

Static Supply Chain Complexity and Sustainability Practices: A Multi-tier Examination

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Abstract

The issue of sustainability is receiving increasing attention, and this debate now needs to be extended to consider the perspective of the supply chain. This paper aims to investigate sustainability choices made along the supply chain (SC) by considering the static complexity of the SC. It investigates the different perspectives and tensions that can exist between supply chain partners when sustainability programmes are introduced. Through 18 cases, the paper addresses the different types of static SC complexity faced by the different tiers of the supply chain. For the focal company, the complexity is both upstream and downstream; for first-tier suppliers it is upstream; and for second-tier suppliers the complexity is largely downstream.

These various types of complexity require the adoption of different sustainability practices: for the focal company these involve sourcing and organisational practices; for the first-tier suppliers they involve sourcing practices; and for the second-tier suppliers, organisational practices.

Keywords: sustainability, supply chain, static complexity, fashion

Introduction and Literature Review

Supply chain (SC) complexity has become one of the most pressing problems in modern SCs (Bode and Wagner, 2015; Bozarth et al., 2009; Choi and Krause, 2006). Modern SCs are made up of many key partners, often located internationally, whose relationships can lead to tensions within the SC, arising from their different visions and approaches (Harms et al., 2013; Van der Byl and Slawinski, 2015). As SC complexity increases, as determined by the heterogeneity of the SC partners, the difficulty of each SC company in planning and deciding on activities to implement inevitably grows (Sarkis et al., 2011). The complexity of SCs is considered a relevant topic for investigation (Hall et al., 2012) as the system within which a company operates and interacts will determine its performance (Sarkis et al., 2011). When a complex system expands to include a greater number of interacting partners, it becomes increasingly difficult to predict the outcomes of the interactions, and as the complexity of the SC increases, performance may deteriorate (Bozarth et al., 2009). The number of actors and nodes involved in a SC is defined as the SC's static complexity, and this reflects the structural elements of a multifaceted SC system (Hall et al., 2012; Park and Kremer, 2015). This concept provides the theoretical background to this paper. Static complexity thus refers to the physical configuration of a system, and the structural characteristics of the system will reflect its level of uncertainty (Park and Kremer, 2015). This is a time-independent complexity, unlike dynamic complexity, which is defined as the uncertainty caused by the amount of change in a system. This results from time-dependent activities that increase complexity by introducing unexpected events into a system (Park and Kremer, 2013; Park and Kremer, 2015; Wu et al., 2007).

Many authors have explored how extended and interconnected SC systems can be affected by strong static complexity (e.g. Birkie et al., 2017; Dittfeld et al., 2018). SC complexity is crucial as it can impact performance in various ways. Recent literature has focussed on the potential impact of complexity on SC sustainability (Mirghafoori et al., 2017; Sarkis et al., 2011; Tachizawa and Wong, 2015) as friction frequently develops between SC partners when sustainability programmes are introduced (Bozarth et al., 2009).

Companies from several industries have been focussing their attention on the challenges of sustainability and have started by revising their internal practices. However, considering the internal perspective only is clearly insufficient (Krause et al., 2009), especially in international

industries (Harms et al., 2013). Most of the current literature focuses on complexity issues as they impact individual companies only, without considering the SC perspective, especially in relation to the adoption of sustainability practices (Aitken et al., 2016).

Hall et al. (2012) confirm the limitations of this perspective, arguing that firms focusing on individual sustainable development without a joint SC vision are unlikely to find satisfactory solutions to their sustainability challenges. Asymmetries in the implementation of sustainability practices are evident when the practices of focal companies are compared with those of their suppliers or partners in the distribution channel (Ulstrup-Hoejmose et al., 2013). This can lead to tensions between partners in a SC (Sarkis et al., 2011; Serdaran, 2013; Vachon and Hajmohammad, 2016). Extended networks are complex to manage because this requires cooperation, but such cooperation is often hampered by constraints determined by the structure of the SC. The number of SC actors and the types of relationship between SC partners are just some of the factors affecting the implementation of sustainability in the SC. This is further intensified by the complexities associated with international SCs (Vachon and Klassen, 2006).

As reported in the studies mentioned above, the link between complexity and sustainability has been hinted at in the literature, but further studies are needed to shed light on the complexities related to undertaking sustainability in SCs (Sarkis, 2012). This paper focuses on static complexity, resulting from the structural configuration of a SC system (Park and Kremer, 2015), and scrutinizes the impact of complexity on the implementation of sustainability practices in different tiers of the SC. This is summarized in the following research question.

RQ: How does static SC complexity influence the adoption of sustainability practices at different levels of the SC (focal company, first-tier suppliers, second-tier suppliers)?

To tackle this research goal, a case-based methodology was selected. The sample investigated was composed of 18 companies drawn from three tiers of the SC (focal companies, first-tier suppliers, second-tier suppliers) and from three different SCs.

The paper is organized as follows. The next section introduces the methodology. The results are then presented and discussed. Finally, the contributions and limitations of the paper are considered.

Research Design and Methodology

Design of the research

Because of the exploratory nature of the topic, this paper is based on a multiple case study approach (Voss et al., 2002). This is appropriate when the phenomenon under investigation is still poorly studied as it offers the opportunity to achieve in-depth results through direct experience and to understand all facets of a complex phenomenon (Voss *et al.*, 2002). Multiple case-studies are conducted to achieve a depth of information and to increase the external validity of the results (Voss et al., 2002).

