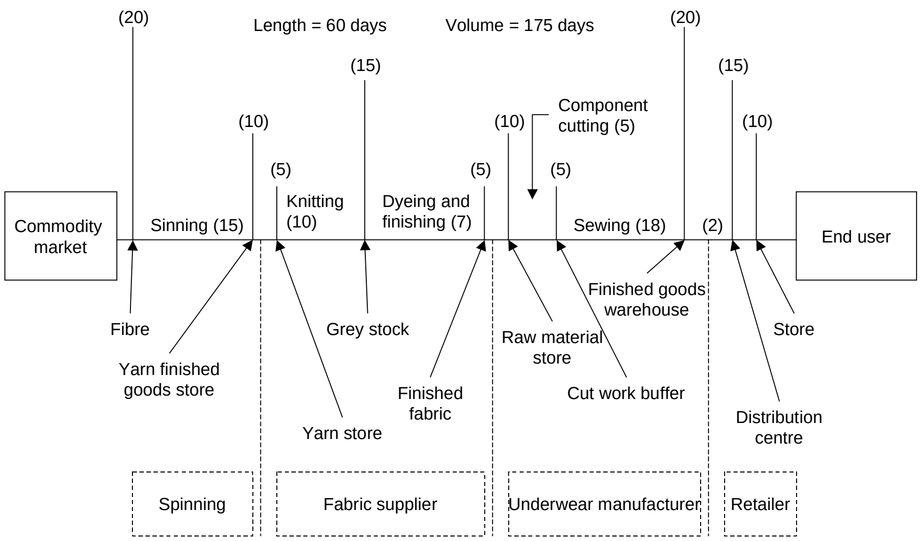


Figure 16: Example for a Supply Chain Map
(Source: Scott / Westbrook 1991, p. 25)

In this map, stocking points are illustrated by the vertical lines. We can therefore derive the actual logistical segments that exist within the supply chain. As SCOTT and WESTBROOK (1991, p. 25) observe:

> "[...] it is not uncommon for there to be tall vertical lines on both sides of organizational boundaries, with a short horizontal line in between."

Subsequently, an analysis has to be performed wether these interruptions in the goods flow are optimal under given circumstances or if a relocation or elimination of these stocking points would lead to a better overall performance of the chain. It should be emphasized again that logistical segments are not necessarily congruent with organizational boundaries. And indeed, as PERSSON (1995, p. 19) argues, if there are logistical segments which do not adhere a common coordination mechanism, losses of performance occur:

> "The larger the degree of dependency, the less possibilities there are of structuring elements into relatively autonomous segments, the greater the requirements will be for coordination, and the more waste in terms of queues and inventories."

On a general company-focused level the *order penetration point*, or *decoupling point*, is regarded as dividing two essential logistical segments into a supply chain according to the logistical coordination mechanisms of postponement and speculation. It is usually promoted to use a speculation or push approach up the stream from the decoupling point to the "source", whereas further down the stream to the end customer a postponement or pull strategy is promoted. On this very general and simplifying level we have thus established two logistical segments which can be managed and coordinated mostly autonomously according to push or pull criteria.

However, the mere differentiation of logisticial segments according to pull- and push principles appears too simple, especially in the context of more complex production chains. A transfer to the interorganizational supply chain management concept is still lacking.

Other criteria have to be added to ensure a efficient segmentation of the supply chain. Due to the introductory character of this paper, we will not treat this subject further, but logistical segmentation seems a promising tool to manage the very complex supply network.

iii. Benefit Distribution

As the overall aim of SCM is to gain competitive advantage for the implementing companies, this advantage will be reflected by benefits that the companies acquire through SCM implementation. A general question arising in this context is: How should the benefits of the common performance of activities be split among the members ?

Imagine a simple supply chain, with actors A, B and C as shown in Figure 17. Before implementation of SCM every supply chain member had held a certain amount of stocks and a certain variety of products. Due to the integrative SCM concept, stocks can be reduced drastically at companies A and B due to more transparent processes and improved information flows. Company C, cannot reduce its stock level, as it has to maintain customer contact and is thus subject to fluctuations in customer demand. We observe cost reductions for companies A and B without similar effects for company C. On the other hand, C does not encounter any special benefits from the stocks it has to maintain, as increased demand due to reductions in prices or better availability of the product favours all companies in the supply chain. Therefore, it may be assumed that C would not engage in an inter-organizational management approach which drastically favours all companies but itself. SCM , of course, should lead to win-win situations for all members of the supply chain, but imbalances will undoubtedly occur. Therefore, the planning of the supply chain implementation has to contain considerations for the distribution of benefits as well.

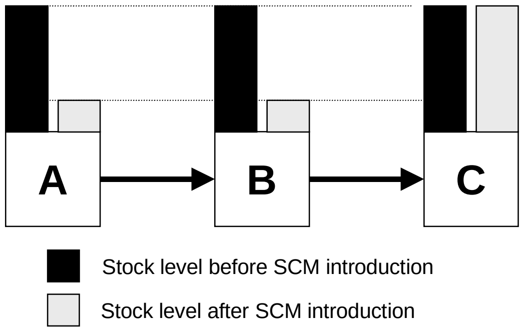


Figure 17: Imbalanced benefits of an SCM implementation

Furthermore, before discussing the distribution of potential benefits, their identification, that is their measurement has to be ensured as well. Whereas the reductions in inventory seem to be quite clear in the example depicted above, rises in demand cannot as easily be identified and attributed to the implementation of the SCM concept.

The issues raised above, especially the negotiation of a benefit allocation mechanism, can be related to the configurational aspects of SCM. However, problems also arise in the coordinational, that is the more operational dimension. The agreed upon allocation mechanism will most likely perform coordinative functions as well. This means that the individual company's decisions will be influenced by the allocation mechanism in order to assure benefits not only for the acting company, but for all members of the supply chain.

Let us take the example of the three companies A, B and C from above. C is the only company in our supply chain with direct customer contact. It is thus not dependant on any information about sales or demand forecasts of its fellow supply chain members - on the contrary, it controls this information itself. What should the incentive for C to engage in supply chain management be ? As we have seen above, the concept might lead to decisions that, ceteris paribus, benefit the other companies (A and B), but not necessarily C. Obviously, companies A and B have to share their benefits with C (configurational aspects). After establishing the SCM partnership, C will continuously need further incentives to share information with its supply chain members in addition to regulations which have been agreed upon before. Thus, the coordinational function of the benefit allocation mechanism becomes obvious in order to avoid and circumvent opportunism. This problem will have to be subject of further research in academia. However, the topic is comparable to the transfer pricing problem faced by multidivisional companies seeking to set transfer prices which ensure allocational as well as coordinative functions for intra-company but inter-profit center trade (Eccles 1985).

2. Network Design for Global Supply Chain Management[‡]

Global supply chains are very complex phenomena as they reflect the patterns in the division of labor in intra- and interorganizational enterprise networks on a local, national, supranational (regional) and global scale. Therefore, from a logistical or supply chain point of view the task of designing the network of a global supply chain has to take into account several specific dimensions of the logistical network phenomenon. These main aspects of network design are surveyed in this chapter, subsequently a short example to illustrate their interdependent relations is presented.

a) Dimensions of Network Design

Figure 18 presents the main dimensions of network design for global supply chain management as they will be discussed in the sections below. Literally these dimensions of network design are called institutional/functional, spatial/geographical, and coordination/ control.

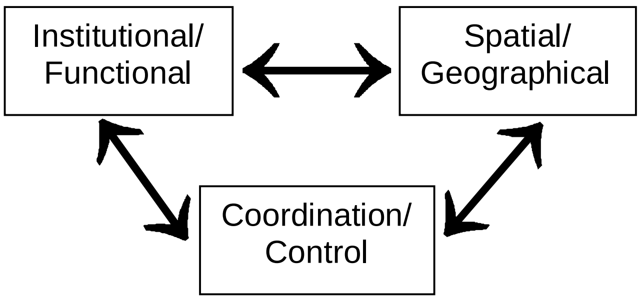


Figure 18: Dimensions of network design for global supply chain management

The *institutional/functional* dimension takes a look at the general institutions of a supply chain and the generic functions or tasks which have to be performed. As a consequence, its main focus is laid onto the logistical tasks and their fulfillment through the institutional as well as functional division of labor in the supply chain. The *spatial/geographical* dimension accentuates another basic characteristic of logistical networks, namely their extension through geographical areas which can reveal different socio-economical as well as physical and socio-geographical characteristics. Therefore we have co take into account that supply chains are space bounded phenomena which are characterized by a spatial spread of institutions and functions. Finally, the dimension of *coordination/control* emphasizes the way of planning, triggering and coordinating logistical tasks in and between institutions of the supply chain. Therefore the main interest lies on the coordination and control of the specific processes of a supply chain.

[‡] This chapter was prepared and contributed by Thorsten Klaas.

i. Generic Industry Characteristics and the Functions of a Supply Chain

The concept of the supply chain is used on two levels of aggregation or two different perspectives throughout the logistics literature.

On a *macro level,* the term supply chain describes the four *generic industries of an economy* involved in the general economical value adding processes of mining / growing raw materials (extractive industries e.g. lumbering, mining or agriculture), stepwise transforming the raw materials into parts and end products (manufacturing industries, e.g. vehicle manufacturing), selling the products to the end customer (trading industries, e.g. wholesaling, retailing), and transferring parts and end products to intermediate and end customers of the supply chain (service industries, e.g. logistical service firms) (MAGEE 1968, pp. 333ff.; BALLOU 1978, pp. 399ff).

Since these generic industry specific stages of a supply chain are in general correspondingly represented by different institutions or enterprises, we will call this kind of supply chain the *generic institutional supply chain* (see Figure 19).

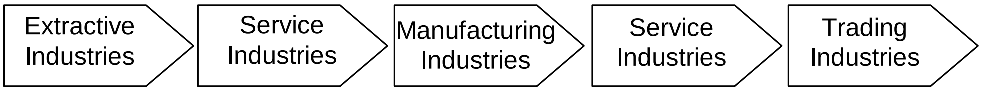


Figure 19: A generic institutional supply chain

With this institutional perspective it also becomes clear that the concept of the single linear supply chain is only an ideal theoretical construct, whose corresponding counterpart in reality is rather characterized by a complex network of many different supply chains which again are made up of many different enterprises (see chapter B.1 above). For this, just imagine that every step in the generic institutional supply chain is represented by a vast number of business enterprises which are possibly interconnected by many supply chain relationships. But for the purpose of theoretical analysis the ideal supply chain remains a strong and suitable tool, which helps to unravel the complex connections of supply networks experienced in reality.

On a *micro-level,* the term supply chain refers to the ‘internal’ supply chain of a generic institution, i.e. a business enterprise in the extractive, service, manufacturing or trading industry. Here the term encompasses the chain of generic operations or tasks a generic company has to fulfill to add value to the product for its customers, who are the next step in the institutional supply chain. Such generic activities are for example product design, procurement, production and distribution. Figure 20 shows such a generic functional supply chain (SCHARY/SKJØTT-LARSEN 1995, p. 22; STEVENS 1989).

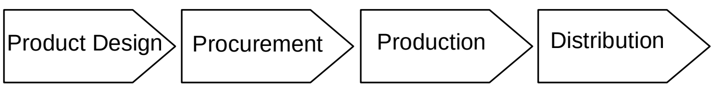


Figure 20: A generic functional supply chain

Due to the presented macro-micro relation, it becomes obvious that both concepts are closely interwoven. This is the case since the typical characteristics of an industry determine the main environmental conditions for an individual enterprise and an enterprise chooses a supply chain strategy to cope with these conditions or even changes them by innovative concepts (see e.g. PORTER 1985). Furthermore, depending on the scale of *vertical integration,* more than one industry can become relevant for a single company. This is also particularly important for the expanding or changing span of control over activities in the supply chain, initiated by new concepts of cooperative planning and control in logistics and supply chain management. As a consequence, the supply chains of vertically integrated and cooperating companies have to be divided into separated but interconnected parts or segments, corresponding to the contextual factors of each industry. Thus, from a logistical point of view, the relevant characteristics of these industries which transcend the supply chain of a single company or of a company network have to be taken into account for global network design. Figure 21 shows the main characteristics of the four basic industries from a supply chain perspective as presented by MAGEE (See MAGEE 1968, pp. 333-335; BALLOU 1978, pp. 399-402) which were also reflected in our generic institutional supply chain. Each industry reveals a special set of characteristics which determine the configuration of a particular global supply chain.

