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Linking sustainability-oriented innovation to supply chain relationship integration

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ABSTRACT

Sustainable strategies applied in the context of supply chain management are receiving increasing attention from practitioners and researchers. In this regard, innovation in products, organizational structures, and business methods can be the key to achieving economic, social, and environmental outcomes. The purpose of this paper is to analyze how sustainable-oriented innovations (SOI) can influence inter-organizational relationships in sustainable supply chain management. The research is based on two case studies of Brazilian focal companies (Braskem and Mercur) and their respective suppliers and customers. We have identified different realities regarding operational aspects, supply chain structure, and the strategic orientation for sustainability. The cases outlined provide in-depth insights into the forms of SOI, i.e. product and organizational innovations. A practical implication includes the illustration of how the sustainability innovations allow the reaping of positive effects to businesses along the supply chain. Collaborative relationships with suppliers and buyers can be seen as a source of learning, development of new technology processes, and information acquisition. We position our research within the realm of sustainable SCM as a contribution to the increasingly discussed relationship dimensions and present links to the sustainable innovation literature, which is rarely amalgamated with the SCM discipline. This establishes a more concrete connection, where further research at this intersection would be required.

1. Introduction

Sustainable strategies applied in the context of supply chain management are receiving increasing attention from practitioners and researchers (Carter and Easton, 2011; Beske and Seuring, 2014; Pagell and Wu, 2009). Strict regulations, consumer requirements for more transparency, and even the role of CEOs' internal values have influenced businesses to consider sustainability as a competitive priority. In this regard, innovation in products, processes, organizational structures, and marketing methods (Organisation for Economic Cooperation and Development (OECD), 2005) can be the key to achieving economic, social, and environmental outcomes (Carvalho and Barbieri, 2010).

The development of social and environmental strategies, however, is often a challenge for organizations. Sustainability requires new ways of thinking, and the most usual mechanism for implementing novelties and improvements is developing new knowledge and applying it throughout innovations (Organisation for Economic Cooperation and Development (OECD), 2012). Besides the traditional economic indicators (e.g. revenues, profits, market share), when innovation meets sustainability, it is also possible to reach stakeholder requirements and earn recognition for being "a responsible company." In this case, image and reputation are very important tools for competitiveness (Montalvo et al., 2011).

Nevertheless, previous studies reveal that the link between

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innovation and sustainability is still not well developed because of reasons such as the numerous interpretations of the meaning of sustainability, which brings a diversity of connotations, e.g. green, eco, environmental, and social innovation. This also leads to an applied dichotomic view of sustainability (yes or no) to studies in the field instead of a dynamic and processual perspective (Adams et al., 2016). Therefore, Adams et al. (2016) introduce a sustainability-oriented innovation construct that aims to promote changes in processes and products based on clear objectives of creating social and environmental value while simultaneously generating economic returns. To develop these sustainability-oriented innovations, relevant changes are needed in business models. Innovative development also requires new behaviors and relationships with stakeholders along supply chains in particular (Ayuso et al., 2011; Iles and Martin, 2013).

So far, there is a lack of empirical evidence from Latin American countries and other emerging economies showing the different realities regarding sustainability management integration in supply chains. Exploring such evidence can contribute to the diversity of knowledge in the sustainable supply chain management (SSCM) field (Pagell and Shevchenko, 2014). Although limited in quantity, some empirical studies reveal how Brazilian companies are managing sustainability strategies in their supply chains and how innovation has contributed to integration (e.g. Carvalho and Barbieri, 2010; Diniz and Fabbe-Costes, 2007; Hall and Matos, 2010; Silvestre, 2015). The pronounced differences raised for related empirical research are four types of uncertainties appearing in emerging economies (technological, commercial, organizational, and societal), so companies usually act in a proactive manner (Hall et al., 2011; Silvestre, 2015). It is interesting to note that relationship aspects in the context of SSCM (Beske et al., 2014) and developing countries (Diniz and Fabbe-Costes, 2007; Khalid et al., 2015) have been raised as an important issue, but no single piece of research has put them at the core of their arguments.