Sustainability choices are influenced by the characteristics of an industry and so, to increase comparability among the results, the SCs included in the sample came from the same industry. The fashion industry was selected for its relevance in terms of both SC complexity and sustainability. The fashion industry relies on very complex SCs, composed of a plethora of suppliers, often very small, which are frequently fragmented and located globally in low-labour cost countries. At the same time, these companies are very dispersed downstream, distributing their products worldwide. Regarding sustainability, the fashion industry represents a challenging sector with problems at both environmental and social sustainability levels, as confirmed by several disasters in recent years. Furthermore, the industry's production and distribution processes are high in terms of pollution and consumption (Lo et al., 2012). However, in recent years, several companies in the industry have established programmes to improve their sustainability profiles (Caniato et al., 2012; White et al., 2017).

Sample selection

Three SCs operating in the fashion sector were included in the research. First, we selected focal companies for these SCs, based on the following criteria: First, we selected international companies that experience SC complexity in their global networks; big groups were selected, and here the personal knowledge of the authors was used. We then selected exemplar case

studies of sustainability: for this, secondary data (e.g. websites, sustainability reports and Global Reporting Initiative rankings) were sought to identify relevant sustainability cases.

On the basis of this screening, two focal companies in the luxury segment were identified: the best examples of sustainability in fashion are found in the luxury sector, thanks to the large investment potential available to these companies. Once the focal companies were selected, their SCs were examined: for one focal company, a single supply chain was selected as the company operated entirely in the leather industry. For the second focal company, two supply chains were identified (silk and knitwear) as being equally important to the company but potentially different in terms of sustainability and SC complexity. We included in the research sample the first-tier suppliers to the focal companies until we reached 80% of the total supplied to each focal company. The focal companies provided the contacts for the key informants in their suppliers, but to avoid information bias, the interviews with these first-tier suppliers were conducted without the participation of the focal company.

Similar criteria were applied to the selection of the second-tier suppliers: together, they needed to cover at least 80% of the production of each first-tier supplier, and again interviews with second-tier suppliers were conducted without the participation of the focal company or the first-tier suppliers. A larger number of second-tier suppliers (13) was necessary to get a stronger representation of this node of the chain as company size is traditionally far smaller in this tier. Moreover, second-tier suppliers may not have a proactive attitude towards sustainability and therefore may be characterized by different sustainability programs (Macchion et al., 2018)”

A total of 18 companies were included in the research: two focal companies, three first-tier suppliers and 13 second-tier suppliers. These 18 companies were all involved in three high-end fashion SCs with products positioned in the luxury segment. Although totally independent, SC B and SC C serviced the same focal company, providing two different products (i.e. silk products and knitwear products, respectively). Focal company B provides different product categories to the luxury sector, and for each product category it makes use of specialized suppliers.

The full sample is summarized in Table 1, while Figure 1 indicates the details of the products realized by each tier of the three SCs.

Table 1: *Analysis of Sample*

Supply Chain	Company	Position in the supply chain	Turnover 2018 (Mln €)	Location	Description of the tier
SC-A – leather supply chain	Focal Company A (FCA)	Focal company (brand owner)	1.000-2.000	Italy	Manufacturing is 100% outsourced; High number of different customers and suppliers
	Producer A (BPA)	First-tier supplier	25-50	Italy	High number of variants and low batch size Big differences among customers even if their number is not high Long lead times for supply
	Tannery-1A (T1A)	Second-tier supplier (leather)	10-25	Italy	High number of variants and low batch size Lead time of supply not always quick
	Tannery-2A (T2A)	Second-tier supplier (leather)	25-50	Italy	
	Tannery-3A (T3A)	Second-tier supplier (leather)	10-25	Italy	
	Tannery-4A (T4A)	Second-tier supplier (leather)	10-25	Italy	
	Tannery-5A (T5A)	Second-tier supplier (leather)	50-100	Italy	
	Tannery-6A (T6A)	Second-tier supplier (leather)	10-25	Italy	
	Tannery-7A (T7A)	Second-tier supplier (leather)	10-25	Italy	
	Tannery-8A (T8A)	Second-tier supplier (leather)	50-100	Italy	
	Tannery-9A (T9A)	Second-tier supplier (leather)	10-25	Italy	
SC-B – silk supply chain	Focal Company B (FCB)	Focal Company (brand owner)	1.000-2.000	Italy	
	Neck Tie Producer-B (NTPB)	First-tier supplier	1-5	Italy	Medium number of variants Few product categories; High globalization of raw materials
	Silk Factory-1B (SF1B)	Second-tier supplier	50-100	Italy	High number of variants High number of customers with different requirements Long lead times
	Silk Factory-2B (SF2B)	Second-tier supplier	50-100	Italy	

SC-C – wool supply chain	Focal Company B (FCB)	Focal Company (brand owner)	1.000-2.000	Italy	Manufacturing is 100% outsourced. Big differences in type of customers and per country Long lead times of supply with many suppliers to be managed
	Knitwear Producer-C (KPC)	First-tier supplier	25-50	Italy	High number of products Medium heterogeneity in customer needs Several raw material suppliers
	Weaving Factory-1C (WF1C)	Second-tier supplier	100-150	Italy	High number of variants High number of customers with different requirements Long lead times
	Weaving Factory-2C (WF2C)	Second-tier supplier	50-100	Italy	