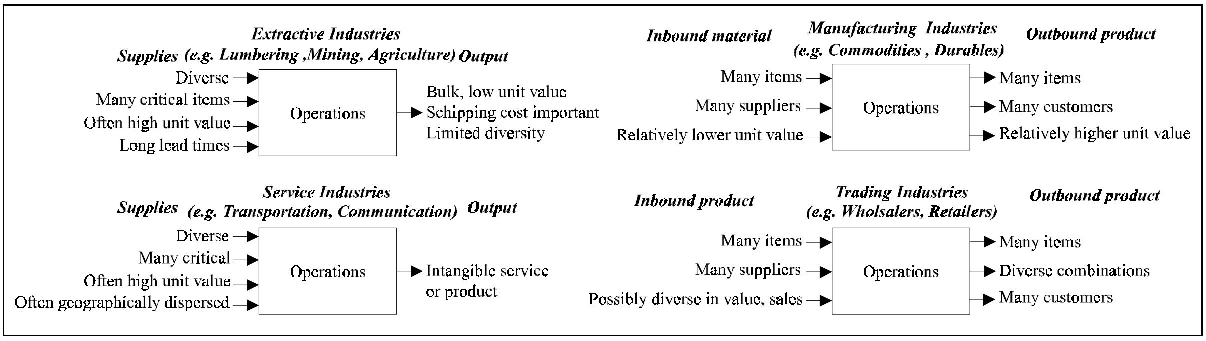


Figure 21: The main characteristics of the four basic industries from a supply chain's perspective

The relationship between the *institutional* and *functional* view of the supply chain can be illustrated as follows. Take the case of a coal mine which obviously belongs to the extractive industries. In order to mine raw materials like coal one has to ensure the supply of an extremely diversified field of 'input material'. Think for example of the purchase and maintenance of the custom made high value machines for the purpose of underground or opencast mining which are purchased from specialized firms all over the world. Therefore, the functional supply chain's procurement function has to handle a broad range of high and low value products which should be considered in the design of the logistical 'input' network. On the other hand, the function of production is geographically bound to the site of discovery of the raw material as is the corresponding logistical 'throughput' network. The 'end' product itself is simple with a relatively limited diversity and a low value density, so the logistical 'output' network has to take advantage of economies of scale in transportation to secure low transportation costs. This short example demonstrates that the 'nature' of an industry and the corresponding typical characteristics – like commonality or value density – of the 'logistical objects' which pass through this 'industry specific' supply chain represent main determinants, which have to be included into the design of the tasks in functional supply chains. Furthermore, the changing logistical demands implied by the altering characteristics of a logistical object flowing through the value adding processes of a supply chain's institutions are the main drivers for a context-oriented segmentation of the whole supply chain from a functional as well as an institutional perspective and thereby for the division of labor in the supply chain.

ii. Spatial Dispersion of Global Supply Chains

From the viewpoint of *global* supply chain management, the supply chain's geographical or spatial expansion plays a strategic role in the task of network design. Especially the balancing of the critical trade off between cost efficiency through global integration and standardization and local market responsiveness through spatial decentralizing and customizing of selected supply chain activities is a very difficult problem. Therefore the spatial dispersion of a supply chain according to particular demand patterns of spatial markets as well as the resource supply in specific geographical regions is a critical design dimension which has to be included into the analysis of network design. With reference to the *production units* of a supply chain, DICKEN suggests four basic types or empirical patterns of spatial dispersion by which a global supply chain may be characterized (DICKEN 1998, pp. 214ff.). These basic types are displayed in Figure 22.

The *globally concentrated production* (Figure 22a) concentrates the manufacturing of all end products on one geographical location. As a result the end products must be *exported* to other spatially distant (e.g. national) markets. This 'production driven' spatial configuration takes advantage of economies of scale in the production process. The centralized structure of production in combination with the export of end products is the typical starting point for companies beginning with their international business career. A typical example are Japan's car manufacturers, who started their international business activities by exporting their completely home-built cars into world markets (DICKEN 1998, pp. 215f.).

With *host-market production* (Figure 22b) the production units are located in and oriented to the adjacent geographical market regions, e.g. national markets. All end products are manufactured in a separate, spatially dedicated, production site which serves only this limited, clearly defined and spatially nearby market. This spatial configuration is obviously 'market driven' and takes advantage of the proximity to the market and its specific customer needs by customizing the products to the spatial variations in customer demands, tastes and preferences. But this customized spatial individuality is limited by the possible loss of economies of scale which could be reached in a centralized and more standardized production serving all national markets (see e.g. globally concentrated production). As COOPER (1993, p. 14) observes:

> "If economies of scale exist which extend beyond the size of national markets, then there is a potential cost advantage to companies through centralized production. In other words, it will be worthwhile making in one location, to serve a number of national markets, rather than to have national manufacturing firms."

On the other hand, administrative tariff and non-tariff barriers stimulate enterprises to erect plants in other national markets (DICKEN 1998, p. 216).

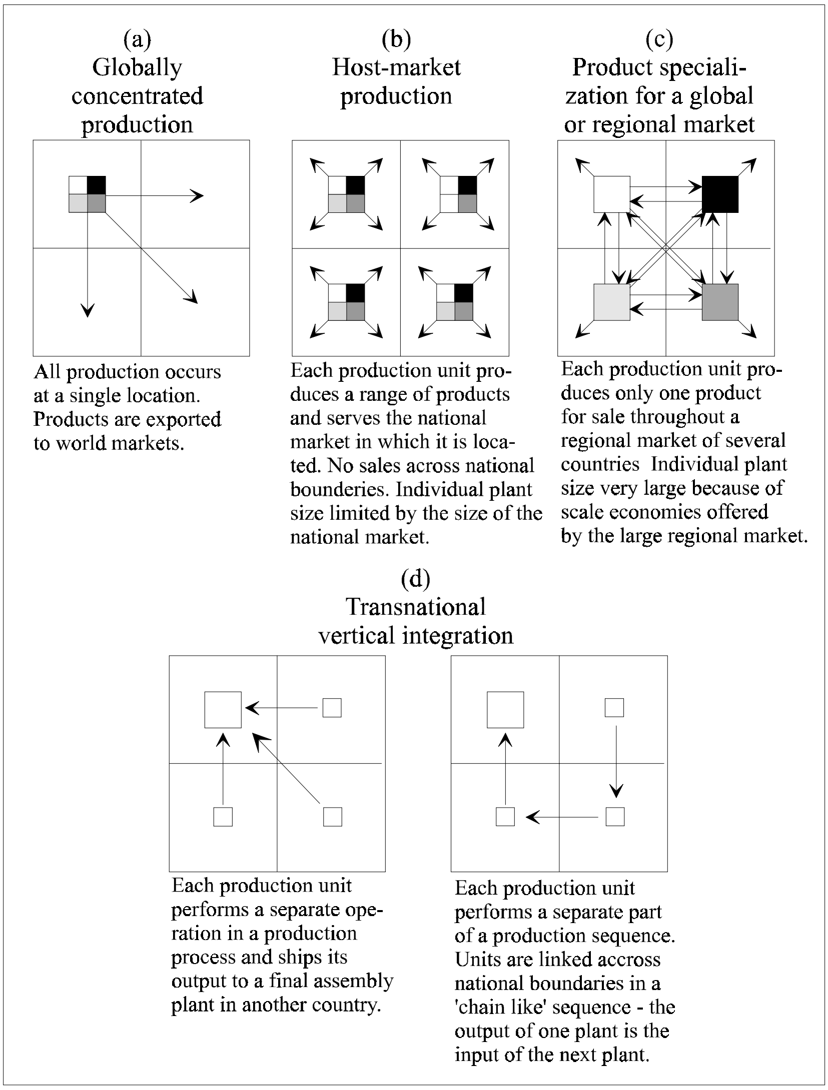


Figure 22: Basic patterns of production units spatial dispersion in global supply chains

The type of *product specialization for a global or regional market* is characterized by the positioning of manufacturing facilities, each specialized on *one type of end product*, in different geographical locations or markets. This spatial configuration is motivated mainly by differences in economically relevant factor endowments (e.g. labor costs, proximity to raw materials and the like) between regions or nations. The production should be carried out in the geographical region which is best suited for the specific production’s demands. The classical argument for favoring this pattern of a spatial logistical network has been the differences in labor costs between nations.

Whereas the presented types where ‘output-oriented’ because they focused on the final production and distribution of different end products, the two subtypes of *the transnational vertical integration* are rather ‘input’-oriented. Here the main focus lies on the spatial segmentation of the production processes itself which leads to the final manufacturing stage or assembly of the end products (This final stage then could correspond to the three types of spatial dispersion presented before). This segmented production process can be arranged in a parallel or sequential way. Depending on e.g. the labor intensity or the degree of standardization of the product and the production process, these types of spatial configurations take advantage of differences in economic relevant factor or resource endowments between spatial regions.

These patterns of spatial arrangements of production units in global supply chains identified by DICKEN are by no means complete or represent uniform ideal types without overlapping features to the other presented patterns. But they strongly indicate the necessity of considering the spatial structure of logistical networks or supply chains as a critical dimension at the network design for global supply chain management.

iii. Coordination and Control of Global Supply Chains

Basically the activities in supply chains can be coordinated and controlled according to two diametrically opposed philosophies. On the one hand, a supply chain process can be triggered for fulfillment founded on *pure anticipation*. This means that all activities in the supply chain are finished *by prognosis or plan* in advance of *assumed customer demands*. On the other hand, a supply chain process can be triggered for fulfillment founded on *pure reaction*. This means that all activities in the supply chain are closely connected *to received customer orders* as a consequence of responding to *real or materialized customer demands*. The opposed poles of anticipation and reaction are the distinctive marks for the differentiation between the logistical concepts of *speculation* and *postponement* in the logistics literature (see bottom of Figure 23).

Pure postponement points to the control-strategy of delaying all activities in the supply chain until the arrival of a customer's order. Waiting for a customer's order to arrive and reacting on it by triggering the whole functional supply chain regarding this order, gives the supplier the opportunity to customize his performance in order to meet the individual customer's specifications without the risk of obsolete inventory (HOEK 1998, p. 56). Therefore the control principle of postponement is closely connected to the *concept of customization* (LAMPEL/MINTZBERG 1996).

Pure Speculation, on the other hand, means triggering and controlling the processes in the supply chain referring to a demand projection (forecast) in advance of a concrete customer demand. To start activity in advance gives the supplier the opportunity to build a (limited) spectrum of products at an efficient scale in production, handling and distribution, which will immediately be available at the right time and the right place of the customer's request in the future (HOEK 1998, p. 56). Therefore the control principle of speculation is closely connected to the *concept of standardization* (LAMPEL/MINTZBERG 1996).

Between these two extreme cases of postponement and speculation a continuum of intermediate control-strategies combining both principles can be identified in the literature, depending on specific logistical product and market contingencies. Due to the sequential linkage of the value chain processes, the activities can be postponed stepwise pathway back the supply chain. Depending on what supply chain activity is postponed, different kinds of postponement can be distinguished. Figure 23 presents these types of postponement in a condense manner, corresponding to the most frequently used terms in the literature (See HOEK 1998, pp. 63ff.; HOEKSTRA/ROMME 1992, pp. 62ff.).

Logistics or *geographic postponement* is dedicated to the transfer activities concerning the properties ‘time and place’ of the logistical objects in the supply chain. Forward deployment of inventory of finished products is delayed until customer orders are received. This kind of postponement is reflected by the case named ‘shipment to order’ or one kind of ‘segmented standardization’ respectively in Figure 23.

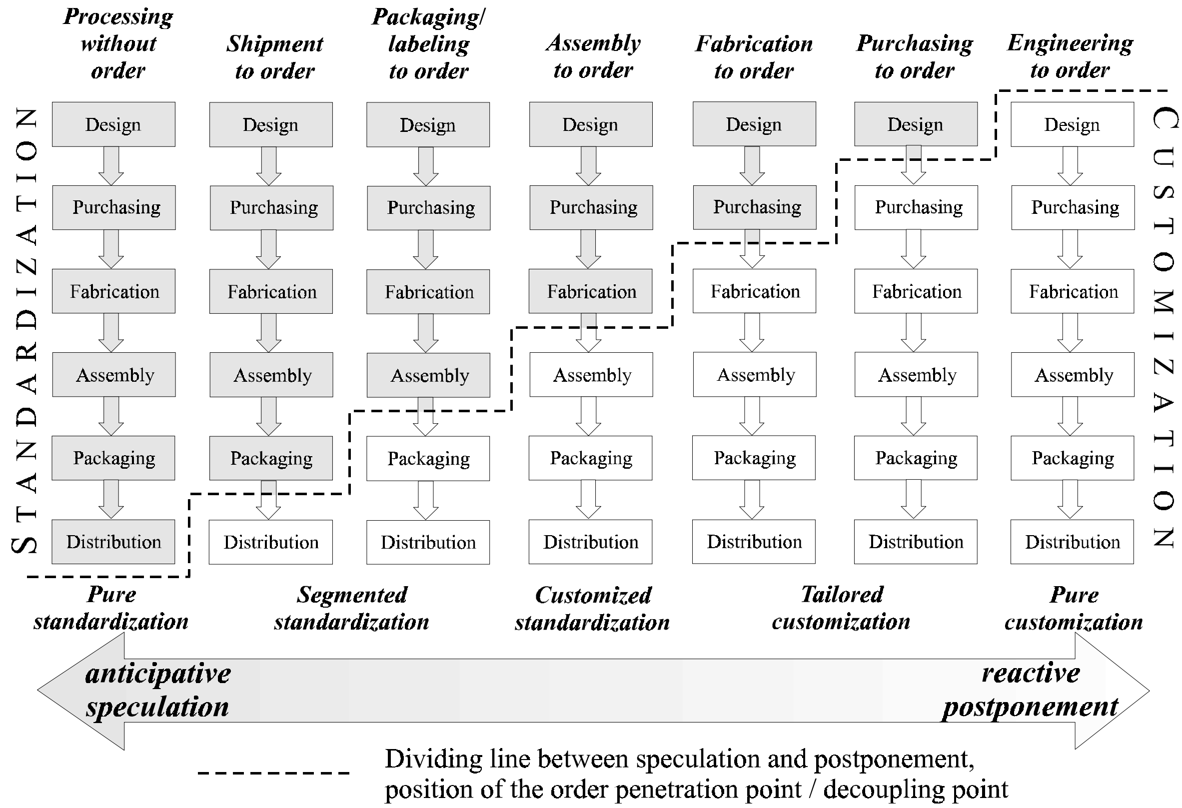


Figure 23: Basic control logics for supply chains

With *form* or *value-added* postponement all transformation processes in the supply chain are delayed, which change the physical properties of the product towards further specification or customization. Depending on how deep the supply chain is penetrated by the principle of postponement, five subtypes of form postponement can be differentiated: Packaging and labeling to order, assembly to order, manufacturing/fabrication to order, purchasing to order and engineering to order. By partially applying the principle of postponement on the processes of the supply chain and thereby controlling the other processes by speculation, the supply chain is divided into two segments: One anticipative and plan or forecast-controlled, one reactive and order-controlled. The point at which the control logic is changed is called the order penetration or decoupling point (see the dotted line in Figure 23).

