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How to improve supply chain flexibility using strategic supply chain networks

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Abstract In many industries supply chain flexibility is becoming a more and more important concept for gaining competitive advantages. By the design and use of strategic supply chain networks significant improvements of supply chain flexibility can be achieved. The article identifies resources, objects and parameters of supply chain flexibility and highlights the potentials of a strategic supply chain network to realize high supply chain flexibility. The findings are relevant for both scientists and practitioners, who are interested in supply chain management. It is demonstrated how to manage the structural, technological and human potentials of the strategic supply chain network to gain outstanding supply chain flexibility.

Keywords Supply chain management · Supply chain flexibility · Strategic supply chain networks · Flexibility potentials

1 Problem description

In the current market, business is characterized by a great division of labor. Manufacturing depths in enterprises are often lower than 25%. Furthermore, globalization and competition require international distribution and/or procurement of products and services in less time. This leads to intense competition, which forces enterprises to simultaneously control costs, quality and speed [27, p. 141]. Apart from that, in many sectors in which the customers require wide-ranging product variety, the demand for goods is difficult to predict [10, p. 171]. According to the specialization of enterprise, robust concentration on core competencies is essential. Enterprises are forced to streamline their efforts in order to achieve significant, comprehensive cost reductions; reduce their utilization of resources, shorten the cycle times and reduce inventories all while improving their service simultaneously [12]. These tasks translate into immense challenges for corporate management, which requires the optimization of frictions in the production and logistics processes, as well as the establishment of continuous materials and information flows along the value-added process. A single company cannot meet these requirements alone [40, p. 40].

Supply chain management (SCM) is a suitable concept to meet these difficult requirements [22, p. 65]. The objective of supply chain management is the strategic and operative planning and controlling of materials and service flows, including the associated information and money flows along the entire supply chain. In SCM, not only the first tier suppliers, but also second and third tier suppliers, along with the second and third tier customers—up to the final consumer—all have to be integrated [7, p. 1]. The whole value-added process has to be planned and realized by all of the companies in the supply chain and has to be directly generated based upon the customers' demands. In doing this, an improvement in customer orientation can be achieved, as can the alignment of supply with demand, the reduction of stocks along the value chain, and a flexible and appropriate production level [1]. The single enterprise is no longer at the centre of considerations, because an integrated view of the value chain is now taken. Accordingly, the aspiration of achieving the optima in single

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enterprises, in which a total optimum in the supply chain is desired, has to be put aside. Suboptimal occurrences within single enterprises must be compensated for using suitable equilibrium mechanisms.

The basic target of SCM consists in the effective design and efficient optimization of the entire supply chain. For this purpose, strategic and long-term cooperation and/or networks have to be established between the companies involved in the value-added processes [34, p. 495]. All of the enterprises involved have to concentrate on their core competencies, and they have to incorporate them in a cooperative manner with the network participants. For this purpose, every enterprise must be willing to open its boundaries to its partners. Furthermore, the cooperation is not automatically based on long-term contracts; however, trusting agreements are very important. In order to achieve common competitive advantages a high level of integration of all partners is imperative. The actions of integration involve, for example, the design of inter-organizational planning and controlling systems, the product design process, stock management, the cooperative design of packages, the integration of common logistics service providers, as well as the synchronization of transports [41, p. 1034].

Up to now, it has been the cost, time, quality and service aspects that have been discussed in the context of SCM. In addition, flexibility in the vital success factors is a critical turnkey in the actual business environment [18]. It is important to consider that it is insufficient to improve flexibility in only one single company of a supply chain. An improvement in the flexibility of an entire supply chain is necessary to achieve remarkable performance results. We call this flexibility of supply chains, or supply chain flexibility (SCF) [8, p. 235].

In this contribution we will investigate the actual scientific literature that addresses the topic of supply chain management and supply chain flexibility to find out the basic definitions, assumptions and possibilities for the realisation of supply chain flexibility. Adapted on a literature review we will present some conceptual considerations as to how to improve SCF using strategic supply chain networks.

2 Basics of flexibility and supply chain flexibility—a literature review

We define flexibility as the ability of a system to perform proactive and reactive adaptations of its configuration in order to cope with internal and external uncertainties. The great importance of flexibility is evident [19, p. 1]. It has been proven for different industries by Vickery et al. [43, p. 16] and Mártinez and Pérez [29, p. 681] that flexibility itself—and the flexibility of the supply chain in particular—are significant turnkeys to the company's financial performance.