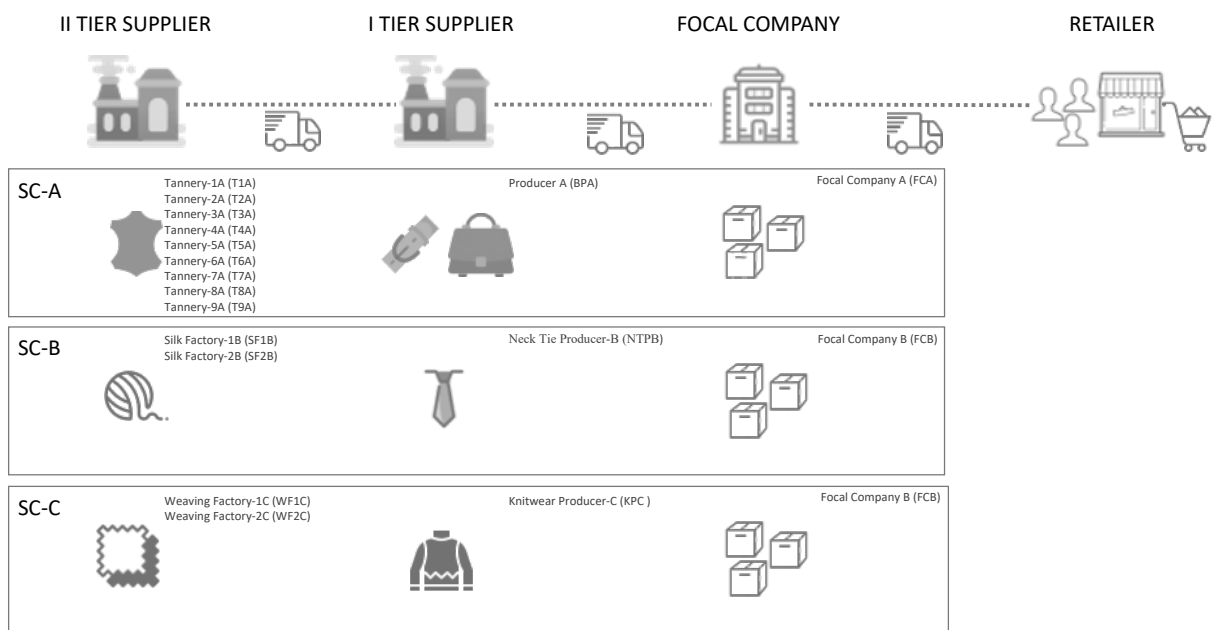


Figure 1: Products realized by each tier of the SC

Data collection

The research team followed a semi-structured research protocol using open questions for all 18 case studies. A research protocol increases research reliability and validates the research by guiding the data collection. Furthermore, a protocol provides essential information on how to carry out the case studies by standardizing the procedures used to collect the data (Yin, 2009).

Interviews were conducted by multiple interviewers, and trick questions were included to verify the information and avoid bias. In each focal and first-tier company, at least three informants (i.e. SC, purchasing, and sustainability manager) were interviewed through direct interviews

made during visits to the company. In the second-tier companies, the interviews were conducted directly with the president or owner. Each interview was conducted by at least three researchers, and the interviews lasted for over 120 minutes. One researcher conducted the interview while the others observed, took notes and sometimes asked for clarification. The data collection began in January 2018 and ended in November 2018. More than 20 interviews were conducted in each SC, with an overall number of around 70 interviews conducted. The members of the research team met after each site visit to discuss insights and emerging themes.

The information provided by informants was triangulated with an analysis of the company's code of conduct, sustainability and CSR report, as provided by the company or as available from their website and press releases. The sources of evidence therefore included: semi-structured interviews, researchers' observations, and additional documentation. The triangulation of three sources of information reduces bias (Yin, 2009). The companies' names were changed to the letters A, B and C to maintain their anonymity. All interviews were tape-recorded and then transcribed and combined with secondary data. Quotes from informants are included to illustrate each case.

Data coding

To answer the research question, two groups of variables were considered: static SC complexity and sustainability practices. This study aims to contribute to elaboration of theory (Fisher and Aguinis, 2017) by using existing concepts and conceptual models as a starting point from which to generate new theoretical insights. We therefore used existing models that had already been adopted for studying SC complexity (Bozarth et al., 2009) and sustainable supply chain management (González-Benito and González-Benito, 2006; Moretto et al., 2018). These models oriented our data coding (Tables 2 and 3). We used these concepts to collect and organize data to structure new theoretical concepts (the data analysis is reported in Annexures A and B and is available upon request). Finally, we refined the existing theoretical models in the light of their application in the new context, and as summarized in the research propositions reported in the Results section.

