



## **Environmental Sustainability and Supply Chain Management**

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# Environmental Sustainability and Supply Chain Management — A Framework of Cross-Functional Integration and Knowledge Transfer

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**ABSTRACT:** The purpose of this paper is to discuss mechanisms of intra-organizational knowledge transfer within sustainable supply chain management (SSCM). Through a conceptual study design, the focus of this paper is on the transfer of SSCM-associated information and knowledge between functional units. Furthermore, the external stakeholder perspective is taken into account. To support this conceptual framework, the knowledge-based theory provides a theoretical foundation in order to study a company's ability for knowledge sharing. Within this perspective one approach distinguishes between internal and external structures and the individual competence. These findings will be used as a basis to further develop a framework of intra-organizational SSCM knowledge and information transfer as well as cross-functional integration.

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## KEYWORDS

Conceptual Paper, Cross-Functional Integration, Knowledge-Based Theory, Sustainable Supply Chain Management

## I. INTRODUCTION

The linkage between sustainability management and conventional supply chain management (SCM) has gained an increasing amount of interest in the academic and business community (Carter and Rogers; Sarkis, Zhu, and Lai; Seuring and Müller) to the extent that sustainable supply chain management (SSCM) is now seen as an established research field (Seuring). Theoretical approaches refer, for instance, to the differentiation between product- and

process-oriented perspectives on SSCM (Bowen et al.) or internal and external relationships (Harland; Lambert, Cooper, and Pagh). Nevertheless, current studies still address the need for further research, in particular with regard to an advanced building of SSCM theory and development of new concepts (Carter and Easton; Seuring). Overall, research indicates (Pagell, Wu, and Wassermann) that there is a potential shift from conventional SCM and purchasing to more sustainability-oriented efforts.

This shift can be described as a decisive move for a company's current and future procurement and supply management activities because a company often faces a high level of complexity. Such complexity can be triggered by the necessity to manage a large number of suppliers in diverse

socio-economic contexts or by a growing demand for an integration of environmental and social criteria in supply chain management (Halldórsson, Kotzab, and Skjoett-Larsen; Seuring and Müller). This integration is demanded, for instance, by customers or media (Andersen and Skjoett-Larsen; Carter and Dresner; Walker, Di Sisto, and McBain). If a company is not able to meet these requirements, it may risk a reputation loss. In contrast, however, SSCM can also create opportunities such as product and process innovations, which fit the increasing market for environmental-friendly and socially responsible products and services (Carter and Jennings; Geffen and Rothenberg; Kassinis and Soteriou). As a consequence of these challenges and opportunities, the purchasing department is involved in a dialogue not only with its suppliers, but also has to exchange information and knowledge with other departments within the same company such as research and development (R&D), production, or the sustainability department.

In this process, supply chains can be divided into external (inter-organizational) and internal (intra-organizational) components. *External supply chains* (upstream and downstream; Vachon and Klassen, “Extending Green Practices”) are characterized by the flow of materials, capital, and information between the different external partners (e.g. suppliers, focal company, retail, consumers, disposal/recycling), whereas *internal supply chains* encompass the interaction among the different functional units within the (focal) company (Harland; Lambert, Cooper, and Pagh; Seuring and Müller). Combining both supply chain perspectives implies that functional units have to exchange sustainability-relevant information internally to meet the requirements of external stakeholders (e.g. information about human rights compliance) or to comply with internal quests (e.g. reduction of CO<sub>2</sub> emissions across the supply chain).

In this paper, focusing on the necessity of

transferring internal SSCM-related information and knowledge raises the following question: *How does cross-functional integration play a role in intra-organizational transfer of SSCM-relevant information and knowledge?*

To answer this question, a conceptual framework has been developed. Although, there is a considerable interest for SSCM and for new theoretical approaches from both academic and practitioner sides (Matos and Hall; Reuter et al.; Simpson, Power, and Samson), the SSCM literature is limited with regard to a discussion of intra-organizational alignment from a theory-based perspective (e.g., Gattiker and Carter). In order to help fill this gap and to investigate SSCM with the focus on cross-functional collaboration and knowledge transfer, the knowledge-based theory (Grant; Sveiby) has been deemed suitable for this paper. This theory emphasizes the role and relevance of knowledge for a company—the “creating, storing, and applying knowledge” (Dyer and Nobeoka 345)—to gain competitive advantage (Grant; Spender). Sveiby applies this knowledge-based approach of the firm (in the following simply referred to as the *knowledge-based view*) to explore a company’s internal and external transfer as well as conversion of knowledge. However, Sveiby does not explicitly portray the intra-organizational integration or refer to sustainability issues so his model will be modified conceptually with regard to intra-organizational SSCM characteristics.

The paper is divided into five sections. After the introduction, the second section gives an overview on the background literature regarding sustainable supply chain management and cross-functional integration. The third section sketches the knowledge-based view with focus on intra-organizational aspects. In the fourth section, a conceptual framework of cross-functional integration in intra-organizational SSCM is developed and discussed with regard to corresponding

measurements. The final section draws a conclusion and points out areas for future research.

## **II. SUSTAINABLE SUPPLY CHAIN MANAGEMENT AND CROSS-FUNCTIONAL INTEGRATION**

As SSCM is already seen as an established research field (Seuring) and cross-functional collaboration has been discussed since the 1980's (Takeuchi and Nonaka), the following section provides an overview on related literature and findings in these two fields so far.

### **II.I. SUSTAINABLE SUPPLY CHAIN MANAGEMENT**

SSCM can be understood as a further development of the conventional SCM—extended by the integration of the three (environmental, social, and economic) dimensions (Carter and Rogers; Seuring and Müller). In order to outline the underlying meaning of the management concepts, this section sketches their main characteristics.