The main drivers for the importance of SCF are the increasing complexity of the value-added processes and the shortening of response times to demand changes [44, p. 599]. The complexity of business processes is increasing as companies attempt to respond to their customers' needs with an increasing number of highly customized products. At the same time, the offered products themselves are becoming increasingly complex. This complexity results from the different embedded technologies. A single company can no longer produce or handle these technologies alone. The general trend of outsourcing and decreasing the vertical range of manufacturers intensifies this phenomenon. Thus, complexity is driven by the strong need for coordination in the value-added processes [37, p. 177]. Another point that contributes to this is that service is becoming increasingly important in the customers' eyes. Products sold are no longer just the physical objects, but are now a bundle that includes the product itself and the attendant services. For example, the customers' needs for pre- and post-sales information or the disposal of products after their lifetime is becoming a critical factor for companies. These product services often cannot be supported alone by an original equipment manufacturer and have to be provided in cooperation with two or more companies. Coordination is a necessity that drives complexity, and thus underlines the importance of SCF.

A fast response to changing demands is the second critical driver of competitive advantage in today's markets. Customers expect their needs to be satisfied at the time of their expression. Companies therefore must have quick response times to changing needs, in order to gain or hold market-shares [39, p. 62]. However, this requirement is difficult to accomplish because it runs into the problem of complexity that we mentioned previously.

Vickery et al. [43, p. 16] define supply chain flexibility as encompassing those flexibility dimensions that directly impact firms' customers and that are the shared responsibility of two or more functions along the supply chain, whether internal or external to the company. We classify this definition as a very general one. Duclos et al. define SCF more precisely as the flexibility within and between all of the partners in the chain, including departments within and between an organization, and the external partners, including suppliers, carriers, third-party companies, and information systems providers. These authors underline the idea that SCF includes the flexibility to gather information on market demands and the exchange of information between organizations [13, p. 450]. We agree with this definition, but emphasise that we regard SCF to be based on the embedded resources and on the designed

network structure of the supply chain [46, p. 75]. Table 1 provides an overview of important works dealing with SCF.

Supply Chain Flexibility can be seen as an ability of a supply chain that helps to gain competitive advantage and improve success. To improve the flexibility of a supply chain we suggest building up and using certain supply chain networks. By configuring supply chain networks it is possible to design and manage an important part of an entire supply chain. Within supply chain networks specific flexibility potentials can be developed to realize a high degree of supply chain flexibility.

3 Creating strategic supply chain networks to improve supply chain performance

3.1 Basic assumptions for the creation of strategic supply chain networks

A strategic supply chain network is characterised by a selected circle of supply chain members, a collective identity, an internal role differentiation and power division, the delegation of responsibility, its' limited permanence, the possibility to transpose members, and a rational procedure for the realization of common targets executed by all of the participating companies. The strategic supply chain network is a virtual organization because every embedded member remains independent while participating in the network [45, p. 45]. A distinction of the strategic supply chain network is that the members participate in a high level of communication and arrange common strategic and operative measurements to improve performance in logistics, production and customer services. Consequently, the strategic supply chain network can act as if it were one independent enterprise. This new organizational point of view opens a wide range of possibilities to accomplish the integration of SCM [9, p. 206]. The possible structure of a strategic supply chain network is depicted in Fig. 1.

To design and manage a strategic supply chain network, the SCM has the task of first establishing an effective structure within the supply chain, and secondly, to guarantee on an efficient performance. The tasks of an SCM can be assigned to the life cycle. It is here that we differentiate between the stage of design, performance, development and termination. Furthermore, regarding the management tasks, we have to distinguish between strategic and operative tasks [7].

In the design stage, exemplary important strategic tasks are the selection of the appropriate partner enterprises, the evolution of a common target system as well as the evolution of a common strategy. Constructing a strategic supply chain network normally begins on the initiative of an original equipment manufacturer (OEM). In these beginning stages, it is essential for the OEM to find eligible partners that fit into the scope of the strategic concept for a strategic supply chain network [23, p. 1]. These partners must have complementary competence profiles, along with the ability and intent to cooperate intensively with other companies. Selected managers of the OEM and the partner companies form the lead committee of the strategic supply