Bozarth et al. (2009) suggest that static SC complexity should be investigated at three levels of a manufacturing plant. In the supply chain investigated, each node is a manufacturer, and for

this reason, Bozarth et al.’s model was considered appropriate for use in our analysis. The three levels are:

- *Manufacturing*: In order to consider the number of parts and products realized by each actor, the volume of orders and any critical issues derived from sharing the production schedule with partners are considered.
- *The downstream side*: This provides an understanding of the extent of the customer base and the requests that each actor in the SC is called upon to manage. Product life cycles and demand variability are analysed in order to understand which actors must manage critical issues at the supply timing level.
- *The upstream side*: This verifies how many suppliers are connected to the individual company, the type of relationship that is established and their location at the international level.

Static SC complexity is associated with the physical configuration of the SC and will include consideration of the interconnections both upstream and downstream for every level and actor in the SC (Park and Kremer, 2015). For this reason, the three levels were analysed for all companies in the SC, using the single company as the unit of analysis. In this way, each link between the companies was studied in depth to investigate the influence of SC structure on the implementation of sustainability practices. The coding for the items used in the analysis is summarized in Table 2.

Table 2: *Static SC complexity (adapted from Bozarth et al., 2009)*

Type of static SC complexity	Drivers	References	Coding
(High if all or most of the drivers are high; medium if at least one item is high or if all of the items are medium; low if most of the items are medium)	Number of products	Closs et al. (2008)	High: the company is managing several products, in different colours, materials and sizes Medium: the company is managing several products, but with similar colours or materials Low: the company is managing a low number of products
	Number of parts	Huang et al. (2005)	High: each product has several parts Medium: each product has just a few parts Low: each product has one or two main parts
	Volume batch production	Duray et al. (2000)	High: each batch has several items (flow) Medium: each batch has some items Low: each batch has a small number of items
	Manufacturing schedule instability	Vollmann et al. (2005)	High: schedule is difficult to predict in advance, as it might change at a daily level Medium: schedule is predictable in advance, but might change at a weekly basis

			Low: schedule is defined in advance and respected
Downstream complexity (High if all or most of the drivers are high; medium if at least one item is high, or if all the items are medium; low if most of the items are medium)	Number of customers	Choi et al. (2019)	High: the company is managing several customers (more than 50) Medium: the company is managing between 10 and 50 customers Low: the company is managing less than 10 customers
	Heterogeneity in customer needs	Choi et al. (2019)	High: each customer has specific requirements Medium: customers have requirements classifiable in clusters Low: customers have similar requirements
	Duration of product life cycles	Bozarth et al. (2009)	High: products last less than one season Medium: long for some parts, short for others Low: products last more than one season
	Demand variability	Chen et al. (2000)	High: demand is difficult to predict and strongly variable each season Low: demand is predictable as quite stable each season
Upstream complexity (High if all or most of the drivers are high; medium if at least one item is high, or all of the items are medium; low if most of the items are medium)	Number of suppliers	Goffin et al. (2006)	High: the company is managing several direct suppliers (more than 100) Medium: the company is managing between 50 to 100 direct suppliers Low: the company is managing less than 50 direct suppliers
	Long and/or unreliable lead times	Vollmann et al. (2005)	High: lead times longer than 6 months and unreliable Short: lead times are shorter than 6 months and reliable
	Globalization of the supply base	Bozarth et al. (2009)	High: company uses a global supply base with variable collection per collection Medium: company uses a global supply base but stable collection per collection Low: company uses a local supply base

SC sustainability practices were analysed by focusing on the complete range of sustainability practices identified as appropriate for fashion companies. According to González-Benito and González-Benito (2006) and Moretto et al. (2018), two types of practice are used:

- *Organisational practices.* These reflect the extent to which a company and its SC explicitly define a sustainability policy and develop clear objectives and a long-term plan for establishing sustainability objectives. It will include selection and implementation of sustainability practices and assessing the outcomes of those practices. Organisational practice will include the sustainability responsibilities implemented by full-time employees devoted to sustainability management and improvement.
- *Operational practices.* These include all the practices that focus on developing and implementing more sustainable processes in both sourcing and manufacturing.

The list of sustainability practices adopted by Moretto et al. (2018) was used as a reference framework and is summarised in Table 3.

Table 3: *Sustainability practices for sustainable supply chain management – (adapted from Moretto et al., 2018)*

Type of sustainability practice	Detailed sustainability practice	References
Organisational	Definition of sustainability goals	Lueg et al., 2015; Choi and Li, 2015; Winter and Lasch, 2016.
	Sustainability governance structure	Shen, 2014; Turker and Altuntas, 2014.
	Regular meetings on sustainability	Turker and Altuntas, 2014.
	Employee training	Shen, 2014; Turker and Altuntas, 2014.
	Increase organisational awareness of sustainability	Lueg et al., 2015; Fuentes and Fredriksson, 2016.
	Adoption of recognised sustainability standards	Winter and Lasch, 2016; Da Giau et al., 2016
	Certifications	Shen, 2014; Turker and Altuntas, 2014; Lueg et al., 2015; Da Giau et al., 2016.
	Communication and reporting	Turker and Altuntas, 2014; Shen et al., 2014; Lueg et al., 2015.
	Budget	Lueg et al., 2015; Choi, 2016; Li et al., 2016.
	Benefit and organisational welfare	Perry and Towers, 2013; Winter and Lasch, 2016.
Operational - Sourcing	Philanthropic initiatives	Perry and Towers, 2013; Da Giau et al., 2016.
	Purchase of sustainable material	Caniato et al., 2012; Das, 2013; Kraft et al., 2016.
	Suppliers selection	Winter and Lasch, 2016.
	Suppliers monitoring	Shen, 2014; Turker and Altuntas, 2014; Winter and Lasch, 2016.
	Supplier collaboration	Caniato et al., 2012; Turker and Altuntas, 2014.
	Inbound logistics	Caniato et al., 2012; Li et al., 2016
	Traceability	Perry and Towers, 2013
Operational Manufacture	Supplier development	Caniato et al., 2012; Turker and Altuntas, 2014
	Evaluation and consumption mapping	Da Giau et al., 2016; Winter and Lasch, 2016; Li et al., 2016.
	Introduction of eco-building solution	Caniato et al., 2012
	Eco-friendly production processes and machines	Lo et al., 2012; Turker and Altuntas, 2014; Li et al., 2016; De Angelis et al., 2017.