Logistics and form postponement can have quite different effects on the spatial positioning of functions and the division of labor in the supply chain. Logistics postponement favors a rather ‘upstream’ position of inventory and by this often reveals a geographically centralized production and warehouse facility structure. Form postponement, on the other hand, fosters a temporal ‘downstream’ position of separable parts of the transformation process which can lead to a more decentralized spatial structure of the supply chain as well as a transfer of value-adding tasks to other downstream institutions in the supply chain e.g. logistical service firms. But this influence is also contingent upon the characteristics of the market demand and the properties of the product which in turn affect the type of form postponement applied (ZINN/BOWERSOX 1988).

b) Exemplary redesign of a global supply chain: The case of Hewlett-Packard

The three presented dimensions of network design converge into an integrated and comprehensive view of global supply chains. The types of the involved industries, the corresponding functions or processes in the supply chain, the properties of the products, the specific demand patterns of the relevant markets, the market's idiosyncratic socio-economical and geographical characteristics, as well as the properly applied control strategy, these are all critical elements in the search for the effective and efficient configuration of a global supply chain. But as already mentioned, these factors are by no means independent, so that the design of a global supply chain is an incredibly complex and intricate task. The interdependence between these design critical factors will now be illustrated by a concluding example (LEE / BILLINGTON / CARTER 1993): The case of Hewlett Packard (HP) which restructured its supply chain for its well known HP Deskjet-Plus ink printer series.

The HP Deskjet-Plus series was very successful and penetrated international markets with remarkable growth rates. But the printer industry was also a highly competitive one and the key to success, besides the innovative technology, was the provision of a high level of availability of printers to dealers and consumers. If there were not enough printers on the shelf in the store when the consumer required it, there was an increasing threat of the consumer switching to another product with equal features offered by a growing number of competitive imitators. As a consequence, maintaining a high product availability at acceptable i.e. competitive costs was a main target for the global supply chain of the HP Deskjet-Plus series. So HP decided to reengineer its HP Dekjet-Plus supply chain regarding the possibilities of cost reduction while keeping up the high service level. Within this reengineering project, two alternative configurations were considered.

The first alternative represented the status quo of the contemporary supply chain, which was called the *factory localization*. All production activities were concentrated on the manufacturing plant in Vancouver/Washington (USA). Every customized printer type destined for all other countries' specific local market demands was produced at this single location. Those localized printers differed in the integrated power supply module with the correct voltage and plugs, the appropriate manuals in the right language, and the market specific packaging and labeling. The HP management decided to operate the distribution centers (DC) to provide very high levels of availability so that the dealers' orders could be fulfilled quickly 'off the shelf'. The finished products were shipped to three DCs located in the home market of the United States, Europe, and Asia. The overseas DCs were served by sea freight with about one month lead time. Due to those long lead times for delivery to the overseas DC in combination with the sharp competitive market requirements, the international as well as the national supply chain were controlled by forecast-driven plans in an anticipatory mode which can be characterized as make to stock by standardization. The delivery to the dealers, on the other hand, was triggered by order so that the whole supply chain could be characterized as a shipment to order type or kind of segmented standardization (Figure 23). Figure 24 shows the configuration of the supply chain characterized by factory localization.

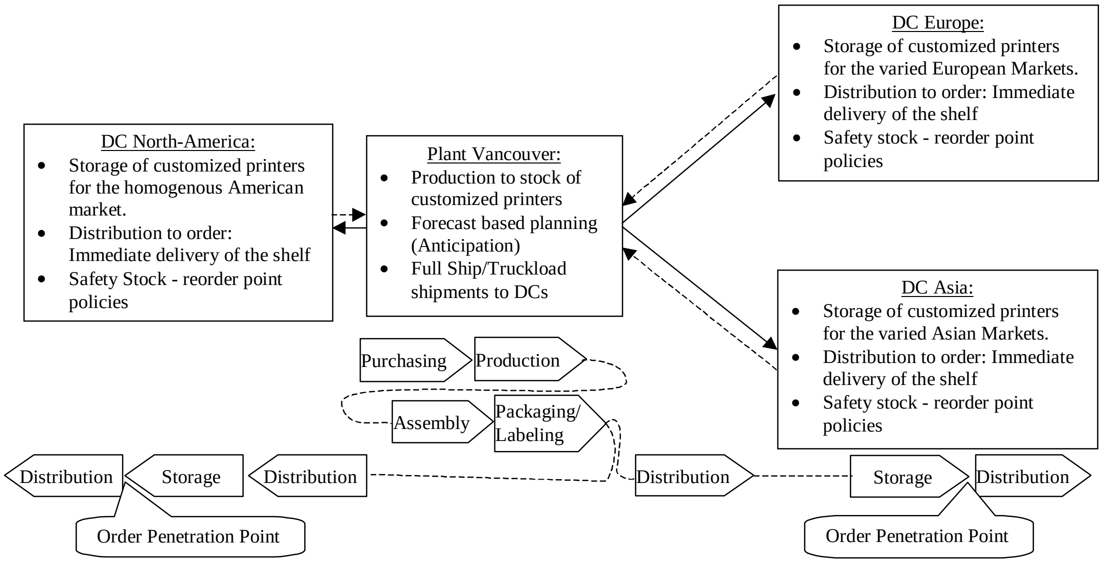


Figure 24:The alternative of factory localization

The second alternative is called *DC-localization* and is characterized by a substantial enlargement of the location-specific tasks assigned to the overseas DCs. Final customization activities have now been moved into the geographically distant warehouses in Europe and Asia. Only the customization of the American printers remains completely at the manufacturing plant in Vancouver because of the spatial proximity between the plant and the American DC and in order to make use of economies of scale in the production plant. The Vancouver plant now produces a *generic printer* which contains all generic features fitting to all served markets. It is prepared for further localization in the DCs of Europe and Asia. The main characteristics of DC-localization are shown in Figure 25.

The change in the division of labor between the overseas warehouses and the manufacturing plant enables a shift in controlling the processes in the supply chain. By passing the processes of final assembly, packaging and labeling to the overseas DCs, which are considerably closer to the target markets, it becomes possible to postpone these customizing activities until the dealers' orders are received and to react to them by quickly localizing the generic printer according to the varying national market specifications. So the overseas DCs with their enlarged responsibility regarding the final value-adding processes of the supply chain are controlled by customer orders, whereas the processes in the manufacturing plant in Vancouver remain plan-controlled. This reflects the subtype of form postponement namely ‘assembly to order’ or ‘customized standardization’ as shown in Figure 23.

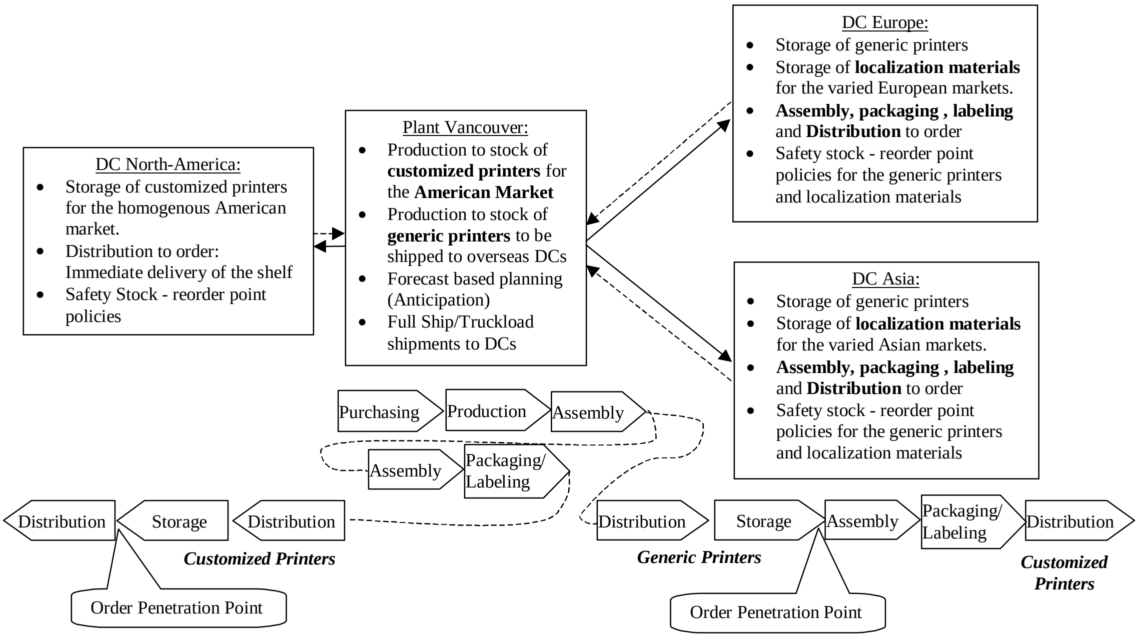


Figure 25: The alternative of distribution center localization

The advantages of the DC localization option compared to the factory localization are the following:

- Lower overall inventory levels by risk-pooling effect: The quality of the demand forecast for the generic printer is higher because variations in the market demands in the national markets can be compensated by aggregating all demands in terms of generic printers. As a result, DC localization achieves reasonable lower inventory levels at the high value generic printers, with slightly higher inventory levels at the localization materials in the warehouses. On the whole, inventory investment is reduced while maintaining the high customer service.
- Lower transportation costs: An unlocalized printer is much less bulky than a localized one. The factory can ship the unlocalized printers in bigger bulk pallets and cut the costs of transportation.
- Image and administrative considerations: The development of a local supply base of the localization materials for the DCs can help to increase a local content and local manufacturing presence, thus making a product more marketable.

The realization of the DC-localization HP model is enabled and supported by a modular redesign of the HP Deskjet-Plus Printer. This concept is named *design for localization* or *design for customization*. By the specific modular design of the printer it was possible to divide the assembly process into two segments, one generic and one customized. Hence it gets obvious that the design of the product, of the production process, and the logistics processes can affect the degree of customization, the location at which customization can be done, and the cost of customization. In conclusion this relationship particularly reflects the stated interdependence between the three dimensions of network design for global supply chain management described before.

3. Risk Management in the Global Context[‡]

> "Risk is another characteristic likely to cause concern, since a supply chain perspective requires risk sharing." (COYLE / BARDI / LANGLEY 1996, p.11)

In previous chapters we have discussed different phenomenons concerning structure and management of global supply chains. We have already mentioned additional complexities and uncertainties which arise on a global scale. In this chapter we will present implications and instruments of how to deal with these additional complexities, usually subsumed under the term "risk management". Subsequently, we will define "risk management" and demonstrate its specialities in global supply chains.

a) The Meaning of Risk Management

The term *risk* describes a set of unwanted and uncertain events. These events can effect a company as well as a supply chain in different ways. CARTER and CROCKFORD, (1991, p. 1.1-06) explain the necessity of risk management in general:

> "If future events are certain, they pose no problem to management since by definition they cannot be avoided; they simply have to be taken as an essential cost in all business activities. If, on the other hand, future events are uncertain, then the cost to the firm will not be known until after the event has occurred; yet investment and many other decisions have to be made in anticipation of these contingent events."

Thus, risk management comprises the sum of all measures within an organization to prevent or reduce the damages caused by uncertain or unwanted events. Institutionally all elements fullfilling these functions belong to the risk management. We will revisit these institutional aspects later, but will firstly take a closer look at the tasks of risk management. In general, risk management has to fullfil three functions (CARTER / CROCKFORD 1991, pp. 1.1-13):

- It has to consider the impact of certain risky events on the performance of the firm.
- It should devise alternative strategies for controlling these risks and / or their impact on the firm in the light of the corporate philosophy and attitude towards risks.
- It has to relate these alternative strategies to the general decision framework used by the firm.