This leads to the research question: How do sustainability-oriented innovations drive inter-organizational relationships in supply chains? One of the most critical elements for integrating sustainable strategies and practices in supply chains is the firm's ability to develop effective inter-organizational relationships (Paulraj et al., 2008; Gold et al., 2010). However, the causality effect of sustainability orientation on relationship development remains unclear. Understanding how firms that are implementing sustainability strategies aim to significantly strengthen relationships with supply chain partners lies at the focus of this study, which is reflected in the theoretical framework proposed later in this paper with the ultimate objective of improving sustainability performance.

This paper is structured into eight sections. After the introduction, the second part presents the role of innovation in sustainability management; the third section presents a review on inter-organizational relationships in sustainable supply chain management. Next, we outline the research method employed. The fifth section refers to the case descriptions, with the results, discussion, and relation to theory presented thereafter. The paper concludes with some final remarks and suggestions for future research.

2. The role of innovation in sustainability management

Sustainability management poses some of the biggest challenges and opportunities in business. Although many companies still consider it costly, they also admit there is no way to ignore sustainability if they want to remain competitive in the market (Montalvo et al., 2011).

Sustainable innovation is the introduction of products, production processes, management practices, or business methods, new or significantly improved, that bring economic, social, and environmental outcomes (Carvalho and Barbieri, 2010; Gmelin and Seuring, 2015). According to Carrillo-Hermosilla et al. (2010), the meaning and characteristics of sustainable innovations can differ, depending on the context. For instance, developing and emerging countries must have different sets of priorities and concerns when it comes to defining sustainability and determining the most important dimensions to be reached. Therefore, sustainable innovations are intrinsic to spatial, temporal, and cultural necessities and challenges.

Sustainable innovation can be incremental (product and process related) (Henderson and Clark, 1990), influencing the traditional production systems to generate gradual improvement throughout new technology applications and to achieve improved sustainability performance (Boons and Wagner, 2009). Focusing on the organizational level, innovation can be studied in the individual firms and its innovative capacities to develop new technology along with R&D's relationship with other functions like marketing and production (Boons and Lüdeke-Freund, 2013).

However, Boons and Lüdeke-Freund (2013) state that while there is a broader knowledge on what drives sustainable innovations at the firm level, there is still a lack of knowledge on how to create value from win-win situations when sustainable innovations are settled in inter-organizational relationships. In this respect, it would be necessary to consider not only the organizational level but the whole system, thereby promoting changes in the business model to extend both upstream to suppliers and downstream to customers.

In this regard, Adams et al. (2016, p. 181) introduce the Sustainability-oriented Innovation (SOI) concept which involves “making intentional changes to an organization's philosophy and values, as well as to its products, processes or practices, to serve the specific purpose of creating and realizing social and environmental value in addition to economic returns.” The authors suggest that innovation activities oriented to sustainability are based on three main contexts: *Operational Optimization, Organizational Transformation, and Systems Building*. Thus, at first, companies have the objective of *optimization* with incremental innovations based on “technical-fixes” (both to processes or products) in order to reduce impacts. The focus is on exploiting internal capabilities to identify the knowledge existing internally which can disseminate and create a better understanding for all firm members about the importance of sustainability to reach strategic objectives (Adams et al., 2016). Second, innovation activities are related to *organizational transformation*. Here, there is a shift in the mindset of the company, and sustainability becomes more deeply embedded in the company's strategy and culture. Engagement and collaboration with internal and external stakeholders yields SOI (Adams et al., 2016; Ayuso et al., 2011). The social dimension of sustainability emerges more distinctively in this context with new products or services that generate value to poor communities, often referred to as bottom-of-the-pyramid innovations (Adams et al., 2016; Carrillo-Hermosilla et al., 2010; Khalid et al., 2015). Finally, in the *systems building* perspective, SOI is related to a shift in business thinking and business purposes. Firms should work to derive co-created value propositions where innovations would be designed collectively with ambidextrous skills in order to solve complex problems. The main objective would be a shift to new business paradigms (Adams et al., 2016).

Based on the perspective of Adams et al. (2016), it is in the *organizational transformation* context that sustainable innovations become integrated in companies’ cultures and strategies in order to generate value. Establishing a sustainable value definition will determine the direction of new products and services and, in particular, the way that companies create links with suppliers and

customers seeking to share costs and benefits resulting from these sustainable innovations (Adams et al., 2016; Boons and Lüdeke-Freund, 2013). Boons and Lüdeke-Freund (2013) state that companies could create competitive advantage from sustainable innovation if they design strategy-oriented business models to create value for customers and stakeholders. However, the challenge would be on how to integrate strategies of sustainability (and sustainable innovations) along the supply chain, particularly related to relationships and supply chain structures.