Data analysis

To analyse the data, within-case analysis and cross-case analysis were conducted by considering each actor of the SC. For this data analysis, the research team met many times after the initial site visits to develop a strategy for synthesising the data.

To maintain the narrative of the findings, in the within-case analysis, several quotations from informants have been included. To reduce the data for the cross-case analysis, companies at different levels of the SC were compared on the basis of their sustainability practices and static complexity (Annexures A and B are available upon request).

Data reduction was first performed at the single company level; data were then compared at the SC level and actors were considered at the same time. Behaviours of companies at the same SC level were comparable in terms of their SC complexity and in terms of the sustainability practices adopted.

A cross-case analysis at the SC level was then performed to summarize the main evidence and the major commonalities, as reported in Tables 4 and 5.

Companies at different levels of the SC may implement different sustainability practices and face different SC complexities, therefore, the analysis of results started with investigating the sustainability practices adopted at each SC tier (the cross-case analysis is presented in Annexure A). Table 4 presents a summary of the practices most often cited at each level of the three SCs.

Table 4: Sustainability practices at different levels of the SC

	Focal Company	I tier suppliers	II tier suppliers	Common practices at all 3 tiers
Organisational practices	Definition of sustainability goals (Economic incentives for managers) Sustainability governance structure Regular meetings on sustainability Adoption of recognized sustainability standards Certification Communication and reporting Benefits and organisational welfare Philanthropic initiatives	/	Regular meetings on sustainability Certification Benefits and organisational welfare	Employee training (Training on health and safety) Definition of sustainability goals (code of conduct; formal or informal policies)
Operational practices – Sourcing	Purchase of sustainable materials (eco-friendly packaging) Supplier selection (sustainable vendor rating; Extension of RSL and MRSL) Supplier collaboration Inbound logistics Supplier development	Supplier selection (Selection of certified suppliers; selection of suppliers according to geographical location)	Purchase of sustainable materials (eco-friendly packaging; recycled raw materials) Supplier selection (selection of certified suppliers; extension of RSL and MRSL; sustainable vendor rating)	Purchase of sustainable materials Traceability
Operational practices– Manufacture		/	Evaluation and consumption mapping	Eco-friendly production

			Eco-friendly production processes and machines (new clean technology) Introduction of eco-building solutions for environmental improvement (renewable energy)	processes and machines (manufacturing machinery renewal) Introduction of eco-building solutions for environmental improvement (energy efficiency improvements)
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The results were also investigated to consider the level of SC complexity faced by each tier: the data were investigated at the single company level and then aggregated to considering the behaviours of companies in the same nodes of the same supply chain (Annexure B). Cross-case analysis was performed to compare similar nodes in the different supply chains, thereby addressing the commonalities of SC complexity experienced at a particular level (Table 5). The SC complexity faced by the various tiers was then investigated (the cross-case analysis is given in Annexure B and a summary in Table 5). This is described in the following paragraphs.

Table 5: *Impact of static SC complexity on the different tiers of the SC (bold = medium complexity; bold and underlined = high complexity)*

SC complexity	Focal company	First-tier suppliers	Second-tier suppliers
Manufacturing complexity	Not relevant (manufacturing is 100% outsourced)	Medium manufacturing complexity: high number of products, low number of parts, low volume batch, low manufacturing schedule instability	Medium manufacturing complexity: high number of product variants, low number of parts, low volume batch, medium manufacturing instability
Downstream complexity	<u>High downstream complexity:</u> high number of customers, high heterogeneity of customers' needs, short product life-cycle, high demand variability	Low downstream complexity: low number of customers (mainly 1), low heterogeneity of customers' needs, low demand variability	<u>High downstream complexity:</u> high number of customers, high heterogeneity of customers' needs, high demand variability, short product life-cycle
Upstream complexity	<u>High upstream complexity:</u> high number of suppliers, high globalization of the supply base, long lead times	<u>High upstream complexity:</u> medium number of suppliers, high globalization of the supply base	Low upstream complexity: low number of suppliers, long lead times

The data reported in Tables 4 and 5 were then compared, in an attempt to identify which sustainable practices are adopted to cope with various levels of SC complexity for a single tier of the SC. The results of this comparison identify the impact of SC complexity on the implementation of sustainability practices. The main results are summarized in Table 6.