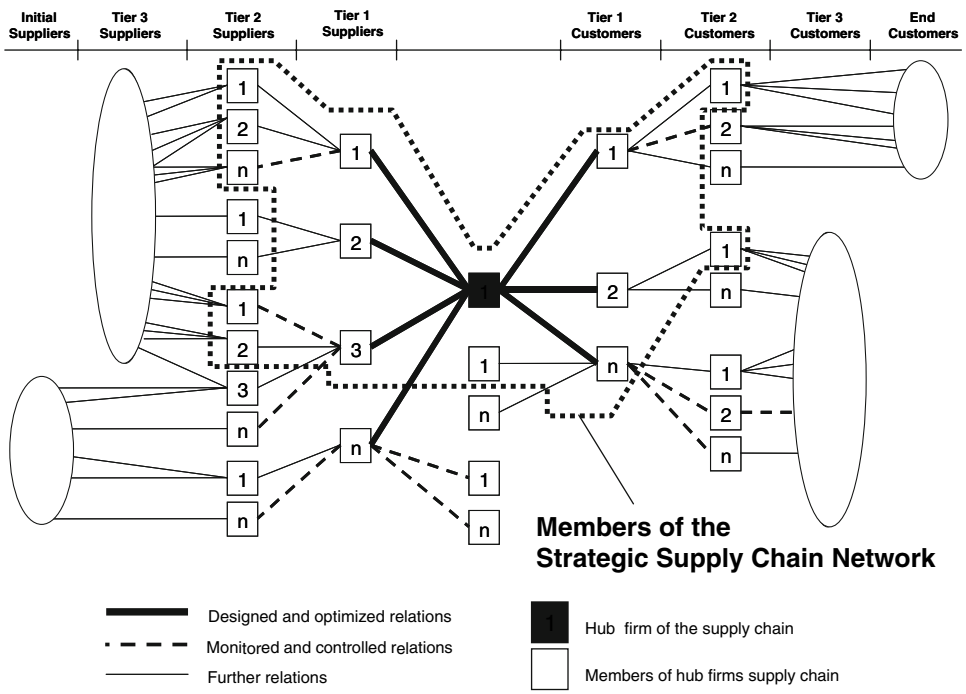

Fig. 1 Possible structure and members of a strategic supply chain network

Table 1 Literature review on supply chain flexibility

Authors	Definition of supply chain flexibility	Described dimensions of supply chain flexibility	Findings
Vickery et al. [43]	"Those flexibilities, that directly impact a firm's customers (i.e., flexibilities that add value in the customers' eyes) and are the shared responsibility of two or more functions along the supply chain, whether internal (e.g., marketing, manufacturing) or external (e.g., suppliers, channel members) to the firm"	Product flexibility Volume flexibility Launch flexibility Access flexibility Responsiveness to target markets	Superior performance in flexibility capabilities impacts a firm's bottom line Not all dimensions of supply chain flexibility have same impact on performance Different functional areas within the company influence different dimensions of supply chain flexibility
Duclos et al. [13]	"Flexibility in the supply chain adds the requirement of flexibility within and between all partners in the chain, including departments within an organization, and the external partners, including suppliers, carriers, third party companies, and information systems providers. It includes the flexibility to gather information a market demands and exchange information between organizations"	Operations system flexibility Market flexibility Logistical flexibility Supply flexibility Organizational flexibility Information systems flexibility	Conceptual model of supply chain flexibility The authors underline the importance of inter-company dimensions of supply chain flexibility
Garavelli [15]	"Ability of a supply chain to properly and rapidly respond to changes, coming from inside as well as outside the system"	Process flexibility Logistical flexibility	Supply chain flexibility must be realized by coordinated arrangements throughout the entire supply chain (synchronization) Supply chain configurations with limited flexibility provide relatively better performance than configuration with no or total flexibility considering the trade-off between costs and flexibility Improvements in a supply chains' upstream flexibility capabilities tend to lead to better results than downstream activities
Das/Abdel-Malek [10]	"Supply chain flexibility is the elasticity of the buyer-supplier relationship under changing supply conditions" Supply chain flexibility arises when there is only little deterioration in the procurement price and penalties under different supply chain conditions	Delivery lead time flexibility Order quantity flexibility	Measure to estimate supply chain flexibility within the buyer-supplier relationship as a function of constraints on delivery lead times and order quantities Flexibility potentials of supply chain partners can be estimated and used as criteria in supplier selection processes
Barad/sapir [2]	The authors discuss flexibility in logistics systems as those capabilities that enable stable performance under changing conditions like changes in demand or interference in demand or supply activities	Basic flexibility (product flexibility, requirements flexibility) System flexibility (trans-routing flexibility, product postponement flexibility) Aggregate flexibility (flexibility to change long term decisions)	Positive correlation between a superior performance in flexibility capabilities (esp. trans-routing flexibility) and firm performance Measurement of flexibility possible via the measures range and response dimensions The higher the uncertainty the more important are the flexibility dimensions