It becomes clear that for companies to develop sustainable strategies including innovative processes and products, it is fundamental to integrate those strategies along supply chains. The next topic will explore the challenges that companies face when engaging their suppliers in sustainable supply chains regarding inter-organizational relationship management and the development of effective sustainable practices.

3. Integrating inter-organizational relationships into SSCM

To integrate sustainability objectives into an organizational and supply chain level, the initial impulse for corporate decisions comes from external pressures and stakeholder incentives (customers, competitors, governments, NGOs), and it is usually transferred from the focal companies to their suppliers in a process of orientation to sustainability and reconceptualization of the supply chain (Pagell and Wu, 2009; Beske, 2012). This is in line with the call for future research by Govindan et al. (2016), where relationship and governance aspects are explicitly put forward. To spread the sustainability orientation throughout supply chains (Beske and Seuring, 2014), companies can innovate in management systems specifically focused on managing risks and performance related to suppliers (Beske, 2012) or develop a supply chain specific for sustainable products (Seuring and Müller, 2008a; Seuring, 2011) leading to different supply chain configurations (Akhavan and Beckmann, 2016).

Considering the two strategies proposed by Seuring and Müller (2008a), both product as well as process-related innovations might be observable. These two strategies are not mutually exclusive but often are implemented simultaneously along the supply chains. Based on a new strategic positioning, companies can introduce innovations applied to products and processes, creating entrance opportunities in new markets, image gains, and competitive advantages (Pagell and Wu, 2009; Seuring and Müller, 2008b; Akhavan and Beckmann, 2016). Moreover, the integration of different actors leads to inter-organizational relationships that reduce conflicts and provide the proper conditions to apply sustainable strategies along the SC (Wolf, 2011; Gold et al., 2010; Kumar and Rahman, 2016).

The importance of relationships in SCs is due to operational and tactical processes. In the case of a sustainability orientation integration, the strategic level, including co-development of competitive resources and capabilities, is critical (Ashby et al., 2012). In Fig. 1 we present a conceptual framework with the crucial elements of a business model applied to supply chains that seeks integration of sustainability strategies.

The starting point of drivers and incentives for sustainable supply chain management has received a lot of attention, and many studies have centered their efforts on these issues (Mathiyazhagan et al., 2013; Sajjad et al., 2015; Govindan et al., 2016). The core argument is that both external and internal factors drive the management of related risks and opportunities (Freise and Seuring, 2015). Focal companies can either pursue a more product or process-related implementation of SSCM strategies and related innovations (Seuring and Müller, 2008a). While the product-related strategy aims at improving the sustainability of products (Seuring, 2011), the strategy focused on processes builds on supplier management approaches, such as supplier selection and development (Yawar and Seuring, 2015). As Seuring and Müller (2008a) already highlighted, these two strategies are closely related to each other and will need management of relationships, an issue heavily explored in recent years.

Therefore, we assume that an effective development of innovative SSCM strategies relies on the integration of inter-organizational relationships. These are explained by three major factors: (1) resource investments, building on the relational view (Dyer and Singh, 1998; Gold et al., 2010); (2) collaboration (Gimenez and Tachizawa, 2012; Blome et al., 2014**),** and (3) governance mechanisms (Alvarez et al., 2010**)**. This should then lead to sustainability outcomes in each of the three dimensions, i.e. economic, environmental, and social. The three constructs are highly discriminant to each other and will be explained subsequently. We argue that they together form a sound conceptualization that is reasonably comprehensive.