Although these tasks are usually related to the single firm, they are applicable and necessary for supply chains as well. It might even be assumed that the complexity of risk management in global supply chains is higher than in the single company. This is due to the enhanced geographical (international) focus on the one hand and the multi-company focus on the other hand.

The globalization of business activities (see chapter C) leads to increased international flows of goods and information. Goods have to cross longer distances,

[‡] This chapter was prepared and contributed by Rowena Arzt.

exposing them to further risks during transport. Some parts of the supply chain might be faced with completely different political and economical environments than others. Thus, the predictibility of risks gets more difficult. As an increasing number of countries have to be considered, risk management becomes more and more complex.

The global supply chain consists of economically mostly autonomous elements with individual aims and strategies. As supply chain management is a basically inter-organizational concept, the implementation of a risk management concept for the whole supply chain requires the balancing of strategies and aims of all members of the chain (see chapter D.1).

Additionally, alternative strategies of risk management have to be related to the general decision framework of an organization. We have to take into account that due to hierarchical aspects it is easier to build up and maintain a general decision framework in a company than in a supply chain. Furthermore, we will see (chapter D.5) that it is difficult to measure the performance of a global supply chain and to find out which part of the success or loss was contributed by each single member.

As a result we should keep in mind that the tasks of risk management in a supply chain are similar to the ones in a firm. However, risk management in global supply chains is more complex than in companies as more possible influences have to be regarded and the decision process in a global supply chain is more difficult than in a firm.

b) Identification of Major Risk Types

In this part we will illustrate the major risks in general and how they effect the supply chain. We already know about the risk management´s tasks and function, namely to reduce a probable loss caused by an uncertain event. But what kind of uncertain events can be distinguished? What are the major risk types to deal with? Table 6 shows a possible systematization of risk types.

Type of risk	**Example**
Natural risks	earthquakes, vulcanos, floodings
Political risks	war, political instability, frequent changes in law systems
Economical risks	transaction exposure, translation exposure, taxes
Cultural / social risks	different mentality

Table 6: Risk Types

Some of the risks mentioned above are easier to handle than others. For example, it appears easier to protect a production site against a flooding than against masses of lava caused by the eruption of a vulcano.

The differences in handling these risks can have several reasons. The more experienced an organization is in dealing with certain risks, the less harm will be caused by the events' effect on the organization. Furthermore, risks can vary in their degree of predictability. In Japan it is more likely to have a heavy earthquake than in other regions of the globe. So every company will be aware of that specific danger and plan measures to reduce a probable damage directly when starting its business. The more predictable an unwanted event is, the easier it will be to deal with its consequences.

Economical and political risks play an important role, especially in international business. In order to better explain their influences on global supply chain management, we will differentiate the risks according to the leverage effect on the supply chain. We have learned that a supply chain consists of elements linked to each other. The term *supply network* stresses this aspect. Above, we used the illustration by DICKEN (1998, p. 215) to show different configurations of supply chains or supply networks.

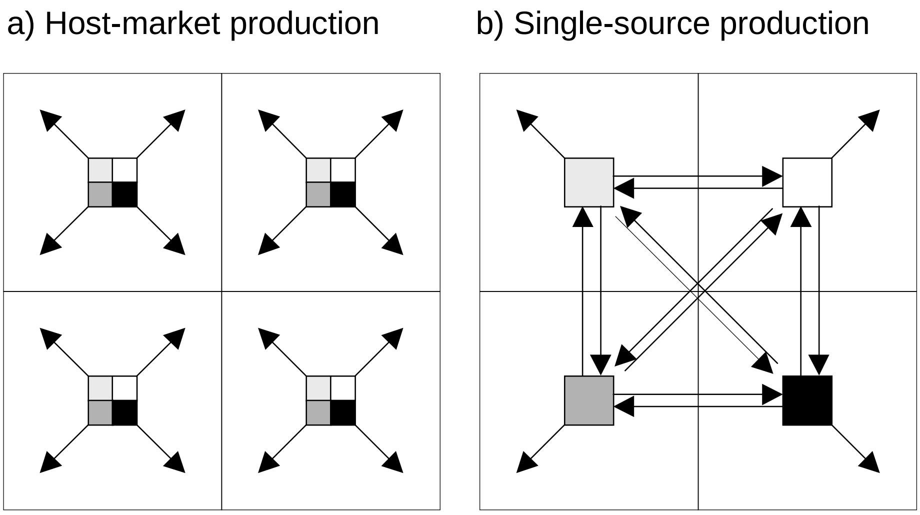


Figure 26: Alternative Supply Chain Configurations

For our purposes, it appears helpul to further differentiate risks according to their impact on the elements of a supply chain: the location of individual sites and the links that exist between them.

i. Local Risks

Risks threatening the members of the supply chain at their individual locations might be called *local risks*. Even if these risks occur at only one location, they can without proper risk management heavily effect the whole supply chain,. However, the harming effect on the whole supply chain is a function of the degree of disturbance by the event itself, of the measures of the risk management to reduce a possible damage and of the relevance of this special location for the whole supply chain.

Each of the major risk types mentioned in Table 6 could cause a local risk. A vulcano could ruin a production site completely, a new manager from abroad with a different mentality could demotivate the staff, which in turn could lead to an opposition against the new management ending up in a decrease in productivity. A political embargo could force a company to stop import or export activities, etc. These are only a few examples, but if events like these hinder the accurate performance of a location, risk management has to look for alternative strategies to replace an element or better – if possible - maintain its function. We will discuss the tools to minimize risks later in detail.

ii. Link Risks

Whereas local risks threaten one location of the supply chain, *link risks* have their leverage on linkages between individual locations. Thus, their effect depends on the stability of the linkage and on the environmental / infrastructural differences between the linked elements.

The stability of a link is influenced by the business relationship between the elements, the distance between the locations, and the infrastructure connecting the sites. The better the business relationship is, the better communication is as well. Therefore, it will be easier to protect the linkages against unwanted influences and to find measures reducing damage whenever a crisis occurs. COYLE, BARDY and LANGLEY (1996, p. 11) emphasize the importance of communication:

> "The sharing of information will continue to be a thorny issue, particularly in cases where vendors and / or channel customers may also deal with competitors of a manufacturer. Some balance and judgment may be necessary, but shared information is the key ingredient to success."

It is obvious that with an increase in distance the opportunities to interrupt the link rise as well. Take for example a gas or an oil pipeline from Russia to Germany. This pipeline crosses a lot of countries and is hard to survey for twenty-four hours a day. It would be the task of risk management to find measures to ensure the gas / oil supply by that pipeline or find an alternative gas or oil source if a damage occurs.

However, there are still other link risks. At least as important as risks caused by a lack of stability are the risks due to the environmental / infrastructural differences between two countries. The term *environmental differences* involves the economical and political differences between two locations within a supply chain. Differences in the economical development of two countries are expressed in various ways. One possible consequence of the distinctive economical situations are volatile exchange rates. Uncertain and often changing exchange rates have a big influence on international business and therefore effect the performance of a global supply chain as well. KOUVELIS (1999, p. 627) stresses the danger of varying exchange rates:

> "The main risk in global sourcing contracts is that depending on the direction of the exchange rate movement and the time the actual payment is made, a buyer can end up paying substantially more or less than the original contract price."

Researchers found out that there can be currency fluctuations of 1% in a day or of 20% in a year. A contract of about 1 000 000 Euro would thus be worth either 1 200 000 Euro or 800 000 Euro after a year - certainly meaning a big difference for every company (KOUVELIS 1999, p. 627). As the literature on financial management offers financial tools to minimize the exposure to uncertain exchange rates, we will not discuss these instruments in greater detail. (see DORNIER / ERNST ET AL. 1998). Additionally, there are possibilities to reduce the influence of currency fluctuations by the help of operational management which will be discussed later in this chapter.

c) Categorization of Cooper´s Company Clusters According to Predominant Risk Types

We will now take a look at the relation of the configuration of a global supply chain and the predominance of either local or link risks. As it is impossible to discuss this topic in general, we will use COOPER's (1993) generic company clusters we already discussed before to illustrate the configurational influence. Figure 27 shows a categorization according to the predominant risk types.

We can see that a *cloner* is almost only influenced by local risks, whereas the *outreacher* has to deal with both risk types – local risks and link risks, both even to a high degree. *Settlers* have to handle local risks at a medium level and relatively low link risks. In comparison to settlers, *invaders* have to face an increase in link risk, but a decrease in local risks. How can these distinctions be explained?

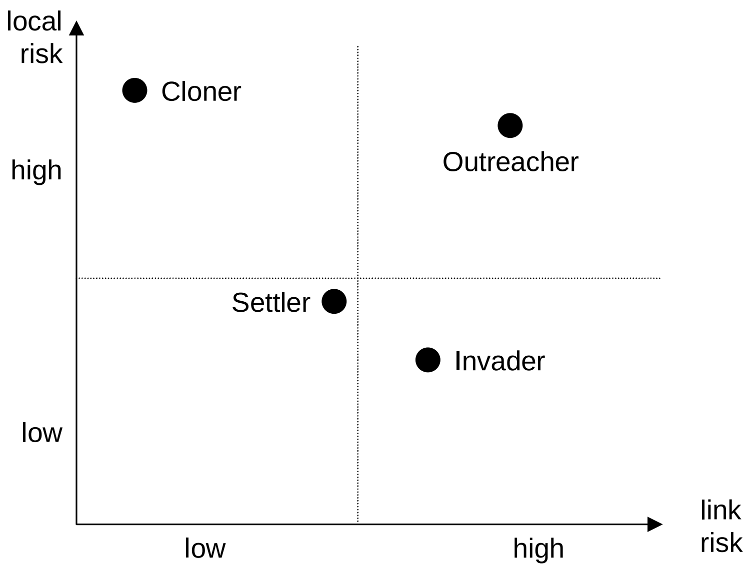


Figure 27: Company Clusters and Risk Types

The illustrated differences are based on the individual characteristics of each generic cluster. As the cloner covers single markets with local production sites and concentrates his procurement and his sales activities on that specific market, the local risk is very high. However the link risk is low because there are no or only few relationships to other supply chain members in a second country or market.

The outreacher has to maintain business relations in various markets, as he is sourcing and selling all over the world. Therefore, the link risk is very high. Additionally, outreachers use the local market for sourcing and selling as well, which explains the high local risk attributed to his configuration.

As invaders receive their suppliance only from one market, they depend on this special link. Additionally, they sell only in the market where the production site is located and do not have to maintain worldwide distribution channels. Thus, the link risk is on a medium level. While they do not source from the local market and only use it for distribution, the local risk is relatively low.

The production sites of a settler are supplied by local companies. Settlers only use their local market for their sales. This indicates that they have to deal with a higher local risk than invaders. However, as settlers receive their necessary resources also from the local market, they do not depend on the link to other markets in the way the invaders do. So the settlers´ link risk is lower than the one of the invader.

Although this categorization is simple and neglects many aspects, it shows that the configuration of the supply chain influences the predominance of risk types and will therefore influence the risk mangagement and its instruments as well.

d) Tools to Minimize Risks

The minimization of risks can be split into two components. On the one hand, the occurence of risks in general can be reduced. Thus, the unwanted event itself would be the focus of analysis. On the other hand the damage caused by the occurence of an unwanted event can be reduced. In this case, only the consequences of the "trigger" event are of relevance, but not the trigger itself.

A well-known and often used tool for the latter component is the insurance. Additionally, it is possible to reduce or prevent risk by coordinational or configurational tools.

i. Insurance

CARTER and CROCKFORD (1991, p. 1.1-11) explain the insurance of a risk as the transformation of an inherently uncertain situation into one of comparative certainty. The insured person or organization has to regularly pay a certain amount of money and will therefore receive an agreed sum in case of the exposure. However, the insurance itself does not reduce the likelihood that an unwanted event occurs. It just reduces the financial damage which can be the consequence of the exposure. If the event never occursthe payments to the insurer are lost.

It is one of the functions of risk management to decide whether it is worth to insure a certain risk or not. Often the risk itself can be reduced by certain measures so that there is a trade-off between investing in measures to prevent the risk or paying for an insurance. An example for an investment into the protection against an exposure would be the use of not inflammable materials for the construction of a warehouse or the installation of a special firealarm system. If that special kind of risk is too unlikely to happen, neither the investment in an insurance nor in measures for protection would be appropriate.

ii. Configurational Tools

Whereas insurances are a tool to reduce the effects of an uncertain event, configurational aspects can serve both components of risk reduction. The classification of Cooper’s company clusters already indicated that different configurations of supply chains result in a different level of exposure to certain risks. However, it is impossible to rank different configurations according to their overall risks or come to the conclusion that one configuration should be preferred in general.