Table 1 continued

Authors	Definition of supply chain flexibility	Described dimensions of supply chain flexibility	Findings
Lummus et al. [28]	"Supply chain flexibility is defined as the supply chain's promptness and the degree to which it can adjust its supply chain speed, destinations and volumes in response to changes in customer demand"	Refer to the conceptual model and proposed flexibility dimensions from Duclos et al. [13]	Theoretical discussion of possible benefits from flexible supply chains, e.g., improved customer satisfaction, lower inventories, positive relationship between each node of the supply chain and supply chain flexibility, positive relationship between IT-systems and supply chain flexibility,…
Martínez/Pérez [29]	Use the definition for supply chain flexibility from Vickery et al. [43]	Basic flexibility/shop floor level	Positive relation between a superior performance in flexibility capabilities and firm performance
		Product flexibility volume flexibility Routing flexibility	Greater uncertainty as perceived by managers is associated with greater emphasis on supply chain flexibility
		Systems flexibility/ company level Delivery flexibility	Aggregate flexibility capabilities are more positively related to firm performance than basic flexibility capabilities, but companies tend to enhance mostly basic flexibility capabilities
		Transshipment flexibility	Not all characteristics that enhance supply chain flexibility can be influenced by a single companies' strategy or policy
		Postponement flexibility	Higher interdependence between companies or use of information technologies can reduce the need for flexibility capabilities
		Aggregate flexibility/supply chain level Launch flexibility Sourcing flexibility Response flexibility Access flexibility	Environmental uncertainty increases the need for flexibility capabilities

chain network. This committee assigns the management team for the strategic supply chain network. The management team develops a common target system for the evolution and the administration. According to the targets, special competition strategies should be elaborated. It is necessary to analyze at first which success factors could be used in order to generate competitive advantages. Regarding the attained success factors, the potential to achieve the success factors, such as information and communication technologies (ICT), R&D, production technologies, logistics systems, and human potentials, all have to be considered. In order for crucial competitive factors in a branch to be realized, these potentials must be exploited (e.g. low costs, high flexibility, a great service level, as well as short cycle times and high product quality). The analysis of the success and competition factors and the strengths and weaknesses of potential partners is vital for the configuration of the strategic supply chain network. In order to determine the targets and strategies we have to differentiate between the "network level" and the level of the "individual actors." Goal conflicts frequently exist between these two levels. The management team of the strategic supply chain network must resolve these goal conflicts [36, p. 1].

In the performance stage, mostly operative tasks are carried out. These include the planning, controlling and coordination of the value-added processes and the service activities along the entire supply chain. For the purpose of achieving the common targets specific inter-organizational planning, controlling and coordination systems are required. In this context, we propose to resort to advanced planning systems (APS), which enable the planning and controlling of production and logistical processes along the supply chain. The emphasis of the advanced planning systems is the optimization of cycle times, stocks and capacities [42, p. 179].

Due to the constantly changing conditions of competition and/or fluctuating interests of the partners in the strategic supply chain network, special adaptations are sometimes necessary. This phase is called the developing

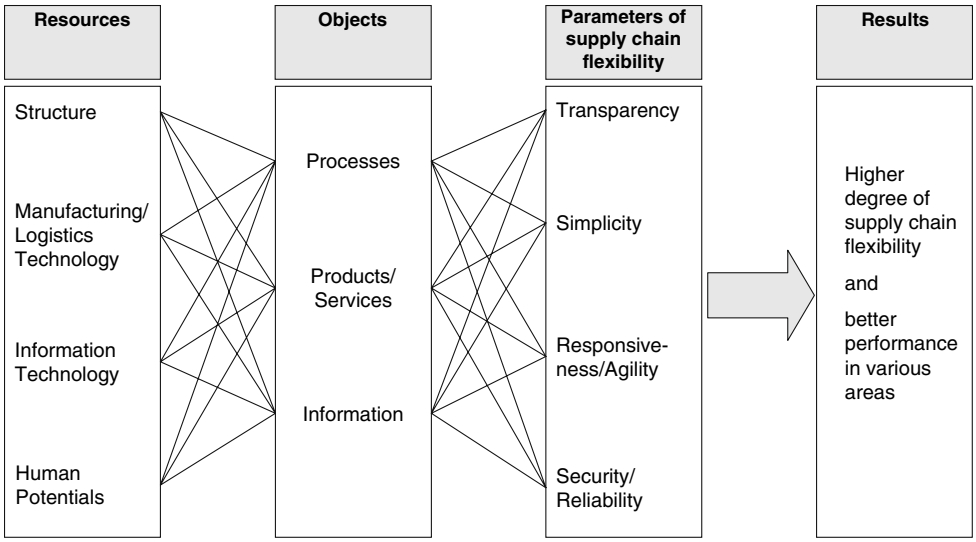

Fig. 2 Resources, objects and parameters of supply chain flexibility

stage which cannot be separated from the performance stage because the processes in the strategic supply chain network continue working. Changes in the structures and the resource bases have to be managed in order to avoid negative influences on performance. Some business relations will be terminated while others will be established. In the case of the termination of individual relations, dissolution processes have to be undertaken [45, p. 40].