The traditional notion of *supply chain management* encompasses both the demand-oriented (downstream) and supply-oriented (upstream) processes (Cooper and Ellram; Esper et al.; Vachon and Klassen, “Extending Green Practices”), although the term literally focuses on the supplier's side. SCM aims at “delivering enhanced customer service and economic value” (Mentzer et al, with reference to La Londe). This term refers to the management of the

*activities associated with the flow and transformation of goods...as well as the associated information flows.... Supply chain management (SCM) is the integration of these activities through improved supply chain relationships, to achieve a sustainable competitive advantage* (Handfield and Nichols 2).

This definition implies that SCM can be rather complex, especially when regarding the different stages of the supply chain. The focal company has to manage not only the flow of materials and goods but also the flow of information. To achieve a proper flow, a company can use information system tools, such as enterprise resource planning (ERP) software or face-to-face interaction with external and internal members of the supply chain (Pagell).

*External* members are the different suppliers (1st tier, 2nd tier, etc.) on the supply side, whereas customers (e.g., wholesalers), consumers, and waste disposal recycling companies, respectively, are members on the demand side. Furthermore, the buying, producing, moving, storing and selling of a company are core activities that characterize the *internal* supply chain (New; Sweeney). All departments that require purchased products or services are, in the wider sense, a part of the internal supply chain. In a narrower sense, these are the functional units that participate in the internal supply chain (e.g. purchasing, manufacturing, sales, and distribution) (Harland S63). In addition to these internal supply chain members, Lambert, Cooper, and Pagh (2) included the departments' R&D as well as finance. First and foremost, the purchasing and logistics departments play the central role in the management of supply chains since they create an interface with external suppliers (Cooper and Ellram).

For several years, SCM also has been discussed with regard to environmental and social issues (e.g., Carter and Easton; Carter, Ellram, and Ready; Sarkis, Zhu, and Lai). Referring to Jayaraman, Klassen, and Linton as well as Cruz, the authors Pagell, Wu, and Wassermann (58) argue with regard to SSCM that

*evidence is growing that the field is reaching a critical tipping point where wide-scale adoption of sustainable sourcing practices may potentially become a dominant dynamic in the supply chain context.*

This further development of SCM leads to a more comprehensive understanding of SSCM. In line with the triple bottom line approach and the notion of sustainable development (Elkington; Kleindorfer, Singhal, and van Wassenhove; Schaltegger and Burritt, “Corporate Sustainability”), Seuring and Müller (1700) define *sustainable supply chain management* as

*the management of material, information and capital flows as well as cooperation among companies along the supply chain while taking goals from all three dimensions of sustainable development, i.e., economic, environmental and social, into account which are derived from customer and stakeholder requirements.*

*In sustainable supply chains, environmental and social criteria need to be fulfilled by the members to remain within the supply chain, while it is expected that competitiveness would be maintained through meeting customer needs and related economic criteria.*

Their definition is illustrated in Figure 1. As shown, there are several internal and external stakeholders who deal with sustainable supply chain management issues.

For instance, there are external stakeholders such as the (national and international) legislation (Carter and Dresner; Walker, Di Sisto, and McBain) and competitors (Klassen and Vachon; Zhu and