3.1. Resource investments

Many authors from sustainable supply chain management literature have addressed the relational view (Dyer and Singh, 1998) and related resource investments as an interesting concept to explore the relational advantages of partner integration and co-creation of valuable resources and capabilities (Vachon and Klassen, 2008; Gold et al., 2010; Touboulic and Walker, 2015). Inter-organizational resources can be generated from investments in specific assets in relationships between companies as social investments when companies partner with local communities to provide sustainability education and improve suppliers' conditions (Huq et al., 2014; Marshall et al., 2015). Investments can furthermore support collaborative social technology and research to develop sustainable products and innovations created in the supply base (Marshall et al., 2015), showing positive impacts on the buyers'

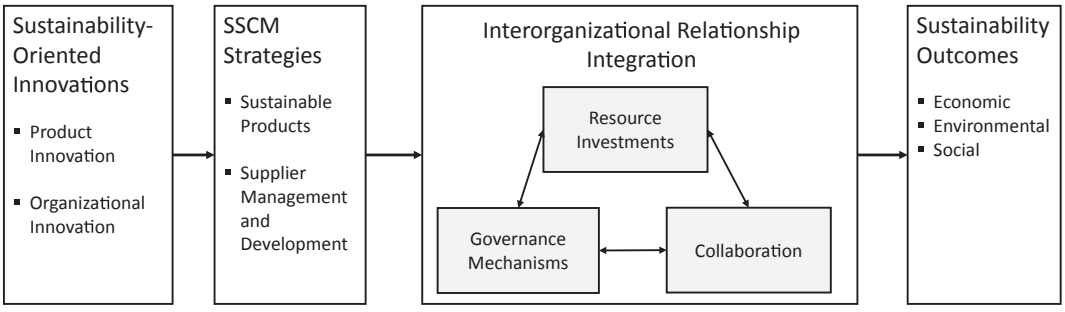

Fig. 1. Integrating sustainability-oriented innovation and supply chain management.

side (Busse, 2016). Also, joint learning processes and knowledge exchange can help develop firms' absorptive capacity to assimilate external information for sustainable technology and innovative products (Chiarini, 2012; Blome et al., 2014).

Therefore, the relational view has been adopted as an approach that analyzes how inter-organizational relationships and relationship investments can be managed so that a source of value for supply chains can be constituted (Chen and Paulraj, 2004; Vachon and Klassen, 2008). The common fundamental elements grounded in both the relational view and SSCM approaches refer to collaboration and coordination.

3.2. Collaboration

Collaboration includes the integration of knowledge and cooperation enabling companies to create unique organizational capabilities (Vachon and Klassen, 2008; Zacharia et al., 2011). Collaborative relationships recognize the need for sharing information and skills and applying complex strategies that require resources that are often not entirely owned by individual companies (Attaran and Attaran, 2007; Nyaga et al., 2010). Collaborative relationships can modify a firm's internal set of capabilities and lead to new technological and strategic resources on both levels, internally and within the supply chain (Rodriguez-Diaz and Espino-Rodrigues, 2006; Zacharia et al., 2011).

When collaborative relationships are integrated and synergistic, it is possible to exchange knowledge, develop innovative capabilities, and generate complementary resources, thereby increasing the possibility of value creation for the entire supply chain (Rodriguez-Diaz and Espino-Rodriguez, 2006; Gulati, 2007). Thus, inter-organizational, collaborative relationships might be promising sources of competitive advantages (Gold et al., 2010; Niesten et al., 2017).

Despite all potential benefits of collaboration in SSCM, it can be difficult to properly manage due to its complex characteristics that involve intense relationships, socialization, trust, time intensity and, above all, knowledge sharing between companies (Aras and Crowther, 2009). To manage the collaboration in order to reach competitive gains, an efficient governance of the SSCM relationships is required.

3.3. Governance mechanisms

Governance mechanisms are defined as parameters and methods by which the relationships between organizations are managed (Grandori, 1997). They are typically divided into formal (control, communication systems, command structures, incentive systems, standardized procedures of operations, and troubleshooting) (Gulati and Singh, 1998), and informal (based on trust, commitment, communication, culture socialization, and joint projects) (Alvarez et al., 2010; Dekker, 2004). In supplier relationships, both formal and informal aspects are frequently used and are aligned with the direct and indirect tools of supplier development (Krause et al., 2007).

Combining formal and informal mechanisms, Wang and Wei (2007) introduced the concept of relational governance. When companies aim to develop new and sustainable strategies, they tend to look for more restrictive and closer relationships with suppliers (Seuring and Müller, 2008a; Pagell and Wu, 2009). Through relational governance, companies can use efficient mechanisms to manage interactions in the supply chain, promote collaboration, and generate relational rents (Paulraj et al., 2008; Zacharia et al., 2011; Tachizawa and Wong, 2015).