Another configurational tool of risk management is to maintain loose connections to different locations or different members besides the predominantly employed link. In a crisis, these loose connections can be activated and replace an interrupted link or a damaged location. Therefore risk management has to consider that spare capacities must be available at the substitutional locations. The locations must offer the willingness, the facilities and the ability to take over the tasks of another production site or link.

If risk management plans and realizes these requirements before an event occurs, the measures are called preventive configurational instruments. Otherwise they belong to the instruments reducing the damage caused by the risk. However, generally the realization of configurational decisions takes relatively long and is difficult to cancel or to reverse. In case of a crisis it could sometimes take too long for the effect of a configurational tool to become visible. Thus, configurational tools should be well planned and used in advance.

iii. Coordinational Tools

Besides configuration, coordinational tools can help to reduce risks. As the configurational tools are related to the structure of the supply chain itself, they refer to the management within a given structure. Decisions about the production volume in general or about the quantity of goods being switched from one location to another belong to those instruments. Coordinational tools allow a faster reaction than configurational tools, but they are limited to the given structure. Risk management has to be aware that switching between production sites e.g. in order to hedge currency fluctuation causes different costs. Those costs can involve compensational payments to the location which is closed or at least where the production volume is reduced. Additionally, transportation costs could increase due to the switching of production volumes. Or there can be a variance from the optimal capacity at the new location causing additional costs as well. Whenever risk management works with coordinational tools, there are at least two locations involved (KOUVELIS 1999, pp. 625-667).

We have seen so far that risk management in a supply chain is more difficult than within a company. Some decisions influence the whole supply chain, some just a single link between two members and others just one location. However, the occurance of a risk always influences the whole supply chain either in a higher or a lower degree. So it is necessary to have an institution, e.g. a board of managers, which takes care that an overall risk management strategy is realized. This strategy should comprise the compensation of supply chain members, tools to prevent risks and tools to reduce a probable damage.

4. Information Management for Global Logistics‡

a) From the Transportation to the Information Era

The role of information in logistics management has changed considerably. Whereas in 1948 the American Marketing Association defined logistics as „the movement and handling of goods from the point of production to the point of consumption or use“ (HESKETT/IVIE/GLASKOWSKY 1964), modern definitions recognize the importance of information (CLM 1998):

> „Logistics is that part of the supply chain process that plans, implements, and controls the efficient, effective flow and storage of goods, services, and related information from the point of origin to the point of consumption in order to meet customers´ requirements.“

This shift is based on the two trends that led to what we today call global logistics management or global supply chain management. During the end of the 19th and the first half of the 20th century it was the transportation technology that made huge progress with the introduction of railways, automobiles and aviation. This resulted in reduced transport times and the connection of until then relatively independent parts of the world. During that period, transportation technology outpaced information technology by far, resulting in two problems for the efficient management of the ever increasing logistical complexity. First there was the problem that except from crude technologies such as telegraphs it was impossible to move written information like order information faster than the physical goods. Even worse, there were no means of managing the ever increasing amount of data generated and needed by the growing global economic networks.

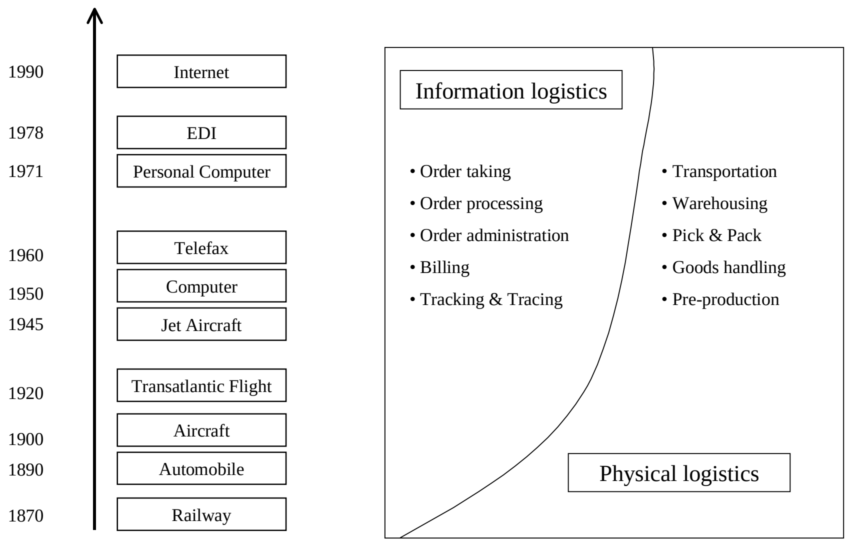


Figure 28: Growing importance of information technology and information logistics

‡ This chapter was prepared and contributed by Martin Gehring.

It was only with the introduction of modern information technology in the second half of the 20th century that these problems got solved. Telefax (Telex) and Electronic Data Interchange (EDI) allowed fast transmission of order data. The rapid development of computing technology opened the way for a new dimension of data collection, storage and usage, enabling modern supply chain management (SCM). And the advent of the internet is about to change the way business is done dramatically with yet unpredictable consequences for logistics management.

The following part will firstly describe the principles and functionalities of modern information management in logistics management, followed by a detailed description of the architecture of a logistics information system (LIS). After that the results will be used to formulate the requirements for information management in supply chains. In the last part, the possible consequences of internet-based electronic commerce for SCM will be discussed.

b) Principles of Logistics Information Management

Basically, the modern logistics manager faces three problems: Allocation, communication and control (ALT/SCHMID 2000).

In the face of ever increasing competition, the pressure to reduce costs determines logistical management. The *allocation* of expensive facilities and means of transport like ships, trucks, aircraft, or warehouses plays a crucial role in achieving this by improving their utilization. The use of information technology offers significant levers to improve allocation and utilization and thereby reduce capacity costs.

Complex global supply chains with several production, retail, and logistics companies involved often suffer from breaks in the information flow or simple information delays. They need sophisticated but easy to use *communication* structures to allow for a seamless information flow.

A high service level is another key factor of success for logistics operations. In oder to achieve this, a thorough quality management has to be implemented, extracting data from the operational processes and using it to *control* the fulfillment of service levels.

Modern information management based on a sensible use of the latest information technology can help to reduce, if not solve, this problems drastically. In order to do this, logistics information management has to be based on the following principles (BOWERSOX/CLOSS 1996).

Availabiltiy and timeliness: Logistics information has to be consistently available throughout the whole supply chain on a real-time 24/7 basis. This is necessary to improve inventory and status information, thereby altering the quality of management decisions by reducing operating and planning uncertainty. In order to achieve this availability the information should not be paper-based and be accessible from every given point of the logistics chain without delay. Changes in status have to be visible in the information system immediately, thus reducing the risk of using outdated status information for management decisions.

Accuracy: The logistics information should give an exact picture of the actual status of the supply chain process. Accuracy is therefore defined by the degree to which physical and information system inventory are matched. The higher the match, the lower the need for safety inventories along the supply chain. Accuracy helps to reduce operating and planning uncertainty as well.

Exception-Based Management: Logistics Operations consist of a huge amount of fairly routine procedures which can and should be handled automatically by the logistics information system. Nevertheless there are cases where routine operations diverge from the scheduled path or where completely new and therefore unstructured processes have to be performed. The LIS has to allow for those exceptions, identifying them and alerting planers or managers. So designed, the system enables managers to concentrate on unstructured problems which most often offer significant opportunities to improve service or reduce cost rather than monitoring routine processes.

Standardization and Flexibility: The LIS has to be able to meet the needs of all parties connected to it. That means a difficult balance between standardization and flexibility. On the one hand, a high degree of standardization within existing supply chain partnerships, for example the use of the same software or the same barcodes along the whole chain, will improve efficiency significantly. On the other hand, the system is ideally designed to allow for easy connectivity to new partners or customers.

Based on these principles, the functionalities of a LIS have to be implemented in order to achieve the highest possible logistics performance. The basic functionalities of a LIS will be addressed in the following chapter.

c) Functionalities of a Logistics Information Management System

A LIS has to include four basic functionalities: Transaction, management control, decision analysis, and strategic planning (BOWERSOX/CLOSS 1996).

On the transaction level, the individual physical logistical activities throughout the logistics process are represented in information systems that similarily process the data which accompanies the physical operations. Typical transaction systems include the order entry, selection, and processing or the inventory assignment. The data gathered by the transaction systems is then used by the management control systems to measure the performance of the logistical system in terms of utilization, customer service, productivity, or financial profitability. Based on the operational data and the control indicators, decision analysis systems are used to improve the performance of the logistical system. Systems used for decision analysis include transport routing or warehouse inventory management. The highest level of information functionality is reached in the strategic planning systems, where problems like strategic alliance formulation or network planning are addressed.

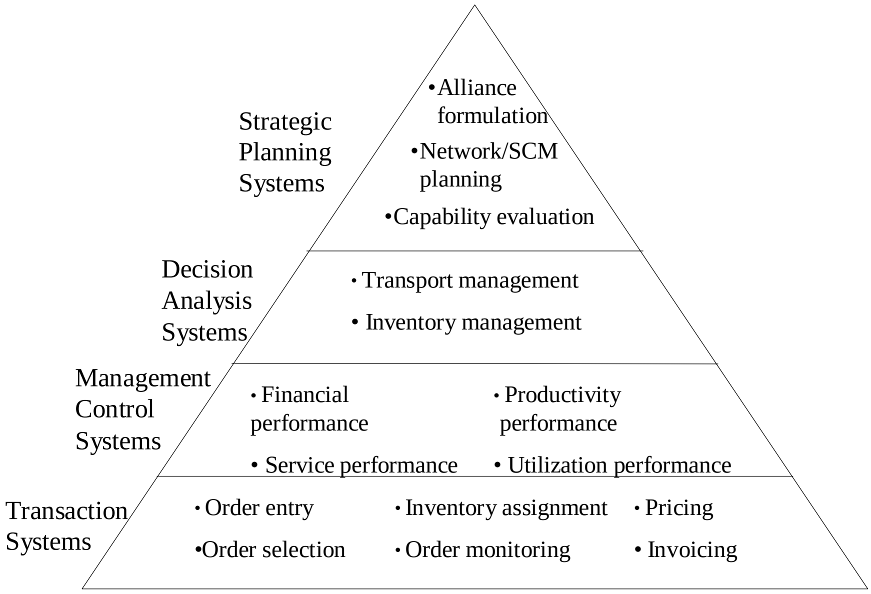


Figure 29: Functionalities of a LIS (adapted from BOWERSOX/CLOSS 1996)

Figure 29 does not only display the different functionalities of a LIS, it also represents, from bottom to top, their historic development and justification from a competitive advantage perspective. LIS were originally used for reducing transaction costs in the operating system, creating a competitive advantage. When nearly all companies used LIS they were no longer useful for this purpose, but became merely a kind of qualification for competing in the market. Transaction systems became standard applications, the next step for generating competitive advantages was the introduction of management control systems until they became standard, too.

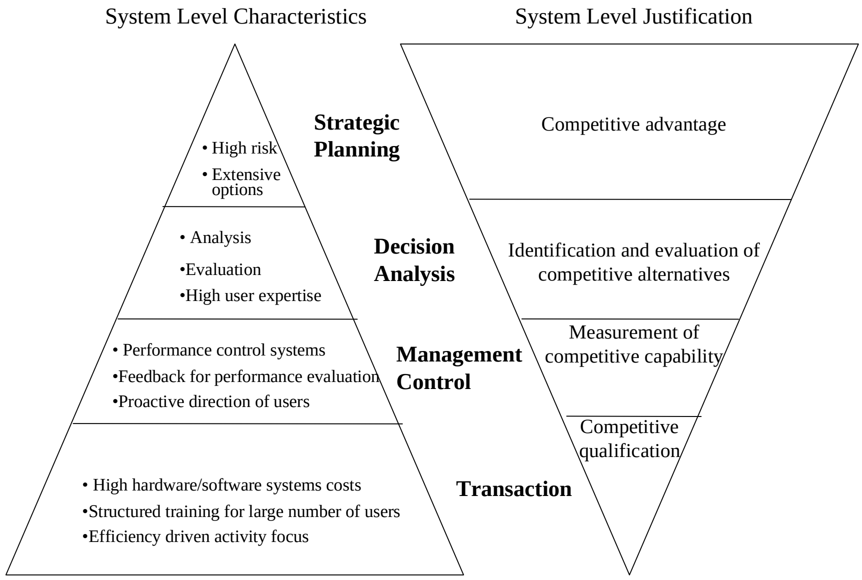


Figure 30: Characteristics and justification of LIS functionalities (BOWERSOX/CLOSS 1996)

Today, sophisticated decision analysis systems have been introduced in many companies, while some first-movers are already testing strategic planning tools like SCM-Software. Figure 30 shows the characteristics of the system levels and their justification in terms of competitive advantages as of today.