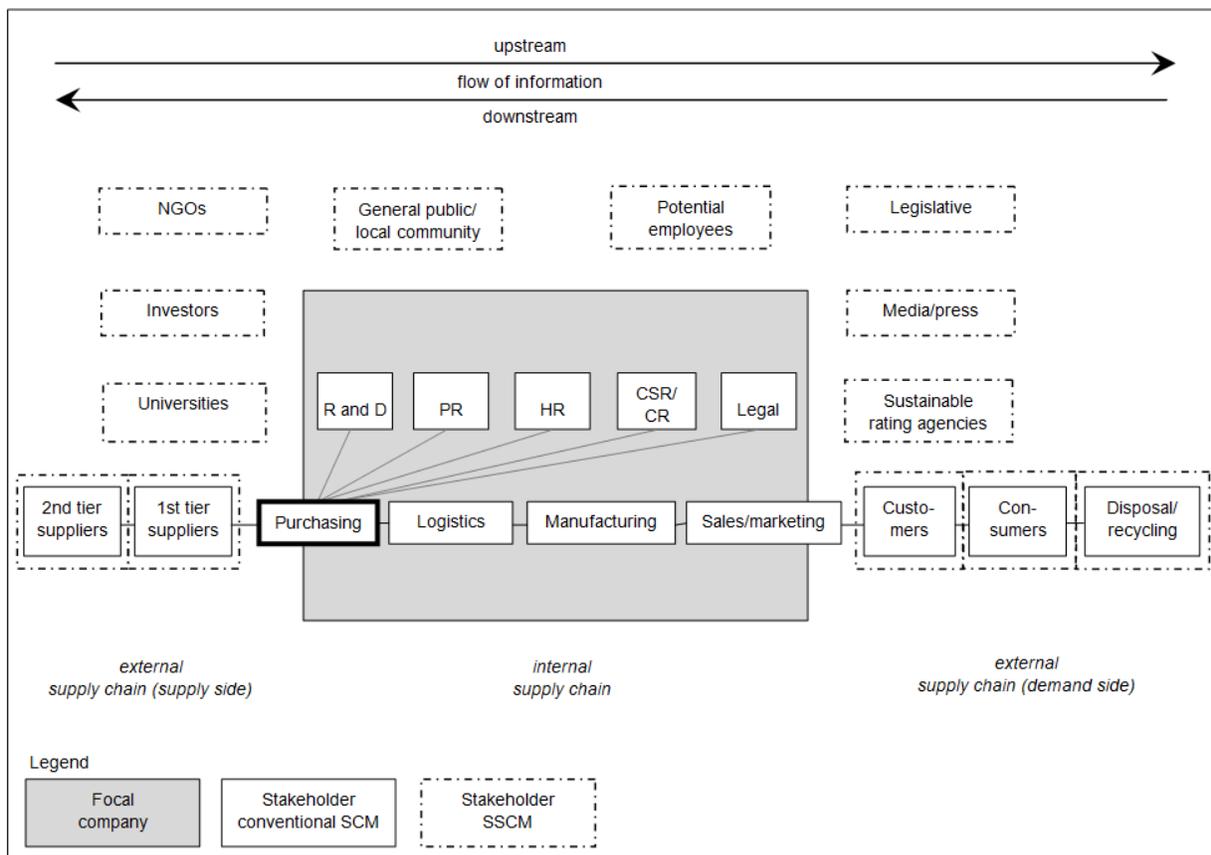


Figure 1: Sustainable internal and external supply chain (according to the understanding of Harland S63; Salzmann et al. 15; Seuring and Müller 1700).

Sarkis), investors and rating agencies as well as NGOs and the general public (Koplin, Seuring, and Mesterharm; Salzmann et al.; Svensson; Wycherly). In addition, suppliers and customers are external stakeholders (Carter and Dresner; Klassen and Vachon). Due to the fact that in recent years the amount of stakeholder requirements has increased for corporate responsibility as well as for environmental-friendly and socially responsible products and services (Carter and Jennings; Kassinis and Soteriou; Sarkis, Zhu, and Lai; Seuring and Müller), the importance of the company internal knowledge transfer between functional units such as public relations (PR) or the sustainability also has risen.

After a summary of different elements and links within sustainable supply chains, an overall objective of SSCM can be formulated as

*to make the supply chain more sustainable with an end goal of creating a truly sustainable chain. When we refer to a sustainable supply chain we are in essence referring to an outcome for that supply chain* (Pagell and Wu, “Building Theory” 38).

This goal seems to be—similar to the one of sustainability—rather abstract, since it cannot easily be defined in terms of form and extent (Haake and Seuring). In order to put SSCM in more concrete terms, Halldórsson, Kotzab, and Skjoett-Larsen evaluated related issues, such as the carbon management in the supply chain, and developed possible generic SSCM strategies. The integrated strategy is considered when sustainability issues become consistent with SCM. Within the alignment strategy, sustainability is complementary to SCM, and in the replacement strategy, the conventional SCM is substituted by full implementation of a sustainability-oriented approach. Whereas these strategies differ widely with regard to the extent of change, the integrated strategy currently seems to be

the most probable in terms of practicability.

According to the above-mentioned SSCM definition by Seuring and Müller, companies have to manage *material, information, and capital flows* within their internal and external sustainable supply chains. This means the various stakeholder requirements, such as the customers’ demand for more sustainable products and services or the need for compliance with norms and regulations on sustainability issues have to be taken into account (e.g. Bowen et al.; Seuring and Müller). These requirements are relevant since they are linked to risks such as possible reputation damages or they are related to opportunities, such as a market potential due to sustainability-oriented innovations and product developments. As a consequence, the different functional units are supposed to work together in order to meet the mentioned requirements and to take the different disciplinary perspectives (Wagner). Such cross-functional cooperation (Hsu and Hu) demands a transfer of information and knowledge. According to Schaltegger and Burritt (*Contemporary Environmental Accounting* 404), such management of information can be understood as “the creation of purpose-oriented knowledge.” Key characteristics of cross-functional integration are displayed in the next section in order to improve the understanding of how and which information can be transferred between the functional silos.

## **II.II. CROSS-FUNCTIONAL INTEGRATION IN THE CONTEXT OF SSCM**

As previously described, SSCM is not just an issue that affects procurement but also departments such as marketing, R&D, or production (Carter and Dresner; Sarkis, Zhu, and Lai). Addressing several sustainability issues (e.g. waste reduction, health protection, or energy savings) that can be relevant for more than just one functional unit, this

phenomenon is, in fact, encompassing sustainability measures since these often cover at least two of the three (environmental, social, and economic) aspects (Darnall, Jolley, and Handfield; Schaltegger et al. 6). For instance, waste reduction can be both a matter handled by the purchasing and in the human resources departments since the employees might have to be trained how to avoid waste in the most efficient and effective way.

Nevertheless, every functional unit within a company covers its own area of specialization in order to fulfill particular tasks that are associated with appropriate qualifications. From the perspective of the knowledge-based view, specialization is needed since *bounded rationality is recognition that human brain has limited capacity to acquire, store and process knowledge. The result is that efficiency in knowledge production... requires that individuals specialize in particular areas of knowledge* (Grant 112).

However, it has to be taken into account that specialization increases interdependencies and the need for coordination between the separate functional units (Olson, Walker, and Ruekert). As a consequence, a balance should be kept between benefits derived from specialization and the integration costs incurred (Galbraith 118–119; Thompson, 64; Turkulainen 16).

Looking at the SSCM literature, some scholars emphasize that SSCM may be facilitated by cross-functional collaboration and with the partners working in unison (Bowen et al.; Gold, Seuring, and Beske). However, there is indication that cross-functional collaboration sometimes is just wishful thinking (Pagell) and barriers do exist (Carter and Dresner; Moses and Åhlström). These barriers lower the potential of transferring internally or externally (sustainability-oriented) information from one member of the supply chain to another. Moses and Åhlström found problems in cross-

functional processes of sourcing decision making, such as the interdependency between the functional units, strategy complications, and functional goals that are not aligned. In order to hurdle these barriers, Moses and Åhlström recommend that all functional goals should be strategically coordinated so that the purchasing strategy is in line with the sourcing decision processes. Regarding these sourcing decision processes, they also stress the necessity of updated information (Leenders, van Engelen, and Kratzer; Pagell) as well as the risk of information overload (Olson, Walker, and Ruekert).