3.2 Using strategic supply chain networks for raising supply chain flexibility

The resources of a strategic supply chain network offer potentials for the improvement of SCF. We differentiate between structural potentials, potentials of manufacturing/logistics technologies, potentials of information technologies and human potentials. These resources act on certain flexibility objects. Here, we understand that those objects in the strategic supply chain network have to be modified to increase SCF. Flexibility objects in the strategic supply chain network are the processes, the products or services and the information. As a consequence of the modification of the flexibility objects by the previously mentioned resources, flexibility parameters will be optimised. The important flexibility parameters are transparency, simplicity, responsiveness/agility and security/reliability [33]. Flexibility parameters generally determine the level of achievable SCF in the strategic supply chain network. The flexibility parameters are connected in a multiplicative manner. This means that if one parameter goes to zero, the SCF also tends to shift to zero. Generally, an improvement in SCF results in superior financial performance for each partner in the strategic supply chain network [4, 16]. Either higher revenues are generated with the same costs, or existing revenues can be achieved with lower costs. Figure 2 depicts this.

The embedded resources in a strategic supply chain network offer great potentials for the improvement of SCF. To utilize existing and new potentials in structure, manufacturing/logistics technologies, information technologies and human resources different measures have to be implemented by the SCM. However, this general recommendation implies an essential problem. Decision makers have no indication which measures would drive SCF. This existing information lag regarding the flexibility-increasing effects of SCM-invoked measures needs to be resolved. Therefore, to improve SCF, a framework has to be developed that assesses alternate SCM measures concerning their effects on SCF.

The initial point for the desired framework that enables an indication of SCF is a system of flexibility relevant parameters. These parameters are influenced by the existing system elements of a strategic supply chain network. As already mentioned and displayed in Fig. 2, some of those elements are the network objects like processes, products/services and information. Additional also resources and partners are elements of a strategic supply chain network. To ensure that only relevant and susceptible elements are considered, the research range has to be clearly delimited. In our contribution, we defined four parameters that are based on these network elements in the delimited research range: transparency, simplicity, responsiveness/agility and security/reliability. Through identifying and displaying occurrences, correlations and behaviours of and between the elements, those parameters enable conclusions to SCF. It is important to mention that strategic supply chain networks in different industries have specific problems and characteristics. To plan improvement measures, we suggest that analyses should be performed to identify which measures would be most effective to realize a high SCF. Therefore, transparency, simplicity,

responsiveness/agility and security/reliability should be evaluated.

The transparency (T) of a system is determined by the degree of knowledge of the system elements. A high level of opacity hampers SCF. Therefore, to achieve a higher level of transparency and higher SCF, it is of the utmost importance that process owners possess a unique knowledge of the elements in the SC. The assessment parameter transparency is defined through the comparison of known system elements and the entirety of elements.

$$T = \frac{\sum_{j=1}^{n} \text{known SC elements}_j}{\sum_{i=1}^{m} \text{SC elements}_i} \times 100$$

Additionally, it is necessary to mention that a high level of transparency can only be reached if elements in all the categories (information, products/services, processes, resources and partners) are well known. If the degree of knowledge in one of those categories is limited, the whole system opacity rises. Thus, a balanced knowledge across all categories generates the best results in terms of transparency and SCF.

Simplicity (S) is the opposite of complexity. Complexity results from a high number of elements and their behaviours in a certain system. In a system with fewer elements and traceable behaviour, simplicity is high and complexity is low. A complex network hampers fast alignments of the embedded system elements due to potential environmental changes. To improve SCF, it is useful to diminish the relevant system elements in a strategic supply chain network.

$$S = \frac{1}{\sum_{i=1}^{m} \text{SC elements}_i} \times 100$$

The parameter responsiveness/agility (RA) enables an inference of the strategic supply chain network's ability to adjust its output in order to response to changed market requirement. The prerequisite for a high responsiveness/agility of a strategic supply chain network is the standardization of the network elements and their exact definition. Thus, the responsiveness/agility refers to the comparison of defined elements relative to the entirety of the elements.

$$\text{RA} = \frac{\sum_{j=1}^{n} \text{standardized SC element}_j}{\sum_{i=1}^{m} \text{SC element}_i} \times 100$$

Security/reliability (SR) is based on the quality of the system elements. Therefore, we have to consider the special criteria of the processes, products/services, necessary information and required resources/partners. Processes are of high quality if occurring changes do not disrupt material and information flows. Regarding products and services, high quality is reached by diminishing technical failures. High information quality is the basis for efficient and effective planning and steering. High quality of all system elements enables the consistent high performance of the supply chain in changing conditions. Therefore, security/reliability is a fundamental prerequisite for a high degree of SCF.

$$\text{SR} = f(\text{quality of SC elements})$$

3.3 How a strategic supply chain network could influence supply chain flexibility

To attain a high level of SCF, a strategic supply chain network has to be used to build up specific flexibility potentials. We distinguish here between structural, technological and human potentials. All kind of flexibility potentials must be strategically planned as well as configured and coordinated in common to provide a high degree of supply chain flexibility at adequate costs. Figure 3 shows the context of designing flexibility potentials to realize high supply chain flexibility.