Based on our literature review, Table 1 presents a detailed set of elements that is intended to be used for the analysis of the empirical data. Table 1 provides the backbone of the interview guideline used during data collection.

Resource investments, collaboration, and governance are discriminant constructs that constitute a holistic perspective on inter-organizational relationships. As outlined above, each construct describes a different dimension of relationships between buyers and suppliers. The last element of the framework is the performance outcomes. Following the logic that performance measures should be available for each sustainability dimension but recognizing that firms implement various measures for environmental, social, and economic performance, we do not operationalize these three dimensions further. Extant studies base performance on participant perception, e.g., Pullman et al. (2009) and Busse (2016) found impacts of social and environmental practices implemented on firms' cost, environmental, and quality performance by polling participants on whether they believed their facility's involvement in sustainability led to an improved performance.

4. Methodology

A multi-case study research method was applied in this study (Yin, 2003). Case studies are considered appropriate under certain research problems, such as those where research and theory are still in early stages of development (Eisenhardt, 1989). The use of a multi-case study method in studies involving sustainability management in supply chains is supported by several authors in the field (Matos and Hall, 2007; Pagell and Wu, 2009; Seuring, 2008; Wu and Choi, 2005). Following these authors, this approach should provide detailed evidence of the facts, especially when the field and the theory are still in development. In line with the argument already made for the contingencies in emerging economies (Silvestre, 2015), case studies provide an approach that is able to account for flexible but detailed access to the field.

The aim of this study was to identify pioneers in the field, which are studied as exemplary cases supporting respective theory building (Pagell and Wu, 2009). Therefore, we conducted two in-depth case studies within different industries but still comparable in terms of sustainability strategies created along the supply chains and in innovation initiatives, both being considered first movers in their sectors.

The case selection was based on the identification of companies with institutionalized concerns and values about sustainability with relationship strategies applied to suppliers and buyers. We also used as selection criteria companies that indicated recent innovative processes or product development based on these sustainability values and those with a significant market share in Brazil. Among the selected focal companies was Braskem, one of the largest Brazilian companies of thermoplastic resins production that in the last years has invested in bioplastics made from sugarcane and claims to be one of the top Brazilian companies investing in sustainable innovations. Mercur was also selected for the study, a medium-sized company specializing in educational and healthcare products that made profound structural changes once it was decided to innovate in sustainable solutions for its market segments. This also follows a theoretical sampling logic. The Braskem case is directed towards the strategy of SCM for sustainable products (Seuring and Müller, 2008a; Seuring, 2011), while Mercur focuses on the supplier-related management processes labeled as supplier management for risk and performance (Seuring and Müller, 2008a). Hence, this classification of approaches is applied to the cases so that both of them are predominantly covered in one case each.

To obtain primary data, semi-structured interviews were conducted with managers and directors of focal companies and

Table 1
SSCM elements to analyze inter-organizational relationship integration.

Resource Investments	- Collaboration in social investments - Partnerships with particular exchanges (mutual experiences; communication and cultural knowledge exchange) - Collaborative investments in sustainable innovations - Complementary resource endowments (ability to identify and evaluate potential complementarities) - Knowledge sharing routines - Relationships based on transparency and reciprocity - Inter-organizational learning - Reputation – company and company's brand	Blome et al. (2014); Chiarini (2012); Dyer and Singh (1998); Gold et al. (2010); Huq et al. (2014); Marshall et al. (2015); Paulraj (2011); Touboulic and Walker (2015)
Collaboration	- Communication and information sharing, - Investment in specific relationships - Joint development projects (cross-functional and technology integration) - Planning and logistics integration - Resource sharing for specific objectives - Development of joint practices in sustainability programs - Values and social norms sharing - Social ties (trust, commitment)	Díaz and Espino-Rodriguez (2006); Zacharia et al. (2011); Beske (2012); Beske et al. (2014), Touboulic and Walker (2015); Chen and Paulraj (2004)
Relational Governance	**Formal mechanisms** - Control and communication systems - Command structures - Incentive systems - Standardized procedures of operations - Troubleshooting - Legal contracts **Informal mechanisms** - Self-regulations (rules, conventions, or standards) - Requirements of suppliers' self-evaluation processes - Informal social ties or social norms - Information sharing - Value systems - Schema and culture	Gulati and Singh (1998); Pilbeam et al. (2012); Alvarez et al. (2010); Dekker (2004); Pilbeam et al. (2012)

members of their supply chains (suppliers and customers), as described in Table 2. In total, we conducted 14 in-depth interviews in Braskem's supply chain and 19 interviews for Mercur's supply chain case.