Therefore, it has to be assumed that the “right” management of information and knowledge is crucial for a successful SSCM. A lack of knowledge might be an explanation for no or partial cross-functional integration (Pagell). For this reason, the knowledge-based view is used to expose the potential of cross-functional interaction. Moreover, the application of this theory-based approach is an attempt to help overcome the mentioned challenges within sustainable supply chains, such as risk of a reputation loss and demand for environmental-friendly and socially responsible products.

### **III. KNOWLEDGE-BASED VIEW FROM AN INTERNAL SSCM PERSPECTIVE**

The importance of knowledge transfer is discussed in inter-organizational contexts (e.g., Dyer and Nobeoka; Martinkenaite), intra-organizational contexts (e.g., Gattiker and Carter), or both (e.g., Cousins and Spekman; Frazier). Information can be defined as purpose-oriented knowledge (Schaltegger and Burritt, *Contemporary Environmental Accounting* 404), whereas knowledge can be understood as “which is known” (Grant 119). Although there are various definitions of knowledge and of associated concepts (e.g., for a typology of knowledge management, cf. Geisler, Lavergne and Earl), this paper refers principally

to the understanding of knowledge provided in Grant's knowledge-based view. Based on the resource-based theory (Barney; Wernerfelt), *knowledge* is considered a very important strategic resource that can promise competitive advantage to the firm (Gold, Seuring, and Beske; Grant; Kogut and Zander).

For setting up the foundations of the theory, Grant (110–112) describes five characteristics of knowledge that are relevant for the application within a company:

- *Transferability*: The knowledge has to be transferrable with regard to time, space, and between individuals. For a more precise determination regarding transferability, knowledge can be distinguished into tacit and explicit. *Tacit* knowledge—also known as *knowing how*—is what implicitly exists through its application. Its transfer is uncertain and can be costly and slow (Kogut and Zander). *Explicit* knowledge, in contrast, is the *knowing about*. Regarding SSCM issues within a company, corresponding explicit knowledge can be transferred by communication between the different functional units.
- *Capacity for aggregation*: Knowledge can be transmitted, receipted, and aggregated. However, knowledge transfer is dependent on the recipient's capacity to gain knowledge. If there is a common language, this capacity is expanded. A company's internal job rotation system can be a possible way to increase a person's capacity to acquire new knowledge. For instance, job rotation can mean that a purchasing manager works in the sustainability department or in marketing and sales. By rotating jobs, he or she will have the chance to better understand the tasks and processes within the other functional units. Furthermore, he or she can

become familiar with the specific language and culture in the other functional units (Turkulainen 136).

- *Appropriability*: Regarding the appropriability of knowledge, a distinction should be made between the already mentioned tacit and explicit knowledge. Tacit knowledge cannot be appropriated, as it is stored within individuals; however, explicit knowledge might be acquired. As a consequence for cross-functional integration, Matos and Hall recommend that collaborative teams should use both tacit and explicit knowledge so that they cover “a diverse spectrum of skills and expertise” (Matos and Hall 1097).
- *Specialization in knowledge acquisition*: As already mentioned (cf. II.II.), individuals have limited capacities for acquisition, storage, and processing knowledge. Hence, specialization helps persons and organizations to manage profound knowledge. However, this specialization requires coordination between the different employees and functional units within a company (Turkulainen 58).
- *Knowledge requirements of production*: Finally, the knowledge transfer starts from “the assumption that the critical input in production and primary source of value is knowledge” (Grant 112). This statement refers to the understanding that knowledge is a prerequisite for people to be productive. Therefore, they have to possess and apply knowledge to, for instance, construct or operate a machine (Grant).

As indicated, these five described characteristics of knowledge have to be taken into account when SSCM-relevant information and knowledge are exchanged between the different members of the

internal supply chain.

### *Knowledge within sustainable supply chains*

Regarding sustainable supply chains, detailed information about environmental, social, and economic impacts and performance across the entire (external and internal) chain has to be collected and processed (Foster and Green). This requirement is due to the fact that external stakeholders, such as customers or media, are interested in product properties (e.g. product carbon footprint) or production conditions at the company's and supplier's sites (e.g. human rights compliance). As a consequence, the different functional units have to exchange corresponding information (Carter and Dresner; Foster and Green). For example, the purchasing department requires environmental information from its suppliers, such as left out hazardous substances. This information has to be submitted to the production department, and finally, sales and marketing can provide this information to the company's customers. Such typical information flow within a supply chain can be associated with the *product life cycle* perspective (Birou, Fawcett, and Magnan; Carter and Dresner; Hayes and Wheelwright). According to this perspective, several members of the internal and external supply chain are aligned so that there is a "greater cooperation across functional boundaries" (Birou, Fawcett, and Magnan 37). This collaboration requires transmitting and receiving knowledge within the cross-functional cooperation.