After introducing the general principles and functionalities which qualify a modern LIS as a possible source of competitive advantage, the next chapter will take a closer look at the systems architecture of a modern logistics service provider (LSP). Specific information systems fulfilling the above-mentioned functionalities will be explained and the problem of data management will be addressed.

d) Systems Architecture and Data Management

The core of the transaction systems of any modern LIS is an automated order administration system (AOAS) which takes orders from customers, processes them and generates documentation like the bill of lading. Ideally, the automated order administration system can be connected to customers´ and partners´ systems, allowing for a seamless order flow without manual interference. Coupled to the AOAS should be a tracking & tracing system with status information on every order currently in the system. This requires that every physical item belonging to the order is barcoded and then scanned at various points of the supply chain so that it can be represented in the LIS.

Based on the data from the AOAS, management control systems should be used for performance measurement. They reach from simple statistics on delivery correctness and timeliness to financial systems that calculate the yield for each order, route or location in the supply chain. To optimize this performance, modern LSP use decision analysis systems to evaluate alternative solutions for their operational processes. Tour planning systems determine the allocation of vehicles on an every day basis, GPS-based vehicle routing systems allow for immediate adjustments in the case of unforeseen obstacles to the scheduled plan. Warehouse inventory is optimized and yield management improves the utilization of aircraft. On top of this relatively short term planning systems, strategic planning systems are getting more and more sophisticated, using expert systems which mimic the decision profiles of human decision makers. They incorporate ´soft´ facts as well as ´hard´ data for network structure planning or cooperation decisions. Commonly used strategic planning systems for LSPs include network planning and supply chain planning.

An important role in enabling all these systems to work together plays data management. First, data has to be collected. This requires that every transaction of the AOAS is filed together with operational data gathered through the tracking & tracing system or external data sources. This data needs to be stored in a main data storage immediately. The raw data then has to be extracted, cleaned and organized to be used by control, analysis, or planning systems. The result are data marts dedicated to single or multiple applications.The process of building these data marts is the most crucial part of modern data management. Figure 31 shows the systems architecture of a LSP with a so-called data warehouse as data backbone.

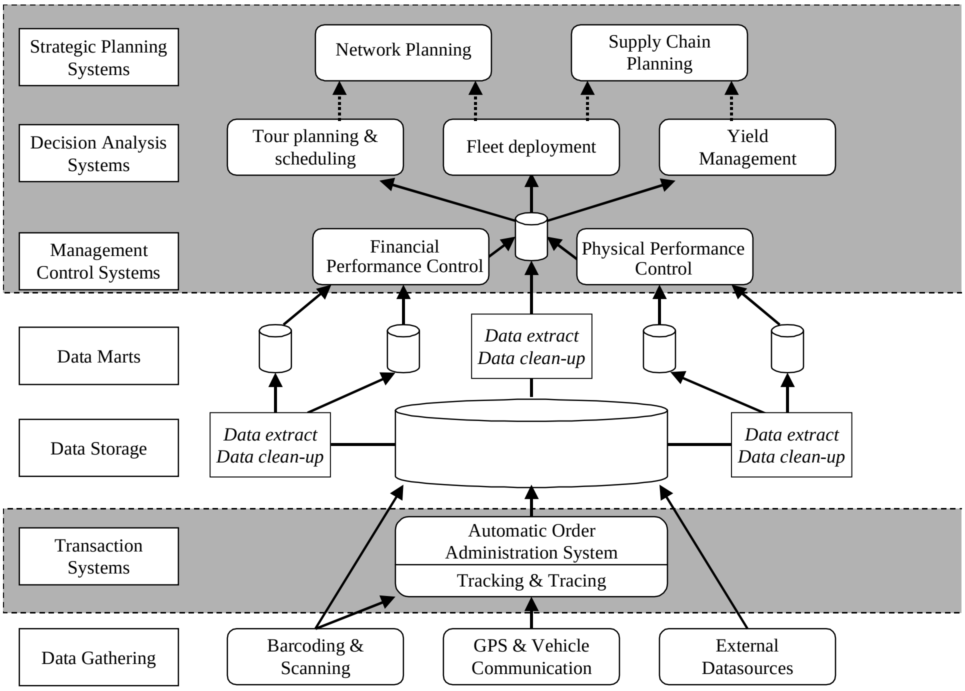


Figure 31: Data management for and systems architecture of a typical LIS

The system´s architecture for a LIS of a producing company, be it a supplier of unfinished goods or an original equipment manufacturer (OEM), is not very different from that of a LSP. Most of all, an OEM has to connect his production planning and material requirement planning systems to the LIS to allow for a seamless information flow.

Using the described LIS and obeying the fundamental principles will enable a company (LSP, supplier, or OEM) to manage its logistics information in a more efficient way. But from a systemic point of view, taking into account that supply chains consist of many of those companies, efficient information management of a single company will not suffice. It has to be ensured that the following companies in the chain can use the information as efficiently to reach a high logistics performance of the whole supply chain.

e) Requirements for Information Management in Supply Chains: From old EDI to open EDI

In order to enable successful information management for complete supply chains, the information flow as well as the flow of goods will have to ignore the borders of the different companies. The key for this seamless flow of information is electronic data interchange (EDI). Historically, EDI meant either the connection of companies using the same transaction systems or the task of connecting enterprises with different transaction systems. In both cases the companies in question had to engage in rather high and quite specific investments. In the first case they needed compatible transaction systems which often meant that one or both parties had to implement a completely new system in order to reach compatibility. The mere connection of this compatible systems proved no big problem afterwards. In the second case the companies, instead of changing their transaction systems, established EDI connections that could send data between the different systems.

This required sophisticated transformation of data from one proprietary system to the other. Soon a third solution evolved in the form of Value Added Networks (VAN). Specialized companies mostly from the telecommunication sector (for example AT&T, British Telecom, or Saturn) offered networks which trading partners could use for their information transfer. These VANs were relatively slow, very expensive for the users since they had to pay fixed and variable fees, and inflexible. Summarizing, EDI in the pre-internet era meant either the establishing of bilateral connections for long-term use or the use of VANs (Cases A1 and A2 in Figure 32). It therefore did not allow for flexibility as demanded in the general principles of information management and was very expensive.

The progress in information technology is about to change that (KALAKOTA/WHINSTON 1996). Internet technology offers a simple, easy to use, and inexpensive standard for establishing information networks between companies in the form of extranets. There are several factors making the internet the favorable platform for EDI:

- Low cost: access to the internet is offered for a flat monthly rate, often including unlimited usage. The technical infrastructure needed is very cheap compared to the dedicated structures of old EDI.
- High standardization: the internet offers common file standards like SGML or HTML and simple transfer protocols like e-mail or FTP.
- High flexibility: low connection costs and easy standards allow to connect and disconnect to an internet-EDI network within minutes.

On the downside, there is still the problem of security and stability. The information passed through the extranet or even the internet has to be secure, meaning save from being intercepted from unauthorized parties and the connection has to be stable. Encryption technology with 128-bit key and Secure Socket Layers (SSL) are the latest developments in addressing the security problem (CONWAY/KOEHLER 2000). Denial of service attacks that stunned prominent websites out of action in January 2000 have caused a more sincere view of stability issues. Nevertheless it seems that internet technology is suited perfectly for EDI.

That means that for the first time it will be possible to enable EDI on a standardized platform that offers flexibility as well. Web-EDI will take SCM one significant step further. The enhanced connectivity is the basis for a more efficient information management in supply chains. Together with this connectivity, SCM-Tools as the latest development in strategic planning tools may allow for an integrated planning of whole supply chains instead of synchronizing the single links of the chain. And the internet may even provide the resources for an integrated data management with data warehouses running on internet technology. Figure 32 displays the change in EDI schematically.

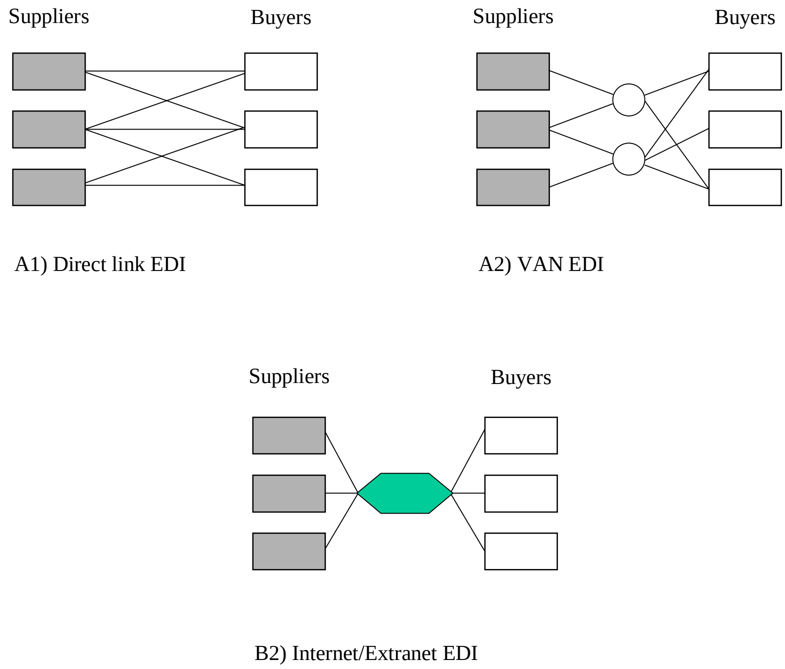


Figure 32: Structure of old EDI versus Internet Technology EDI (SHAW 2000)

The rise of the internet offers new possibilities for information managment in global supply chains. But it also is about to change the very structure of this supply chains by changing the way business is conducted. The last chapter will take a look at e-commerce and e-business and its consequences for supply chain and logistics management.

f) The Future of SCM in the Age of Electronic Commerce

The internet as a technology and communications medium offers new possibilities for information management in global supply chains, as we have seen above. But that is only a small fragment of the changes the Internet will introduce upon businesses and the way business is done. Dubbed electronic commerce or electronic business, new or at least more efficient ways of conducting business transactions are emerging. Electronic commerce is going to change the relationships between business partners and is therefore about to change not only the information management but the very structure of global supply chains.

With its high flexibility and standardization the information technology in form of the internet will lower the coordination costs of economic transactions. As it has been argued even before the advent of the internet, this will result in a rise of the proportion of economic activity coordinated by markets (MALONE/YATES/BENJAMIN 1987) and thus in a decline of economic activity coordinated by hierarchies or cooperative partnerships. This would mean the end of traditional supply chains if you follow a supply chain definition that focuses on partnership and cooperation or, using a broader view on supply chains, a significant change in the structure of many supply chains.

By taking a closer look at some of the possible structural changes that might occur to supply chains we will see that there are cases in which the above-mentioned „shift to the market“ argument might be replaced by a contrary „shift to more cooperation“ hypothesis.

Figure 33 shows a rather simplified version of a supply chain. Electronic commerce based on the possibilities of the internet can now affect every single stage of the chain.

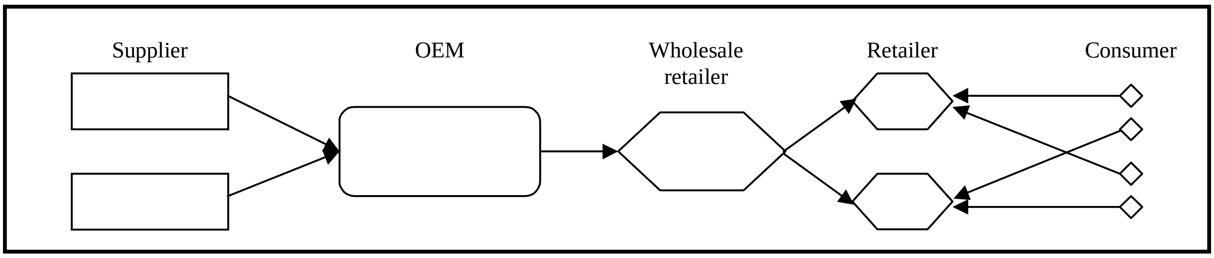


Figure 33: Simplified classic supply chain structure

i. Business-to-business Electronic Commerce

In the relationship between supplier and OEM we already have seen the introduction of electronic market places in different industries. Prominent examples include General Motors, Ford, and DaimlerChrysler partnering in the automotive sector or Shell and Chevron in the energy sector. These big OEMs are using this spot-markets or reverse auctions to buy parts or raw materials. The difference to traditional supply chains is that in this electronic market places the number of suppliers is literally unlimited. The extreme case would be that the OEM (or a group of OEMs) buys from a different supplier every day or even every minute, depending on the quantities offered. The advantages of this business-to-business Electronic commerce are mostly with the OEM which see a vast potential for reducing sourcing costs. On the supplier side the advantage is that more suppliers can offer their goods, the supply chain is no longer a kind of „closed community“, but the price competition will get stiffer for the suppliers. Figure 34 shows the changes to the supply chain structure. It is important to notice that the same structure is possible between OEM and wholesale retailer. The described cost savings through this electronic markets rely on the assumption that the internet will reduce the costs of getting information drastically as argued in the „shift to the market“ argument. But this does only go along with very homogenous products with identical product qualities. The above-mentioned market places fall into this category of electronic markets for homogenoues goods.