Table 6: Link between SC complexity and sustainability practices (bold = medium complexity; bold and underlined = high complexity)

SC complexity	Sustainability practices		
	Focal company	First-tier suppliers	Second-tier suppliers
Manufacturing complexity	Low manufacturing complexity	Medium manufacturing complexity	Medium manufacturing complexity Operational practices: Manufacture: evaluation and consumption mapping; eco-friendly production processes
Downstream complexity	High downstream complexity Organizational practices to drive the sustainable strategy implementation along the whole SC	Low downstream complexity	High downstream complexity Organizational practices: definition of sustainability goals; regular meetings on sustainability; internal reporting; micro-budgets
Upstream complexity	High upstream complexity Operational practices: sourcing Organizational practices: definition of sustainability, governance structure and standards, regular sustainability meetings, certification	High upstream complexity Operational practices: sourcing; supplier selection; supplier monitoring; traceability	Low upstream complexity

Results: Impact of static SC complexity on sustainability practices

Focal companies face high downstream and upstream complexity

The focal company presents with a higher number of sustainability initiatives compared to the other tiers of the SC. This is driven by two factors: First, the focal company is responsible for pushing sustainability along the SC as it is expected to guarantee the sustainability standards of the entire SC. Second, sustainability decisions will result from the level of SC complexity that a focal company engages with, particularly in terms of upstream and downstream sustainability. Regarding upstream complexity, the focal company must cope with a broad and international supply base and with a very long lead time. Production activities are outsourced, and the supply base is also responsible for the sustainability performance of the focal company. Furthermore, regulations in different countries vary and may not be totally consistent with the focal company's requirements. For these reasons, it is not sufficient for a focal company to check sustainability at the internal level, but it needs to broaden its sustainability implementation to include the upstream SC level. Focal companies therefore devote significant effort to the operational practices of their sources, with the ultimate purpose of making the whole SC more sustainable. The efforts extended towards the operational practices of the sources are wide, both in terms of the selection of raw materials, such as dropping unsustainable materials in favour

of eco-packaging and materials not included in the Restricted Substances List (RSL), and in developing the skills of suppliers. It is necessary to extend their code of conduct to include suppliers, to implement continuous supplier auditing, to include sustainability criteria in supplier selection and in supplier monitoring, etc. Due to these requirements, the focal company is required to adopt practices that drive and foster sustainability along the whole chain. For the focal company, it is not sufficient to implement these practices at the first-tier level, they also need to control or manage the process in such a way that it includes other tiers, such as the second-tier companies. In illustration, FCA reported:

For us it is fundamental that our suppliers are consistent with our sustainability goals. For this reason, all of the sourcing practices, including supplier selection, supplier monitoring, supplier collaboration or supplier development for weaker suppliers, is necessary. We cannot focus just on the first-tier, but we need to guide decisions also at the second-tier.

The downstream complexity is particularly critical to a focal company because the company is required to meet the expectations of customers from a worldwide spectrum who have significantly different sustainability requirements. For example, FCB mentioned: “*More than 90% of the turnover derives from export through an ever-growing number of stores: nowadays we have more than 1.000 stores spread all over the world*”. Different countries request totally different things in terms of product features, timing and also sustainability requirements. To manage this complexity, some organisational practices are adopted that drive sustainability change throughout the whole SC, for instance with sustainability reporting, philanthropic initiatives, information to customers about sustainability initiatives or benefits for workers in the downstream channel.

Cross-case analysis also highlights the huge adoption of organisational practices that has occurred (e.g. sustainability governance structures and standards, regular sustainability meetings, certifications, etc.) in driving this implementation through different SC stages, both upstream and downstream. Organisational practices need to mitigate the tension in relation to sustainability that exists both within the company and throughout the SC. Through a definition of a common standard, the extension of a code of conduct, and the full awareness of internal

employees, a focal company can be recognised as advanced in terms of sustainability by both customers and suppliers.

Manufacturing complexity, however, is not an issue for the focal companies, which are accustomed to fully outsourcing their production to external suppliers. This impacts strongly on their level of upstream complexity because of the huge number of suppliers to be managed. As mentioned before, focal companies allocate production to suppliers, but they are still in charge of selecting, negotiating contracts and controlling the raw materials and components of the suppliers in terms of their sustainability objectives.

On the basis of these considerations, we make the following propositions:

RP1.1: Focal companies face a high level of upstream complexity, mitigated through a proper combination of both sourcing practices (e.g., supplier monitoring and selection, supplier collaboration, supplier development, etc.) and organisational practices.

RP1.2: Focal companies face a high level of downstream complexity, mitigated through the adoption of organisational practices.

First-tier suppliers face high upstream complexity and medium manufacturing complexity

For first-tier suppliers, downstream complexity is not an issue. First-tier suppliers are often very small companies and are highly dependent on the brand owner (the focal company). Thereby, in collaborating with the brand owner, they are forced to adopt the sustainable practices of the focal company. They are subject to the brand owner's guidelines, which direct them towards a path of sustainability that is in close alignment with the brand. For instance, this is the case with first-tier SC A, which for some years, has been under the financial control of focal company A. After its partial acquisition of this supplier, the focal company A decided to establish a sustainability improvement plan for this supplier, aimed at containing the sustainability risks arising from managing a complex SC.