### *Transfer of knowledge in SSCM*

In order to coordinate the transfer of knowledge, Grant points out that the differences between tacit and explicit knowledge (Nonaka) have to be considered. As a consequence, the more informal "knowing how" and the quite formal "knowing about" have to be merged so that the specialized

knowledge of the different functional units can be integrated. Here, Grant (114–115) suggests four mechanisms, where the first three aim at reducing communication and learning costs and the last one aims at relying on communication:

- *Rules and directives*: These mechanisms present a standardized format of communication (Van de Ven, Delbecq, and Koenig). In the context of SSCM, there exist the European directives on hazardous substances in the electronics industry (Preuss). In another example, some companies have created internal rules concerning purchasing restrictions to suppliers who exploit child labor (Koplin, Seuring, and Mesterharm). Furthermore, rules can convert tacit knowledge into explicit (Grant).
- *Sequencing*: According to Thompson, sequencing can be coordination by plans, meaning that knowledge and other issues such as capabilities and activities can develop gradually and dynamically (Helfat and Raubitschek). Regarding a logistical integration, production planning or inventory management could be measurements that affect energy consumption across the entire supply chain (Vachon and Klassen, "Supply Chain Management").
- *Routines*: In comparison to the mechanism sequencing, routines can be understood as "simple sequences" (Grant 115). They can differ greatly (Pentland and Rueter) and, within a company, they can be used for simultaneous activities (Hutchins). Examples are assessment or monitoring routines that help to evaluate the environmental performance within a company (Klassen and Vachon; Simpson, Power, and Samson).

- *Problem solving by groups and decision making*: Since problem-solving processes by groups are communication intensive, they can be rather resource consuming (regarding time and capital). Thus, the building of cross-functional task force teams should focus on “unusual, complex, and important tasks” (Grant 115). Product development (Pagell) or crisis management (Hutchins) are two such examples of cross-functional teams.

With reference to product development activities, Pagell states there are a considerable number of related studies that emphasize the importance of cross-functional team work (e.g., Wheelwright and Clark). Although Pagell expresses a need for internal cross-functional integration in such occasional tasks, he also stresses that repetitive tasks require other approaches. Such approaches, in turn, can be connected to Grant’s first-mentioned mechanisms, the rules and directives, sequencing, and routines.

Based on Grant’s knowledge-based view, Sveiby aimed at expanding the field of knowledge transfer by focusing on strategy formulation. His work will be outlined in the following section.

#### *Strategies toward knowledge transfer*

In his work, Sveiby distinguishes between three dimensions of “intangible assets” (Sveiby 346–347) of a company: *external structures* (e.g. relationships with suppliers, customers, and the company’s image), *internal structures* (e.g. staff, infrastructure, and patents), and *individual competences* (e.g. competences of the company’s employees). All three dimensions are linked reciprocally to each other. When knowledge is transferred within a company, its value can be created (Lavergne and Earl; Sveiby). Furthermore,

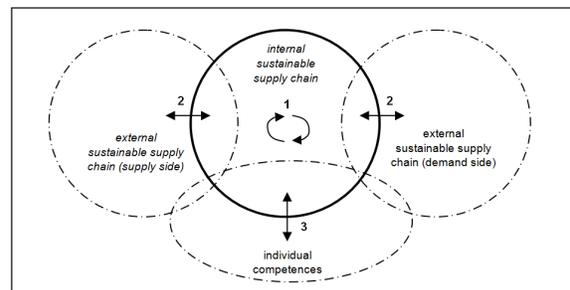
the knowledge transfer can occur in different kinds of activities within the internal structure. For instance, such activities can focus on using comprehensive database or ERP software (Pagell; Sveiby). The enabling of these activities is “the backbone of a knowledge strategy” (Sveiby 348).

In the following section, Sveiby’s model (347) will be used and adjusted in such a way as to focus on the particularities of sustainable supply chains and the company’s internal perspective. After having set this framework on intra-organizational SSCM, potential measurements will be discussed in regard to facilitating knowledge transfer in internal SSCM.

#### IV. FRAMEWORK OF INFORMATION AND KNOWLEDGE TRANSFER IN SSCM

When Sveiby’s model is modified with regard to SSCM, three different kinds of knowledge transfer can be depicted (*Figure 2*): (1) the intra-organizational knowledge transfer within the company’s internal structure; (2) the inter-organizational transfer of knowledge with external stakeholders; and (3) the transfer between individuals and the internal structure.

Knowledge transfer within *internal structures* (1) implies that SSCM-relevant tacit and



*Figure 2: Knowledge transfer in sustainable supply chains (modified from Sveiby 347).*

explicit knowledge can be shared and spread within the internal boundaries of the company. Activities such as using a common database (Sveiby), tools to improve interactive IT communication (e.g. intranet, company's internal wiki), or holding meetings on a regular basis can support such knowledge transfer. Furthermore, cross-functional collaboration can facilitate the transmission and receipt of information and knowledge. Since an internal structure is related to a manifoldness of economic, environmental, and social problems and solutions, the integration of different functional units is proposed (Sweet, Roome, and Sweet). The idea is to

*capture this system complexity by integrating information from different sources, and relating this information to the unique environmental and business contexts within which it arises* (Sweet 266; with reference to Roome, *Sustainability Strategies, Taking Responsibility*).

Furthermore, information and knowledge transfer is not only necessary within the internal structure but also with external stakeholders (2). Regarding the entire supply chain, a company has to consider both direct stakeholders, such as suppliers and customers, and indirect stakeholders, such as legislative bodies, NGOs, and media (cf. II.L., Figure 1). While Foster and Green focus on the information flows and links for sustainability-oriented innovation processes, they also refer to consultants and universities as possible external collaboration partners for innovations. Thus, it is worth noting that a lot of different flows generally are related to sustainability-oriented product and process innovations (Hansen, Große-Dunker, and Reichwald). Furthermore, in addition to the sheer quantity of information, the variety of information and knowledge flows to and from the different stakeholders has to be taken into account. For the purpose of transferring knowledge, collaborative teams can be built by internal and external supply chain members (Matos and Hall).