After initial contacts with the focal companies' representatives, we used the technique of snowballing. This technique is frequently used in social research where the initial research participants serve as references to indicate new respondents to participate in the survey, and so on, until it reaches a "saturation point." The saturation point is the time observed at which respondents repeat information already obtained in the previously conducted interviews.

Data was analyzed using the content analysis technique, based on a predominately deductive logic (Mayring, 2000) following the framework and constructs outlined in the theory section. For internal validation, we attempted to establish clear conceptual definitions of the key terms and variables related to the research (Gibbert et al., 2008). In addition to interviews, we analyzed field notes based on observation and documents such as managerial and sustainability reports, newspapers, and government reports. Since reliability refers to the consistency in which a research procedure evaluates a phenomenon the same way in each trial (Gaskell and Bauer, 2008; Yin, 2003), we submitted our interview guideline to three researchers to verify the clarity of the questions and made revisions following the experts' suggestions.

5. Results 1 – sustainability-oriented innovations

5.1. Product innovation at Braskem

Braskem is one of the largest companies in Brazil and the third largest producer of thermoplastic resins in Latin America. One of the company's strategic goals focuses on sustainable innovations; therefore, the company invested in green polyethylene (PE), a bioplastic produced from plant-based ethanol.

In the case, we see an innovation related to a product, the green PE. Braskem has followed other important companies in the plastic industry that have invested in green chemicals, exploring options to produce polymers from renewable biomass.

> *"Our investments portfolio in innovation is totally geared towards revolutionary products in environmental issues, and we plan to maintain it because our mission is to reach the global leadership of sustainable chemistry." (Sustainability manager)*

The green PE was Braskem's first experience in developing a business line that differs from its core business. The decision for producing such bioplastic was motivated by research on market potential for "renewably-sourced" PE and was reinforced by customers.

> *"We had technology that was not 100% settled yet but a Japanese client, Toyota Tsusho, really wanted the product. They saw the market potential for this product; customers wanted to buy something different and sustainable, so they decided to invest in our project." (Sustainability Director)*

The development of this bioplastic required innovative processes (regarding the ethanol catalysts) and investments in a specific industrial plant. The green PE also required the establishment of new relationships along the supply chain. Braskem had to develop new resources and invest in relational capabilities with a new set of suppliers. Braskem's main suppliers are the ethanol industries that are part of a very integrated and regulated market. Brazil is the world's leading producer of sugarcane but also ethanol used in automotive fleet. Despite the ethanol market's internationalization leading to a better management of socio-

Table 2
Interviewee characteristics.

Cases	Actors in the SC (33)	Department
Braskem	Focal company (9)	Industrial plan of green polyethylene unit, strategy, renewable technology, procurement and logistics, sustainability management, sales, marketing
	Suppliers (2)	Sustainability management
	Buyers (3)	Business management, sustainable technology
Mercur	Focal company (11)	Business management, impacts, procurement, R&D, innovation
	Suppliers (6)	Operations, business management, sustainability
	Buyers (2)	Business management

environmental problems under national and international certification systems, there are still high risks involved for producers in this industry. Sugarcane production still is a symbol of massive natural resources exploitation and slavery in Brazilian history. Environmental impacts are related to land use, water contamination, and CO_2 generation from straw-burning practices. From the social aspects over the years, the industry had its image undermined by innumerous allegations of serious labor condition violations, including child labor, unsafe working conditions, and even workers' death in the fields from starvation (Lins and Saavedra, 2007).

Therefore, developing a product with environmental appeal based on sugarcane by-products has been a challenge in operational aspects and for legitimacy in new markets. It requires constant legislation conformance auditing (social and environment), assurance that cultivated areas are not part of Amazonian territory, and extensive, transparent information about suppliers' practices.