In contrast, first-tier suppliers face high upstream complexity due to the extensive globalization of the supply base and the increasing number of both sub-suppliers (carrying out specific phases of the production cycle) and raw material suppliers that they have to manage. For this reason, first-tier suppliers implement operational practices in their sourcing to guarantee sustainability

parameters, such as the selection of certified suppliers (the validity of the supplier in relation to sustainability is guaranteed by a third party) or local suppliers (to control operations in a simpler way).

These practices are also necessary to guarantee the extension of sustainability programmes along the chain. The focal company sometimes delegates to the first-tier supplier the control of sustainability initiative implementation across the upstream channel of the chain. This is often a challenge for the first-tier supplier because they have low bargaining power due to their small size. This problem was reported by first-tier supplier SC-B:

We cope with big suppliers that already have sometimes their own sustainability strategy. Our focal company is asking us to extend their code of conduct to these suppliers and also to use the same supplier assessment questionnaire with them, but we are weak and not very important and so it is something that is quite hard to achieve. We are not in a strong position in terms of bargaining power.

As the case study shows, manufacturing complexity is relevant to first-tier suppliers, given that they are the actors in charge of performing most of the production activities for the final product. Despite this relevance, the overall importance is only medium because the product variance is not complex: the companies included in our analysis were realizing just one product category, although perhaps in several variants and colours. Fashion products are also quite simple and do not generally include a large number of components. This is a typical feature of the fashion industry and is especially true of clothing. Regarding the sustainability dimension, the research highlights that major sustainability practices are not developed at this tier.

On the basis of these considerations, we make the following proposition:

RP2: First tier suppliers mainly face upstream complexity and should be able to mitigate it through adoption of proper sourcing practices as pushed by the focal companies.

Second-tier suppliers face high downstream complexity and medium manufacturing complexity

Second-tier suppliers collaborate in the production of different brands, and they must manage a large number of customers, which complicates their downstream activities and therefore, their

sustainability practices. Downstream complexity is the main element to be considered in the implementation of sustainability practices by this tier. These companies have a wide customer base, which is highly varied in terms of dimensions and requirements, and they have generally been selected at a global level in the search for the best raw materials worldwide. Second-tier suppliers must cope not only with the first-tier suppliers but also with the focal companies (for instance, in defining the characteristics of the products), and this hugely increases the number of actors that they have to manage. In this situation, sustainability is used to achieve differentiation from competitors: second-tier suppliers therefore implement sustainability organisational practices, making sustainability part of their internal routine and included in the definition of their goals. They have regular meetings and budgets for sustainability. They also demonstrate the value of sustainability programmes internally to employees with benefits and structured organisational welfare and externally through the achievement of sustainability certifications to be displayed to customers.

Manufacturing complexity for second-tier suppliers is not high and has less impact than their downstream activities. This is because the products supplied have a low number of parts. The components are simple and differ only, for instance, in terms of colours, whether textiles or leather, and this translates into fewer manufacturing problems. Second-tier suppliers adopt operational sustainability practices in managing their businesses, including the evaluation of energy consumption and its improvement through eco-friendly production processes. These sustainability practices are also necessary to ensure the satisfaction of customer requirements. An example of this is reported by a second-tier supplier for SC C:

We are strongly focused on our manufacturing activities. The internal variety we manage is pretty low: the most complicated thing is the number of colours. But it is necessary to have sustainable manufacturing techniques to cope with the requirements of our customers as most of the environmental impact is at the manufacturing level.

Upstream complexity is not perceived as an issue at all at this tier because these companies have a low number of suppliers of raw materials; these are mainly stable over time and are managed with long-term contracts. Although they are not pressured in terms of complexity,

second-tier suppliers are devoting increased attention to sustainable operational practices in their sourcing to meet their sustainability strategy goals.

On the basis of these considerations, we address the following propositions:

RP3.1: Second-tier suppliers mainly face downstream complexity, mitigated through the extensive adoption of organisational practices.

RP3.2: Second-tier suppliers face medium manufacturing complexity, mitigated through the adoption of manufacturing operational practices (e.g. eco-friendly production processes, regular evaluation and consumption mapping).

RP3.3: Second-tier suppliers face low upstream complexity but are required to implement sourcing practices that will ensure a sustainable supply chain.

The implementation of sustainable sourcing practices by second-tier suppliers can create conflicts along the SC. Some practices are held in common by the focal company and the second-tier suppliers, such as eco-friendly packaging, sustainable vendor rating, extension of RSL, supplier selection and monitoring. However, the brand owner who is trying to cope with the complexity of managing the sustainability initiative will find the interface with the second-tier supplier less amenable than that with the first-tier supplier. The second-tier supplier will be implementing their own sustainability programme and inevitably, not all practices will be aligned with the priorities of the focal company. This illustrates the very high level of influence exerted by the focal company on the first-tier suppliers and the paucity of independent sustainability strategies formulated by these actors. This conclusion was confirmed by the owner of the first-tier supplier of SC B: *“For us, sustainability was something new, we were not aware of this. FCB is our main customer, we do everything they ask us to do”*.