All relevant flexibility potential will now be investigated and solutions will be elaborated to provide a high degree of supply chain flexibility.

3.3.1 Structural flexibility potentials

Supply chain complexity can be reduced in the strategic supply chain network, because the specific design of this virtual organization enables a broad modularisation of customer orders [11, p. 316]. Thus, orders can be produced

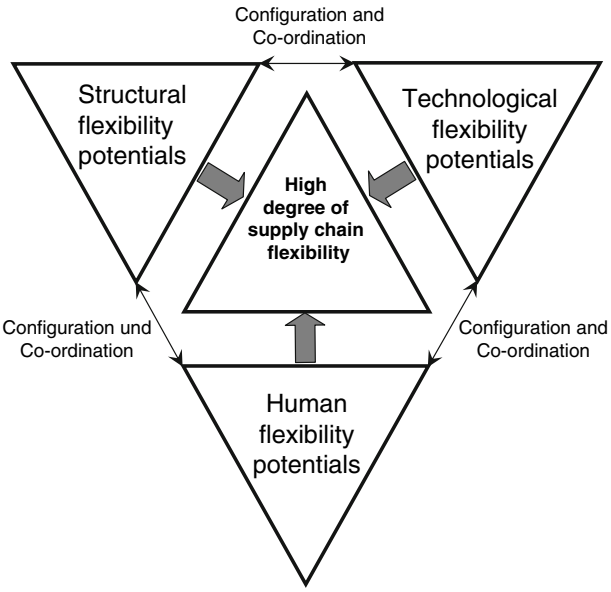

Fig. 3 Flexibility potentials in strategic supply chain networks to gain supply chain flexibility

in alternative sequences and routings through the network of partners. We call that attribute of the strategic supply chain network, the liberality of orders. This means that selected partners can independently handle specific parts of a customer's order, in which they are fully responsible for the order's fulfilment [26, p. 432]. Based on the core competencies of the partners, they coordinate all of the value-added processes upstream within their supply network: First, they configure their supply network on demand by matching the characteristic requirements (capacity, technology etc.) of a specific order to their suppliers' performance profiles. This task can be executed very quickly because the partners in the strategic supply chain network refer to a pool of pre-selected suppliers that they have strategically built in advance. Therefore, with their extensive knowledge regarding the capabilities of their potential suppliers, they can select the best suppliers for each order with relatively little effort. In the next step the suppliers with the best matching performance profiles are activated to participate in the value-added process for the specific order. From this point of time, the supply-demand-relationship is established and the technological flexibility potentials inherent in the strategic supply chain network enable expeditious cooperation between the partners [31, p. 330]. This course of action aids qualitative flexibility because the pre-selected suppliers in the pool provide a wide range of heterogeneous resources and capabilities, and therefore offer a high degree of preparation for varying demands to the strategic supply chain network. Quantitative flexibility results from the access to additional capacities via the integration of two or more suppliers with homogenous capabilities in the value-added process [30, p. 54].

A very important enabler for this configuration of the strategic supply chain network based on demand is a high degree of intrinsic logistical flexibility. To ensure this logistical flexibility and to realize all of the possible potentials for optimising the logistical costs, we propose to integrate fourth-party logistics providers (4PL) as partners into the strategic supply chain network. [32, p. 16] These logistics specialists have the capability to centrally coordinate and harmonize all of the logistical processes in the on demand. [5, p. 41] The main tasks undertaken by the fourth-party logistics providers are inventory management, tracking and tracing services, planning/organization of transports as well as the planning and optimization of routings for the different orders within the strategic supply chain network [3, p. 28].

In addition to the realization of these potentials to increase the SCF, the strategic supply chain network can also resort to traditional potentials such as the holding of inventories or the installation of redundant free capacities as the case arises. However, it is important to mention in this context that these actions have to be planned and determined strategically by committee leading the strategic supply chain network.