These cross-boundary spanning teams are able to combine their expertise and exchange ideas, and they have to develop specific goals and strategies as well as tasks. Nevertheless, such extensive team work can consume many resources (e.g., time, capital). This option is only of interest if the efforts are reasonable with regard to the benefits, such as new product development and effective crisis management (Hutchins; Pagell).

The information and knowledge transfer *from individuals* (3) to internal structures might involve the integration of an individual's competences in the company's structure (Sveiby). Since every employee possesses his or her own skills, knowledge, and experiences (Bowen et al.; Müller and Gaudig; Sweet, Roome, and Sweet), these skill sets can lead to a great diversity of capabilities, which, in turn, can create competitive advantage (Gold, Seuring, and Beske). With regard to the diversity of capabilities and company size, research indicates that larger companies do not only have more resources, but also a wider variety of them at their disposal (Gupta and Govindarajan; Van Wijk, Jansen, and Lyles). Nevertheless, it can be more challenging than in smaller companies to manage these different kinds of specialized knowledge (Turkulainen 141).

After having outlined the constituent parts of the framework of information and knowledge transfer in internal SSCM, the section below focuses on measurements on how the transfer can take place.

#### **IV.I. MEASUREMENTS TO FACILITATE KNOWLEDGE TRANSFER IN INTERNAL SSCM**

The measures that facilitate knowledge transfer within and into internal SSCM can be structured as "levels of knowledge transfer in SSCM" and "coordination mechanisms" (*Table 1*). Whereas the levels of knowledge transfer refer to the

classification proposed by Sveiby, the categorization of the coordination mechanisms is based on the work of Grant. Within this paper, both perspectives are placed in the context of internal SSCM.

Given the matrix above, 12 categories can be distinguished with regard to how SSCM-relevant information and knowledge can be transferred within and into a company. In order to relate these categories to practical application, the set of potential measurements will be discussed by using appropriate examples in the following.

*(a) Within internal structures / Rules and directives*

In cross-functional collaboration, rules and directives can serve as coordination mechanisms that minimize communication (Grant). These mechanisms can be useful if there is no or little need for coordination. For instance, internal rules can refer to how IT

should be used. In such a way, internal policy can govern how and when ERP systems are in operation and what kind of SSCM-relevant information should be integrated into the system. Furthermore, Bowen et al. (177) suggest “detailed purchasing policies and procedures” to formulate guidelines as to how sustainability issues can be implemented in day-to-day purchasing decisions. Rules and directives do not only help to organize recurring tasks, they also can facilitate an efficient mode of working in collaborating with other functional units. Although rules and directives might be used with little effort and less communication once they have been issued, it can take time and can create a need for deliberation for establishing them in the first place.

*(b) Within internal structures / Sequencing*

Sequencing means it is already planned how different functional units can share their expertise on SSCM-

<b>Levels of knowledge transfer in SSCM</b>	<b>(1) Within internal structure</b>	<b>(2) From external to internal structure</b>	<b>(3) From individual competence to internal structure</b>
<b>Coordination mechanisms</b>			
<b>Rules and directives</b>	(a) Setting rules on the use of IT systems for transferring SSCM information	(e) Issuing directives for suppliers about information transfer between suppliers and the focal company	(i) Establishing rules on how individuals should behave in case of difficult SSCM decisions
<b>Sequencing</b>	(b) Transfer of information from internal experts	(f) Learning from suppliers (e.g., job rotation between suppliers and focal company)	(j) Transmitting new knowledge (obtained in seminars, trainings, etc.) into a database
<b>Routines</b>	(c) Holding regular meetings of different functions (specific to management level)	(g) Establishing knowledge-sharing routines (exchange of information between the focal company and its suppliers on regular basis)	(k) Behaving sustainability-oriented (waste/energy reduction)
<b>Group solving</b>	(d) Setting up a task force group for internal improvements (waste reduction, health protection, energy cost savings)	(h) Developing sustainability-oriented products; stakeholder-advisory boards/stakeholder committees	(l) Providing experiences (with crisis management)

Table 1: Measurements to facilitate internal knowledge transfer in sustainable supply chains

relevant issues. For instance, if a new product has to be assessed with regard to its environmental impact, the different functional units, such as purchasing, R&D, and manufacturing, can transfer their specific knowledge into a database. Since some of this information is dependent on background data from other departments, this data collection can be organized sequentially, meaning that a work flow is generated. Alternatively, an (electronic) route card can be used to inform the several functional units about the new product and its environmental, social, and economic characteristics so that the individual departments can also process this information within their unit.

*(c) Within internal structures / Routines*

Within internal structures, routines can help to share knowledge between the various functional units. Brief daily meetings of employees from different departments can facilitate the transfer of up-to-date information. In such cases, the emphasis is on basic information and on exchanging information between functional units, such as purchasing, sustainability department, PR, manufacturing, R&D, marketing, and sales. In addition to such daily cross-functional activities, monitoring and assessment routines also can help to estimate the environmental performance within a company (Klassen and Vachon; Simpson, Power, and Samson).

*(d) Within internal structures / Group solving*

Product development and crisis management are potential application areas of group solving processes (Hutchins; Pagell) within a company. Group problem solving and decision making are measurements that require the most coordination and interaction, when compared to the three activities explained above (Grant). Therefore, it is reasonable to set up task force groups, whenever this effort

proposes a balance between the associated benefit and the expenditure of time and capital. In this context, Grant (115) cites “unusual, complex, and important tasks” as examples of problem solving by groups and decision making. However, it is worth mentioning that task force groups can generate and exchange SSCM-relevant tacit and explicit knowledge. When they are brought together as a cross-functional team, members can learn from each other’s expertise and specialization.