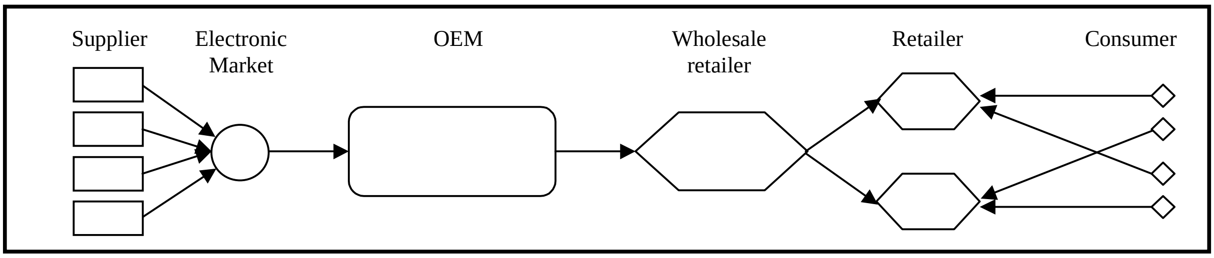


Figure 34: Supply chain with business-to business electronic marketplace

The argument of lower information costs does hold truth when it comes to high value, heterogenous products as well. But here it can be used to show that the cooperative partnerships in existing supply chains will even deepen through electronic commerce when high value products are at the core of the transactions. The internet offers the possibility of yet unknown forms of information transfer and sharing of knowledge. This can be used to establish learning relationships in supply chains where the quality of the product is very important and improvement in product or service quality depends highly on the involved companies sharing their knowledge.

ii. Business-to-consumer Electronic Commerce

Another possible change we have already witnessed is the elimination of whole retail stages. In this case the products are no longer picked up by the consumer in a retail store after being handled from the OEM to the (wholesale) retailer. Instead, the product is delivered to the customer directly from the wholesaler or even from the OEM. Examples for this kind of business-to-consumer Eeectronic commerce include amazon.com as wholesaler or Dell Computers as OEM. These business models are not much different from classic mail order except from using the internet as a new (cost saving) medium. There are different models like auctions, powershopping or simple catalogue ordering, but it is always the elimination of one or more retailing stages that leads to cost advantages (WIGAND 1997). For logistics these models have the special implication that now the consumer does no longer pick up the products at a retail store. Instead they are delivered to his doorstep by a LSP.

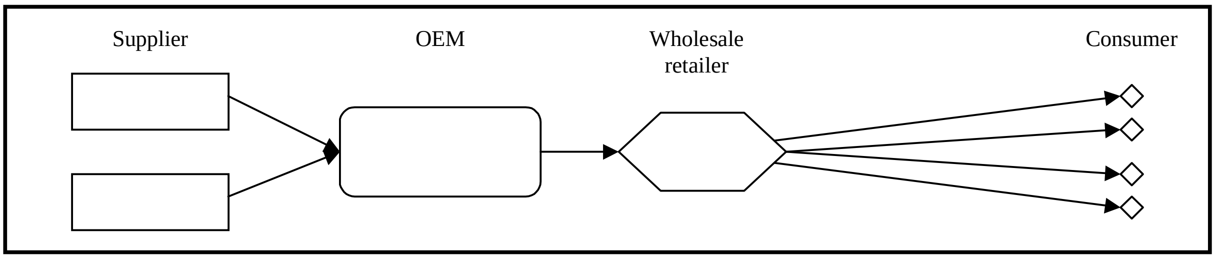


Figure 35: Supply chain structure with business-to-consumer Electronic Commerce replacing the retailing stage (amazon.com)

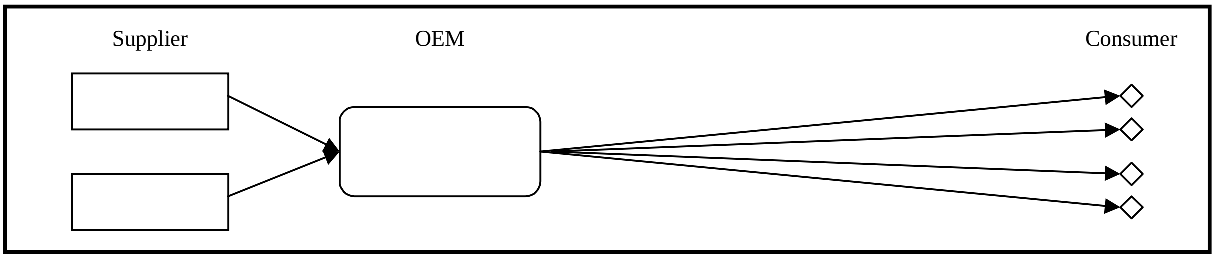


Figure 36: Supply chain structure with business-to-consumer Electronic Commerce replacing wholesaler and retailer (Dell Computers)

As in business-to-business electronic commerce, one major driver for electronic commerce is the reduction of coordination costs in form of search and information costs for the consumers and the elimination of whole retail stages (and with them transaction costs). But again electronic commerce offers new possibilities for the relationships between consumer and retailer/OEM. Never before was it possible for retailers/OEMs to gather so much data about their customers and their behavior. Never before was it possible, on the other side, for the consumers to express their preferences so exactly and to extract so much customized information. Again, the new technology offers not only reduced transaction costs and more market-coordinated transaction but the possibility for learning relationships between parts of the supply chain.

iii. Consumer-to-consumer Electronic Commerce

There is also a completely new business sector evolving in electronic commerce that has not been part of the traditional supply chain yet. Since the logistical implications may be significant, it should also be mentioned in this context. Consumer-to-consumer electronic commerce has been growing rapidly and with it the need for point-to-point transport of small packages over short to medium distances. The pioneer of this business model (ebay) holds more than 4 million c-t-c auctions every day, and many of the items sold have to be transported from seller to buyer by a LSP.

iv. Future Supply Chain Structures in Electronic Commerce

Figure 37 summarizes the above-explained structural changes electronic commerce could introduce on supply chains. Every other combination of old and new structures is possible as well, showing that the range of alternatives for supply chain planning and managing will increase significantly in the future.

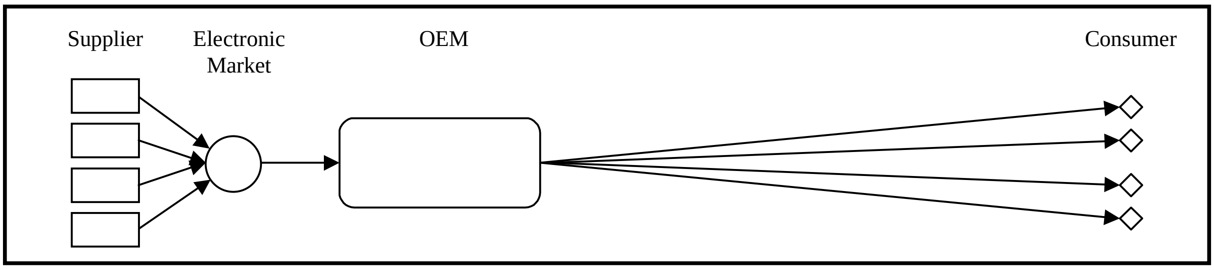


Figure 37: Supply Chain structure with b-t-b and b-t-c Electronic Commerce structures

The progress in information technology offers significant potential for global logistics and supply chain management. Similarily, the internet in form of electronic commerce is about to change the structure of traditional supply chains in many ways, while the information technology should enable the supply chain participants to manage that change accordingly. An interesting hypothesis is that when the information technology and information management offers so much standardization and flexibility at low costs that everybody can easily afford and use it, it will no longer be a competitive differentiator. And then the proportion and importance of physical logistics compared to the information logistics will rise again.

5. Performance Measurement and Evaluation in Global Supply Chains‡

In theory and practice we often find the quotation that "You can't manage what you don't measure." But even measuring operations need not necessarily lead to good results. Managers and employees are warned that "You get what you measure" or "Be careful what you measure because you might get it." Thus, the question is what to measure, how, and why to do it and finally, how to use the measured numbers. In the context of global supply chain management, this question is related to the problem of designing and using logistics-oriented performance measurement and control systems. In the following chapter we will outline the basic conceptional, instrumental and usage-related ideas of these control systems.

a) Conceptual Aspects

i. Performance in Global Supply Chains

The term *supply chain performance* is not clearly defined. However, a first approach to determine its meaning can be made by considering the concept of logistics performance, which is at the origin of the supply chain idea and of central importance for the integration efforts along the supply chain. Following the distinction of the four general process modules of input, process, output and outcome, we can subdivide the logistics performance into four components which are related to the performance of resources, process type, results and effects of a logistics process (WEBER 1986, p. 1197).

The logistics performance is *input*- or *resource-related* if it merely represents the provision of production factors for bridging time and space differences. The capacities of a not further determined logistics process are considered. This includes e. g. the assignment of capacities of equipment (i. e. for transport or warehousing), personnel and IT-infrastructure (like EDI). Measures of resource performance will be mainly cost- and efficiency-oriented.

A logistics performance can be called *process type-related* if it describes the carrying out of a logistics process. It concerns directly the implementation of a transport, handling, storing, order processing, packaging or signing process. The demand for such a logistics performance can be captured in greater detail when refering to the capacity throughput, intensity, number of process items, place, duration and date of the process execution.

An *output- or results-oriented* analysis of logistics performance concentrates on the performed change of time- or space-related characteristics of an object. This would be e.g. a fulfilled delivery of a determined amount of products to a determined customer.

‡ This chapter was prepared and contributed by Constantin Wickinghoff.

Finally, a logistics performance is *outcome*- or *effect-related* if it refers to the effect or the benefit a completed process has on the customer. It thus concerns the delivery service, an important instrument of the marketing-mix and consists of at least the following four components (PFOHL 1996, p. 35):

- *Delivery time*: time between the receiving of the customer order and the customer's receipt of the goods.
- *Delivery reliability*: reliability of keeping the delivery time agreed upon
- *Constitution of delivery*: constitution which indicates in how far the delivery itself is a reason for complaint. It depends on the *accuracy of delivery* with respect to kind and quantity, and on the *state of delivery* which is determined by the extent to which the packing achieves its security function.
- *Flexibility of delivery*: ability describing the extent to which the order processing system can serve particular demands of the customer

The logistics performance components just mentioned offer detailed starting points for process-oriented evaluations including cost calculations within management accounting. However, this rigid conception of performance components is too categorizing and too limited in several aspects to integrate different ideas about aspects of the value creation in the supply chain which could be relevant for management. For example, it is difficult to include the role of knowledge and employee motivation or the managerial and administrative performances which are above all of particular importance in the framework of interorganisational cooperations. Especially, the cross-functional and cross-organisational interdependencies of logistics processes, which become evident when applying an integrated supply chain perspective, show that performance measurement confined to the assessment of original logistics activities does not sufficiently capture the interdependencies with non-logistics activities, although this would be necessary to optimize the supply chain from a systemic- and flow-oriented point of view. Therefore, the concept of logistics performance has to be further developed into a concept of supply chain performance, striving towards a reasonable combination of logistics and non-logistics indicators in an integrated system of performance measurement. If, for example, the delivery reliablity is connected with the market share, the attention of the manager can also be drawn to those alternatives which might lead to this goal and do not normally fall within the orignial scope of logistics (CAPLICE / SHEFFI 1995, p. 74).

In an enlarged understanding of the term we could define supply chain performance with the help of a number of specific dimensions, like effectiveness, efficiency, quality, productivity, working climate, innovation or rentability. Such definitions if they are formulated as being of general validity, are questionable, because it is not clear who measures what, why, when, how and why precisely with the specified dimensions. However, if we do not assign general validity but specific situation-related relevance to a well-justified choice of dimensions, a more flexible and practical concept of performance would be provided. Performance is thus not tightly defined. Instead, "the question of how good performance is to be defined is one which is open to continual debate, choice and amendment within the organisation. At any one time the dimensions being emphasised are likely to be multiple, partially conflicting and often ambiguous" (OTLEY 1995, p. 49). Defining supply chain performance by using some performance dimensions will therefore put the sense and functionality from the point of view of the user in the first place (ECCLES / NOHRIA / BERLEY 1992, p. 146).

ii. Goals and Functions

Performance Measurement in global supply chains basically aims to support processes of problem solving and decision making by providing empirico-conceptional information about supply chain processes. It simplifies and refines the communication of information about supply chain performance between people who are interested in the value creation of the supply chain because it can make visible its processes and effects from different view-points and provides the terms and results of measuring. It thus creates a basis for the evaluation of the consequences of supply chain decisions and their premises. In constructing a transparent picture with the help of relevant performance dimensions, it supports the planning, coordination, organisation and control in global supply chains. More detailed the following functions can be distinguished (BALLOU 1992, p. 639, CAPLICE / SHEFFI 1995, p. 61):

- Provision of information and transparency
- Support of monitoring and attention directing
- Problem recognition and early warning
- Analysis of cause and effect relationships
- Support of control activities
- Support of research and development activities
- Basis for performance evaluation of managers and employees.