3.3.2 Technological potentials

3.3.2.1 Potentials of manufacturing and logistics technologies The manufacturing resources in the strategic supply chain network have to provide a high level of versatility to ensure a high degree of qualitative and quantitative flexibility [25, p. 328]. Qualitative flexibility connotes that different customer orders should be produced on several manufacturing systems, not only in a single company, but also by other partners. Thus, the capacity utilization within the strategic supply chain network can be harmonized, which means the partners can enlarge their capacity by resorting to a partner's free capacity or providing their own free capacity to partners. This contributes not only to the SCF, but also to the economical performance of each partner in the strategic supply chain network [6].

The management of the strategic supply chain network has to support the versatility of certain production and logistical resources. The partners have to decide whether to use flexible manufacturing systems or special devices for the order processing. It is appropriate to use both in a balanced manner. Those partners who are responsible for standard components with fewer variants should mainly use special devices to keep costs low. Additionally, they should partially invest in flexible systems to have a capacity buffer. Other partners that produce different variants must have more flexible production systems. These partners generally use flexible manufacturing systems. The optimal percentage of flexible manufacturing systems for a strategic supply chain network has to be strategically evaluated and determined [38, p. 27]. From an economic perspective, it is very useful to cooperate with some partners that hold the needed resources temporally [20, p. 466].

With a high degree of versatility of the resources used, it is possible to build a pooling and sharing system in the strategic supply chain network. Therefore, it is necessary to define standardised interfaces to enable a quick and easy connection to the logistics and information systems of the partners. The management of the strategic supply chain network has to define organizational "plug and produce" elements for order processing. This means that partners can be connected swiftly if a different order fulfilment is necessary. Free capacities of the implemented resources at the partners can be offered at an internal electronic marketplace. This makes it very simple to decide where alternative manufacturing possibilities exist. Those measures enable lower costs and a higher degree of flexibility [20]. In addition to the qualitative flexibility, the

quantitative flexibility is also rather significant. With a high degree of quantitative flexibility, the strategic supply chain network should be able to handle variable lot sizes. This problem relates to the free capacities of the resources in the strategic supply chain network.

Variable lot sizes can also be balanced with a pooling system. Therefore, it is only necessary to define "first and second-class partners." First-class partners are companies that have a high strategic relevance in the supply chain network (e.g., for R&D, sourcing of rare materials, production capabilities) and are permanently involved in most of the business relations. Second-class partners are companies that are not permanent partners in the strategic supply chain network. These companies have competence profiles that are similar to the first-class partners of the strategic supply chain network. Second-class partners do not want to become a permanent partner because they also work for competitors, or they desire to remain completely autonomous [31, p. 330] They build an important resource base that can be used to handle order peaks. It is possible that over a specific timeframe second-class partners become first-class partners of a strategic supply chain network.

3.3.2.2 Potentials of information technologies The strategic supply chain networks' information systems are an important prerequisite for the realization of its structural, technological or human flexibility potentials [14]. With their ability to quickly and cost- effectively process varying amounts and qualities of data, and to provide a high level of visibility, the information systems support for example the integration of new partners or the liberality of orders in the strategic supply chain network. The information systems of the strategic supply chain network bear the following characteristics: ability to share information between all of the partners in the value-added processes, ability to pass information along in the network and the ability to synchronize the partners' information systems [28, p. 9].

To assure these characteristics of the information systems, they have to be planned strategically in the design stage of the strategic supply chain network. This means that the interfaces of the systems have to be kept as flexible as possible to enable the exchange of data from different systems and via different technologies. This requires an inherent high degree of preparation to achieve the uncomplicated docking of a partner's information system to the systems of the other partners without creating rigid structures [17, p. 18]. The exchange of all business data via the Internet, and the communication with modern open-standard protocols such as XML offer high potential to fulfil these requirements. For the coupling of second-class partners, who only temporarily participate in the strategic supply chain network on demand, solutions such as desktop purchasing systems, Web-based marketplaces or Web interfaces for downloads and uploads should be prepared as standard solutions in the partners' IT systems. This will contribute to SCF because long set-ups and programming activities can be thereby avoided. In addition, these solutions can be used as back-up systems, in case any disturbances arise [14, p. 323].

What is important in this context is to mention that the information systems only contribute to flexibility if the information flows between and within the strategic supply chain network systems can be controlled. Not all of the partners need all of the information. Providing inexpedient information at the nodes in the network would lead to higher complexity, increased probability of failures and thus undermine the SCF. Therefore, we propose to use adequate workflow and groupware systems in order to solve these problems.

IT-service providers should be integrated as permanent partners in the strategic supply chain network. These companies have the competencies to effectively manage all of the information systems. Their integration will assist in realizing the synergy effects for all of the partners and control the costs for IT systems, because frictions and asynchronous improvements can be avoided by a centrally managed IT [24, p. 128].