*(e) From external to internal structure / Rules and directives*

In the context of transferring knowledge from the external structure to the internal, rules and directives can be used to integrate the knowledge from external stakeholders (e.g. suppliers, customers, NGOs, universities). When a company negotiates a cooperation agreement with one of these stakeholders, the company can set rules that stipulate what kind of information and knowledge should be transferred to the company. For instance, a company can be forced by its customers to transmit related information with regard to carbon footprint management (e.g., the retail sector, which has begun to label products with information about the carbon footprint; Halldórsson, Kotzab, and Skjoett-Larsen). As a consequence, the focal company itself can force its suppliers by directives to provide such information.

*(f) From external to internal structure / Sequencing*

In order to obtain external knowledge by sequencing, companies and suppliers can establish a system of transferring staff knowledge across firm boundaries. This knowledge transfer may involve people actually working temporarily in the other company (Dyer and Nobeoka). The particular know-how of a

staff member from the supplier can be used while he or she works within the focal company, or his or her (explicit) knowledge can be stored in documents and IT systems. The latter alternative offers the chance to integrate the knowledge sequentially at the time it is required.

*(g) From external to internal structure /  
Routines*

Dyer and Singh (1998) understand knowledge-sharing routines as one potential source to gain competitive advantage. Referring to Grant, they define a routine as “a regular pattern of interfirm interactions that permits the transfer, recombination, or creation of specialized knowledge” (Dyer and Singh 665). More specifically a company and its suppliers, in the context of SSCM, can create routines by informing each other on a regular basis about the latest developments in product innovation or about relevant legislative projects. Such institutionalized processes can be advantageous due to fact that the partners share unique and detailed knowledge.

*(h) From external to internal structure / Group  
solving*

In order to stimulate the development of sustainability-oriented products, a focal company can form cross-organizational teams with its suppliers and customers (Stank, Keller, and Daugherty; Vachon and Klassen, “Supply Chain Management”; Zhao, Selen, and Yeung). Moreover, companies can establish groups with other stakeholders such as the local community or NGOs. Stakeholder advisory boards or corporate responsibility committees (Hansen 215) also are possible institutions to integrate external knowledge of sustainability-related issues and concerns. The purchasing department can

organize these committees directly at the suppliers’ sites to better understand the local conditions. This acquired knowledge, in turn, can improve risk and opportunity estimating of purchasing requirements and supply chain matters (such as product quality, working conditions, and avoidance of hazardous substances). However, it has to be taken into account that such inter-organizational collaboration might be challenging to organize since several companies (e.g. focal company, 1st tier, 2nd tier suppliers, etc.) and organizations (e.g. NGOs, universities, etc.) can pursue their own goals and strategies to achieve product improvements. Furthermore, the external stakeholders have their own organizational culture and structure that can considerably differ from the focal company’s traits. As a consequence, these mentioned barriers have to be considered whenever there are joint efforts to develop more sustainable products and processes. One option to avoid these hurdles might be an open and regular communication between the internal and external stakeholders.

*(i) From individual competence to internal  
structure / Rules and directives*

Based on the assumption that critical SSCM decisions exist, such as termination of the supplier relationship due to noncompliance with environmental or social guidelines, a directive can require that multiple parties are involved for these crucial decisions. This approach can be applied by employees of one single department, or, in order to improve knowledge transfer between functional units, it can also be used as a rule so that employees from different departments such as purchasing and R&D have to decide collectively. Adopting such a directive might allow a transfer of individual’s knowledge to the internal structure and across the internal supply chain. However, it has to be taken into account that an individual’s perception and acceptance of such a directive can be different depending on the personal

and organizational context or situation he or she is in. As a consequence, it has to be considered that a successful application of rules and directives is dependent on the attitude and behavior of every single employee, although in general, rules and directives might be of help to facilitate the transfer of knowledge between functional units.

*(j) From individual competence to internal structure / Sequencing*

With regard to SSCM and to the transfer of individual competences to internal structures, sequencing implies that an employee passes on information that he or she has obtained in SSCM-associated seminars (such as seminars about handling toxic substances, evaluation of suppliers based on sustainability criteria, or using codes of conduct). In order to process this information sequentially, the employee is enabled to transmit his or her knowledge into a database that offers open access for all employees in other departments across the internal supply chain, or the employee is appointed as a contact person for transferring the specialized knowledge. As a consequence, these knowledge transfer methods can encourage cross-functional collaboration since it supports other employees to possess SSCM-relevant know-how.

*(k) From individual competence to internal structure / Routines*

Measurements, such as waste reduction or energy savings, can be SSCM-related routines of individuals that have an impact on the internal structure. On one hand, this might be understood as a kind of tacit knowledge since it is “revealed through its application” (Grant 111). On the other hand, this can demonstrate explicit knowledge provided the employee informs colleagues about his or her activities.

*(l) From individual competence to internal structure / Group solving*

If, for instance, an employee has gained experiences in an exigency, such as an environmental accident within the supply chain, he or she may transfer his or her acquired knowledge to others within the same organization. This knowledge might refer to how the problem was solved, what kinds of measurements were taken to minimize the risk within the supply chain, and how this environmental accident harmed the company. A pragmatic approach to convert this knowledge can be that the employee plays an active role in a company’s internal training programs (e.g. during seminars that deal with crises management). Although such seminars are provided by external service companies, an additional company’s internal seminar can be more specific with regard to the peculiarities of the company such as its culture and structure. Furthermore, employees can be trained in specific skills, such as being a mediator or intermediary, so that they can contribute to problem-solving processes by their specialized knowledge and experience.

After proposing the application of the 12 different measurements of knowledge transfer in internal SSCM, the following section addresses some practical implications for cross-functional integration in the context of knowledge transfer.