The approach of second-tier suppliers to sustainability was shown to be totally different: all had initiated their own route to sustainability independently of the brand owner. In fact, second-tier suppliers are generally not “green field” companies but companies with their own well-defined sustainability strategies. This is illustrated by the introduction of sustainability practices by second-tier suppliers (e.g. the introduction of ISO certification or the adoption of internal sustainability standards) as early as 2006. At that time, neither the brand owner nor the first-tier supplier was considering expanding their sustainability vision to the entire chain. The

sustainability development of second-tier suppliers has largely been independent of the focal companies' influence. Paradoxically, the very proactivity and independence of second-tier suppliers may hinder the organic development of sustainability awareness along the chain. In fact, it emerged that the strategies of second-tier suppliers and brand owners were not in total alignment, generating conflict or at least, slowing down the companies' progress towards a joint sustainability program. An illustration of such a dispute became evident when a second-tier silk supplier refused to sign the code of conduct of Focal Company B. A declaration by the focal company illustrates the nature of this disagreement: "*The supplier considers its own ethical code adequate to be part of our supply base; however, it has to adapt and become compliant with our policies and documents*".

Conclusions and possible future developments

The results described demonstrate the tensions existing in the field of sustainability at the various SC levels, confirming the need for fresh insights into *how SC complexity influences the adoption of sustainability practices at different levels of the SC (RQ)*. This paper investigates the differences existing between companies at different tiers of the SC in terms of their adoption of sustainability practices. It addresses the role of static SC complexity in differentiating between these behaviours. To accomplish this goal, 18 fashion companies, including focal companies, first-tier and second-tier suppliers, were interviewed. Companies were compared first for SC complexity and then in terms of their sustainability practices.

On the basis of these analyses, we have been able to identify some significant results. The first-tier supplier is often a small company performing the final assembly of a product with a very small number of customers (i.e. low downstream complexity), a medium variety of internal processes (medium manufacturing complexity) but a large number of suppliers, often with a global distribution (high upstream complexity). The first-tier of the SC mainly promotes sustainability through its organisational and sourcing practices. These small organisations may be considered "green field" companies in terms of their sustainable behaviours, and the brand owner's guidelines are essential to make them aware of the importance of the topic and to commit to an individual sustainability trajectory.

In contrast, the second-tier companies are generally producing materials (e.g. leather, fabric or yarn), have a high level of managerial intervention, are of considerable size and have a broad

range of customers (high downstream complexity). However, there is little differentiation between suppliers (low upstream complexity), and they have relatively simple internal processes (medium manufacturing complexity). With these characteristics, some of the sustainability practices of second-tier suppliers are organisational, some involve sourcing and several manufacturing. The second-tier companies in a chain are sometimes larger than first-tier suppliers (more than 250 employees) and have a broad range of customers. This means that first-tier and second-tier suppliers have different levels of dependency on their customers, resulting in an imbalanced relationship between them.

Finally, focal companies face both upstream and downstream complexity, and for this reason, their sustainability practices will include both sourcing and organisational practices. These are further motivated by their responsibility to push sustainability throughout the SC.

Through these outcomes, this paper makes a contribution to both research and practice: Regarding research, the paper aims to link the concept of SC complexity with the implementation of sustainability practices, which is a relatively new area of investigation. The paper does not simply show the relevance of SC complexity to the adoption of sustainability practices, but it addresses three different types of SC complexity (internal, upstream and downstream), indicating the implementation of specific sustainability practices by each of these levels to address and solve the risks associated with SC complexity. The literature has addressed the importance of considering complexity from a SC perspective (Guide and Wassenhove, 2009), and it has also considered the importance of complexity in investigating sustainability (Hall et al., 2012). However, very little literature has considered sustainability at the SC level (Aitken et al., 2016). This paper provides a twofold contribution to the existing literature: On the one hand, this paper considers complexity from the SC perspective, and it then uses this theoretical lens to analyse sustainability. On the other hand, the paper contributes by considering SC sustainability at three different levels of the SC, and at a practical level, it provides an operational view of the topic. The existing literature that investigates sustainability has considered either operational or organisational practices, whereas this paper provides a theoretical contribution in which these two views of sustainability practices are combined. Finally, this paper is a preliminary theoretical attempt to address sustainability problems by comparing the approaches of three different tiers of the SC.

The paper thus provides some useful tools to enable managers to support the implementation of sustainability along the supply chain. It is a particularly relevant tool for focal companies, enabling them to identify the main areas they need to control in order to push suppliers towards sustainability. These results are also relevant for first- and second-tier suppliers, assisting them in fostering sustainability from a SC perspective and not just from a company perspective. On the basis of its results, the paper can support companies in implementing best practice based on their positioning on the SC. One of the main problems faced by managers in relation to sustainability is to define priorities for implementation: this paper offers insights about the selection of practices and suggests the potential role of other SC actors, thereby enabling a selection of SC practices that is consistent with the level of complexity faced by each actor.

The paper indicates opportunities for further research. Because this study was qualitative, additional research with a wider sample is needed to validate the conclusions of the current paper. Moreover, only actors operating within the Italian environment were considered: an extension to include suppliers with a global perspective would enrich the value of the paper. Similar research might be conducted in other industries where the application of sustainability practices in complex SCs is relevant. Further studies are suggested in these other contexts to validate this study and to investigate other potential differences in the application of sustainability practices among SC partners.

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