It is a vital part of the control process, and one with which accounting is particularly concerned, to measure the actual performance so that it may be interpreted and compared with what is desired, expected or hoped for. However, it is important to stress that performance measurement is only one stage in the overall control process in global supply chains; it is also necessary to set standards and to take appropriate action to ensure that such standards are attained. Performance measurement is only a part of a whole performance management cycle (EMMANUEL et al. 1990, p. 31, KAPLAN / NORTON 1996, p. 8).

iii. Problems of Interdependencies from a Supply Chain Point of View

Supply chain processes are produced along the whole value chain reaching from the suppliers, logistics service providers and producers to the retailers and consumers. The division of labour within and between these members of the supply chain network generate functional and organisational interfaces, which organisationally separate interdependent operational and logistical activities (principle of responsibility centres). For the performance measurement in the global supply chain one has to find ways and means to account for these interfaces. By ignoring them one risks to develop and interpret measures in isolation for the support of decisions in individual sections, which can lead to the realisation of local optima. These local optima, however, need not necessarily sum up to a systemic optimum for the whole supply chain, since numerous interdependencies between the single processes exist. The decision to reduce the stocking costs in one section by lowering the amount of goods stored, for example, can lead to higher transport costs in another section. These tradeoff relations do not only exist between different cost measures or their quantitative components. They can be found as well between costs and service measures and in relation to the measures of the various other performance dimensions like employee qualification, customer satisfaction or innovation. It is important to consider the interactions between logistics subsystems, but those between logistics and other parts of the organisation like production and marketing as well as in relation to the other members of the supply network. The performance measurement therefore has to achieve an integrative coordination between the segments of the supply chain in order to avoid suboptimal island solutions and to obtain a systemic and flow-oriented optimisation of the added value (DELFMANN 1999, p. 45, PFOHL 1994, p. 203, HARLAND 1996, p. 69).

b) Instrumental Aspects

i. Concept of a Process- and Problem-oriented Balanced Scorecard

Knowlegde is always limited from a consciously or unconsciously taken subjective perspective of the observer. In order to gain a profound insight into facts and to weigh different arguments against each other, it is therefore necessary to direct various perspectives on facts. This basic idea can also be applied on performance measurement in the global supply chain, which becomes particularly evident in the concept of the balanced scorecard developped by Kaplan and Norton. The balanced scorecard is balanced in so far as it integrates multiple perspectives, dimensions and measures into a single instrument. Strategic aspects can be balanced with operational ones, internal with external, financial with non-financial, cooperative with competetive, and integrated with non-integrated ones (MORGAN 1988, p. 477, KAPLAN / NORTON 1996).

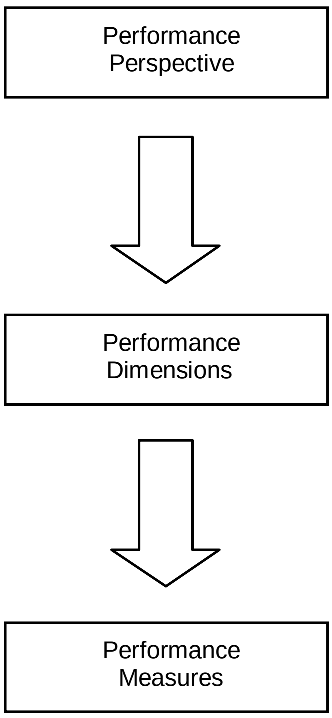
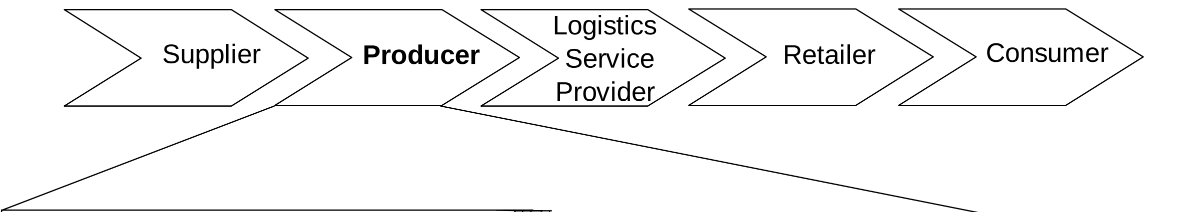


Figure 38: The design logic of performance measurement

The design logic of a performance measurement system by means of the balanced scorecard corresponds in essence with the critical success factor approach. Starting from a relevant strategic *performance perspective* (like e.g. the customer, employee, innovation, financial or resource perspective), one derives the most important *performance dimensions* (i. e. the key success factors, like efficiency, quality etc.) from the strategy of the entreprise as well as from the actor's understanding of cause-and-effect-relations of performance in the supply chain. Afterwards, one formulates concrete goals for these performance dimensions. These are finally operationalised with a limited number of *performance measures*, for which one has to define goal values and with which the goal attainment can be controlled.

It seems reasonable to modify the original concept by KAPLAN and NORTON to such an extent that it better suits the processual character of the activities in the supply chain. By this the conflict area of a vertical disintegration and a horizontal reintegration along with the interdependencies involved can be adequately taken into account. It must be stressed, too, that a performance measurement system has to be situation- or better problem-specific in order to be relevant. The choosen perspectives, dimensions and measures underly a continuous learning process, consisting of the design, implementation, analysis, amendment and redesign of the components (ECCLES / PYBURN 1992, p. 44; WICKINGHOFF 1999, p. 85).



Main Process 2: Commissioning

Perspectives/ Success factors	Input	Process	Output	Outcome
• Customer - Delivery reliance	• Number of free capacities • Index of employee qualification	• Time of commissioning	• Percentage of on-time deliveries	• Number of complaints • Satisfaction value of the last survey

Figure 39: A process-oriented design of a balanced scorecard

ii. Method for Developping an Integrated Performance Measurement System

The development process of a meaningful performance measurement system can be described by the following steps:

1. Problem recognition
2. Goal setting for the performance measurement system
3. Determination of the supply chain process or, respectively the object of measurement

4. Deduction of performance perspectives, dimensions and measures from the strategy (top-down) and from the operational processes (bottom-up)
5. Formulation of hypotheses about cause-and-effect-relationships in order to select and assemble the relevant performance measures
6. Determination of the measuring modalities (techniques, periodicity, addressees etc.) and the documentation
7. Adaptation of the incentive systems
8. Continuous examination of the validity and further development or reconstruction of the performance measurement system.

These steps should be guided by some normative criteria which can help the manager or employee to construct the performance measurement system as well as to evaluate its status quo and possible alternatives to it. These requirements will be assembled in the next section.

iii. Criteria for an Active Management of Performance Measurement Systems

The single performance measures are the building blocks of every performance measurement system for global supply chains. Since theory and practice have already produced a great number of measures, the problem is not so much the invention of new metrics. Rather, an active management of performance measurement systems should try to evaluate and consistently arrange the measures keeping in mind that organisations often dispose of a great amount of data and information for these ends. The criteria in Table 7 can be helpful to evaluate the qualities of supply chain performance metrics.

Criterion	**Explanation**
Behavioural Soundness	The metric minimises incentives for counter-productive acts or game-playing and is presented in a useful form.
Compatibility	The metric is compatible with the existing information, material, cash flows and systems in the organisation.
Economy	The benefits of using the metric outweigh the cost of data collection, analysis, and reporting.
Integration	The metric includes all relevant aspects of the process and promotes coordination across functions and divisions.
Level of detail	The metric provides a sufficient degree of granularity or aggregation for the user.
Robustness	The metric is interpreted similarly by the users, is comparable across time, location, and organisations, and is repeatable.
Usefulness	The metric is readily understandable by the decision maker and provides a guide for action to be taken.
Validity	The metric accurately captures the events and activities being measured and controls for any exogenous factors.

Table 7: Criteria for the qualities of supply chain performance metrics (CAPLICE / SHEFFI 1994, p. 14)

For the construction and management of a performance measurement system it is not sufficient to make requirements for the qualities of the single performance measures. The diverse and complex operative and logistics activities also demand a sophisticated arrangement of well-selected measures, which are complementary to each other and which can convey a well-balanced impression for the evaluation of the supply chain performance. The criteria in Table 8 are useful to create such a coherent system of measures.

Criterion	Explanation
Causally-oriented	The measurement system tracks those activities and indicators that influence future as well as current performance.
Comprehensive	The measurement system captures all relevant constituencies and stakeholders for the process.
Horizontally integrated	The measurement system includes all pertinent activities, functions and departments along the process.
Internally comparable	The measurement system recognises and allows tradeoffs between the dimensions of performance.
Multidimensional	The measurement system is multidimensional if the performance is captured from serveral different perspectives, dimensions and measures.
Problem-oriented	The measurement system is problem-oriented if it is designed according to the specific requirements of the problem.
Useful	The measurement system is readily understandable by the decision makers and provides a guide for action to be taken.
Vertically integrated	The measurement system translates the overall firm strategy to all decision makers within the organisation and is connected to the proper reward system.

Table 8: Criteria for the arrangement of supply chain performance metrics (CAPLICE / SHEFFI 1995, p. 63 ff.)

c) Usage-Related Aspects

The possibilities to use performance measures for management purposes depend largely on the user's profound understanding of the process for which the measurement system has to be designed. The measurement system can either be used to operationalise and control critical success factors of a well-known process or it can serve to explore new, insufficiently understood problems. According to SIMONS, one can distinguish a diagnostic and an interactive use of performance measurement systems (SIMONS 1995, p. 59 and 91).

i. Diagnostic Use of Measures

Diagnostic control systems are those formal information systems which enable managers and employees to assure the attainment of the goals which have been translated from the strategy into concrete performance objectives. The diagnostic use of performance measurement systems in global supply chains serves to monitor the efficiency and effectiveness of supply chain processes by measuring the actual values against defined standards and to take standardised corrective action, in case of deviations from the predetermined course. However, this type of use presupposes a sound knowledge of the process as well as of the relevant data, alternatives and cause-and-effect-relationships of the problem. If one of these parameters is not clear or missing, the diagnostic use of rigid, predetermined rules and programmes to answer a deviation is misleading. In those situations, the management does not possess the necessary knowledge about how performance can be enhanced and doubts if the measures and objectives once defined can still be used. The mode of use then has to be changed from the rather exploitative diagnostic use to the more explorative interactive use (SIMONS 1995, p. 59).

ii. Interactive Use of Measures

In contrast to the diagnostic control systems, the interacitve ones are those formal information systems which are used by managers and employees to cope with new, unique and complex situations. The interactive use of performance measurement systems in global supply chains serves to analyse the status quo and its assumptions. Further, new possible developments and options of action employing the measures to engage in a creative dialogue between managers and employees have to be explored. This interactive use does not necessarily need new performance measures. Rather, the system should be highly flexible so that it permits to question the data, premises and action plans of the situation and to create new scenarios about possible cause-and-effect-relationships as well as about new courses of action. The active participation of the affected employees can not only enrich the required infomation basis, but also improve their motivation (SIMONS 1995, p. 91).

	Diagnostic Use	**Interactive Use**
Process-type	Routine-process: Existence of sufficient problem-solving-knowlege	Innovative process: Incomplete or unknown problem-solving-knowledge
Process-planning	Analytical: Translating strategies into action, i. e. goals and measures	Creative, dialogue-oriented: Search for new goals and action-concepts
Process-coordination	Formal and standardised	Informal, self-coordinating
Process-control	Measurement of actual values, comparison with standards and initiation of corrective action	Trigger of debates between management and employees, support of learning processes

Table 9: Diagnostic and interactive use of performance measurement systems in global supply chains (SIMONS 1995, p. 124)

Ideally, there should be a balance between the exploration of the unknown future and the exploitation of the existing process knowledge of the past. The vision is that of a self-organising team which controls its own operations by means of self-constructed and managed performance measurement systems (JOHNSON 1992, MEYER 1994, p. 94).

E. Conclusion

In the previous chapters we have depicted the concept of global supply chain management. It became clear that supply chain management and a broad based understanding of logistics as a special approach to management are basically synonymous. Supply chain management promotes a more integrated view of relations and processes in and between companies, in order to gain and sustain competitive advantage for the participating companies.

It should be noted that the way to more intensive integration is not always intended. As we have pointed out before, longer lasting and more integrated partnerships may result in benefits for the partners. However, the benefits of integration have to be compared to its costs which are not always offset by the benefits. These may lie in increasing inflexibility and decreasing freedom for the single firm as well as costs of coordination which occur in such interdependent partnerships (see PORTER / FULLER 1986; HERTZ 2000).

In the ever accelerating globalization process, the integrative supply chain management concept seems to promise success for the implementing companies. But we have also presented major problems of the SCM concept. These problems might be differentiated into two levels. The first level might be referred to as the theoretical or conceptual level. Here, as we have pointed out before, there is still no commonly accepted view of the SCM concept itself. The proposition we presented here might be of help in that respect. It includes the constitutionary elements which are the commonly accepted elements of SCM and provides a fundament to build further research on. Problems on the second level, which might be called the applicational level, can be seen as originating in questions of SCM implementation or application, such as the distribution of benefits, risk management, performance measurement, etc. We gave an introduction and illustrated selected aspects of these problems. However, further research is necessary to improve on both levels.

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