#### **IV.II. IMPLICATIONS FOR CROSS-FUNCTIONAL INTEGRATION IN INTERNAL SSCM**

Based on the discussion of mechanisms to facilitate internal knowledge transfer, this conceptual paper offers practical implications. The outcome of the widely conducted discussion can provide suggestions concerning the role of cross-functional integration with regard to the transfer of SSCM-relevant information and knowledge.

### *Knowledge sharing*

Knowledge-sharing routines with suppliers are seen as one potential source to gain competitive advantage (Dyer and Nobeoka). This sharing of knowledge also can be beneficial in the intra-organizational context. If the different functional units across the internal supply chain spread their know-how and experiences among each other, they can improve their understanding for internal and external SSCM-relevant information. Furthermore, these units can learn to speak a “common language” so that sustainability-relevant information (e.g. about the product carbon footprint, necessary information for cause-related marketing activities, or details about standards and norms) can be transferred more easily between the different functional units. Since “efficiency of knowledge aggregation is greatly enhanced when knowledge can be expressed in terms of common language” (Grant 111), it is useful to take such appropriate measurements. Potential measurements can be holding brief daily meetings, where persons of different functional units come together (cf. *c*), or setting up a task force group for internal improvements (cf. *d*). In addition, incentive systems can be an appropriate measurement with regard to integration since incentives can encourage individual employees of the different departments to pursue one common goal (Pagell and Wu, “Enhancing Integration”). Such reward systems might include remunerations (e.g., when waste reduction is achieved within the company through the internal supply chain) or incentives when SSCM goals (e.g., establishing a carbon management system across the entire supply chain) are reached commonly by the different functional units.

### *Informal and formal communication*

Cross-functional integration and knowledge transfer can occur in different modes of communication.

Grant points out the difference between explicit and tacit knowledge: explicit knowledge can be transferred by communication, whereas tacit knowledge cannot. Tacit knowledge, in fact, is transferred via its application. Tacit knowledge in cross-functional collaboration refers to knowledge of an individual person, e.g. an employee from purchasing can know how he or she is able to find the most suitable supplier for components when a new product is developed and how to reach a compromise together with other departments such as R&D as well as marketing and sales when there are conflicting goals between the different functional units about the components. In this context, the employee from purchasing applies this specific knowledge without making it explicit, e.g. through documented guidelines useable through other individuals. Explicit knowledge, in contrast, refers to knowing about; this type of knowledge is more easily transferred. Consequently, purchasing may have knowledge about the properties of the purchased component (e.g. its recyclability) and is able to transfer it to other departments. Thus, practitioners may wish to consider this difference when establishing communication channels between the various functional units. This implies, on the one hand, that cross-functional meetings are useful so that knowledge can be applied more easily and, on the other, that communication tools such as a database are helpful to store explicit knowledge and make it retrievable.

Furthermore, research suggests distinguishing informal and formal communication. Informal communication is seen as an effective way to address problems in real time that occur in the different functions across the supply chain. In contrast, formal communication such as reporting systems can help to exchange information in a more structured way (Daft 582; Pagell; Pagell and Wu, “Enhancing Integration”). This recognition of communication differences results in the fact

that information and knowledge transfer might be communicated formally and be organized by mechanisms such as decision making (cf. *d, h, l*), but informal communication also is necessary to cover all communication levels.

## V. CONCLUSION AND FUTURE RESEARCH

This conceptual paper argues that cross-functional integration assumes a substantial role in the intra-organizational transfer of SSCM-relevant information and knowledge. The knowledge-based view is used to discuss different mechanisms and levels of information and knowledge transfer. In the context of SSCM, there are various internal and external stakeholders whose requirements are of relevance. In addition, to better understand the implications with regard to cross-functional integration in SSCM, the differences between tacit and explicit knowledge, as well as the distinction of formal and informal communication, need to be considered. For example, when a new environmentally friendly and socially responsible product has to be developed, the different functional units need to know how they can work together in order to meet the requirements adequately. Furthermore, they need to know about the demanded properties of the new product. For such a product development, on the one hand, formal communication can be of help to make knowledge transfer across the internal supply chain explicit, on the other, informal communication can be beneficial for establishing a common language across the various functional units.

However, this conceptual framework, like other research papers, also suffers from limitations. First, there are limits regarding the theoretical underpinning of the knowledge-based view. Knowledge cannot be common between all functional units (Grant). This fact involves the

assumption that every employee has his or her individual background, and it might be difficult to develop a similar understanding of what is relevant information in SSCM. In addition, sustainability issues have a value-laden character, meaning every individual will have his or her own perception of sustainability and related knowledge (Seelos; Linnenluecke, Russel, and Griffiths).

Since entire supply chains are rather complex, this paper's approach to develop a theoretical framework cannot cover all the specific aspects such as the interdependencies between internal and external stakeholders, the balance of power, or the individual's ability to learn and acquire new knowledge. Also, it should be noted that sustainability is a rather complex construct (Seelos) that involves a great range of environmental, social, and economic concerns and knowledge.

Therefore, in order to investigate more thoroughly the knowledge transfer and cross-functional integration in SSCM, future research could focus on the unique characteristics of knowledge that is to be exchanged between the different functional units. Hence, the question can be raised, what are similarities and differences of environmental, social, and economic-related information in the internal and external supply chain? Furthermore, the transfer of information and knowledge might be influenced by the individual peculiarities of the transmitters and recipients. Hence, it is worth asking who are the particular persons and organizations that exchange information? Within which structures and cultures do they act? Based on the theoretical framework developed in this paper, a case study or an action research approach might be fitting to better understand the complex structures of knowledge and information transfer between different functional units in SSCM.

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