As previously mentioned, advanced planning systems enable improvements of the SCF. These systems support the quick and easy configuration and controlling of network orders and therefore help to realize the flexibility potentials of the strategic supply chain network. Web-based information systems are used to quickly exchange information between partners at low costs per transaction [21, p. 49].

To emphasise the flexibility potential of the planning and scheduling systems in the strategic supply chain network, the specific planning processes in the network have to be elucidated. The contribution of the planning and scheduling processes in the strategic supply chain network to SCF results from the simultaneous planning approach. Based on the information available in the advanced planning systems, bottlenecks or restrictions to the production and logistical plans can be widely anticipated and delays in the order fulfilment are therefore avoided. Another factor that supports SCF is that the planning and simulation of alternative scenarios for the entire supply chain network enables optimal reactions to unplanned changes. This is especially true for the integration of additional partners and second-class partners with a high degree of preparation for the fulfilment of a specific contributes to flexible reactions. Additionally, reaction strategies to dissolve capacity restrictions, delays or other disturbances of the manufacturing processes are defined in the creation phase of the

strategic supply chain network. By referring back to these strategies, a network planner can quickly align the supply network on—and with—low costs. This is an important comparative advantage of the strategic supply chain network compared with traditional supply chains [35].

3.3.3 Human potentials

Both the qualifications and motivation levels of the employees have a tremendous impact on SCF. This is not only true for the operating staff, but it is also especially for the coordination-managers in the strategic supply chain network. These managers have to disseminate extensive knowledge regarding all of the value-added processes. With the aid of these coordination-managers, it is possible to expeditiously interact with other important persons. This leads to a faster and better response to unplanned events related to their manufacturing and logistics partners. Coordination-managers contribute to a high security of supply in the strategic supply chain network. To manage their job well, it is important that coordination-managers have special skills and knowledge regarding the structures, processes and relations in the strategic supply chain network. This is not only true for all duties and responsibilities on the shop floor, but also for strategic measures. With these competencies, it is possible to anticipate organizational problems that relate to order processing. To train employees, it is expedient to organize common workshops with people in different companies. In this way, personal contacts will be established and consolidated, which may also occasionally help to solve problems in more efficient ways. If finding suitable locations and times to meet is overly complicated, video conferences would be adequate viable option. This is especially true in cases where significant physical distances exist between the members [20, p. 466].

Another possibility to boost SCF is to build a pool of human resources that can be transferred to the different companies of the strategic supply chain network on demand. To enable the exchange of employees between the partners' companies on demand, complementary skills are needed. This is because the partners own similar technologies in manufacturing and logistics. Furthermore, the processes employed by partners should also be similar where possible. In addition to the value-added processes, personnel pooling and sharing could also be used for service processes such as maintenance or the configuration of IT systems. To realize these ideas at first, proper legal constructs have to be established. In many countries, it is impossible to transfer employees to other companies within a certain timeframe. Additionally, companies have to create beneficial incentives for their employees to become mobile.

Apart from quantitative and qualitative human flexibility potentials, we can identify further flexibility potentials in human related areas. We call these the "hidden potentials" because they are not obvious. These potentials have been discussed to some extent in the principal-agent theory and refer to trust and good business relationships between suppliers and buyers. If companies know each other well and appreciate their existing business relations, they perform at a higher level if the other partner requires it. For example, at peak order times partners would work harder to finish orders on time while still maintaining high quality.

4 Conclusion

In our contribution we claimed the ability to build a strategic supply chain network in order to reach a common optimum in a supply chain. The kind of optimum to reach depends on the critical success factors of a supply chain. In some branches, costs present the main success factor that determines competition. However, today in many branches besides for costs, flexibility is gaining a very important position within the realm of competition. By way of constructing a strategic supply chain network it is possible to simultaneously improve flexibility and keep costs adequately low.

The term flexibility has not been uniformly defined. There are some contributions in the scientific literature that address the flexibility topic. In our contribution we defined SCF as the ability of the supply chain to react to internal and external effects within a short time. To improve SCF a combination of different flexibility parameters such as transparency, simplicity, responsiveness/agility and security/reliability all have to be managed. The strategic supply chain network with its managed potentials and resources makes it possible to improve all of the flexibility parameters simultaneously. We defined structural potentials, potentials in manufacturing/logistics technologies, potentials in information technologies and human potentials to be used for the improvement of flexibility parameters. The target oriented management of these potentials leads to an extraordinary advancement of SCF.

Future research in this area must focus on the practical implementation of the strategic supply chain network and its advantages/barriers for modern leadership. Within empirical projects the validity of the stated arguments must be tested.

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