The critical point of ethanol suppliers is that even holding relevant certifications of best agricultural practices like ISCC (International Certification of Biomass and Sustainable Biofuels) and Bonsucro (international certification of sugarcane production and ethanol), the companies only have approximately 50% of sugarcane fields certified. The remaining percentage comes from contracts with so-called "third parties" that are independent producers, small farmers, or agricultural cooperatives whose agricultural practices are not controlled by the ethanol companies.

Although suppliers demand their upstream suppliers to comply with environmental and social regulations, the difficulty of applying an effective traceability system was admitted in the interviews. Braskem created a code of conduct applied for third-party suppliers in order to manage potential social and environmental risks but also to establish closer relationships with suppliers in order to map all production stages.

To develop a market for its new product, Braskem focused its strategies on those clients who use the plastic resin in their product developments and for packaging. The company created a specific label to be used in the products' packages to identify and communicate to customers about the resin produced from ethanol and, at the same time, to be a tool for risk management in potential greenwashing.

5.2. Organizational innovation at Mercur

Mercur is a medium-sized enterprise with a solid market in Brazil and produces products in three major sectors: education, healthcare, and rubber flooring. Motivated by the potential obsolescence of Mercur's products, the company decided to promote crucial changes in its business model, internalizing sustainability values in its business strategies.

Mercur is investigated in this study because of the interesting paths that have been taken to insert sustainability, especially in terms of organizational innovations in its management model. The origin of the steps taken is reflected on by Mercur's CEO: "*We need to have more responsibility. I started to ask myself what is the social role of our company because it changes the society. For companies, the vision of the whole is missing; everything is cause and consequence, so am I producing for whom? For what? We began to ask ourselves these things– about our purpose, our legacy, and how we could make these issues a reality in our business experience.*"

Thus the first proposal in the company was to embed sustainability into Mercur's core business. This decision led the company to a deep process of reflections and discussions about the meaning of a sustainable performance and what tools would be needed to make a business profitable and sustainable at the same time. Mercur defined a set of drivers used to guide the entire organization through the process change, where strategies are designed based on four orientations: sustainability, people, knowledge, and discernment. Mercur also invested in sustainability management education for more than 600 employees and these, in turn, became disseminators of knowledge in order to provide a collective understanding of the company's actions and objectives. For the employees we interviewed, there were two recurrent words: "collaboration" and "commitment."

This new orientation to sustainability also affected the organizational structure and positions. From 2009 to 2011 the company decided to replace management positions with decision-making groups or working teams. These groups were structured for key areas in the company: i) suppliers, involving issues such as logistics, procurement, and supplier relationships; ii) clients, which deals with issues such as sales management, customer management, and innovation; iii) strategy, referring to the development of new projects, which links to the decision-making group; iv) incubator, a department of employees specifically committed to brainstorming new product ideas; and v) learning spaces where creativity and personal knowledge from employees are stimulated to be externalized as one of the companies' sources of innovations. In the centrality of these groups lies the "production and impacts" that congregates representatives of all the other decision-making groups, since they are transversal to all activities.

As stated by Mercur's CEO when applying a decision-making, group-based management model, it is expected to develop problem solutions through interactions amongst people with different points of view on the same problem.

> *"We expect that, in these teams, decisions will be made in a more collaborative way and without emphasis on the hierarchy." (Decision-making group representative)*

"The idea was for Mercur to not be a totally segmented company anymore. We wanted to make the company more interactive, where relations are between people, not between departments." (Mercur's CEO).

This has also led to a deep understanding of the importance of seeing sustainability as a value that transcends the company's actions: "*Sustainability cannot be imposed; it has to be understood. Mercur's stakeholders must identify that sustainability is ingrained in our culture, to the company's DNA.*" (*Mercur's CEO*).

The new alignment of the institutional commitment and the strategic performance of the company also resulted in a new vision for value creation and new concerns along its value chain:

> *"(1) concerns about the company's activities and its implications for people and organizations; (2) for any activity performed it is*

necessary to consider resource consumption and the impact generation of different natures." (Mercur's CEO)

In order to follow its new sustainability values, Mercur improved its relations with stakeholders and its supply chain members by creating closer relationships and collaborations on both elements of its value chain: innovation in products and innovation in processes.

6. Results 2 – SSCM strategies and relationship integration

Both the innovative product development found at Braskem and the innovative organizational structure and processes introduced at Mercur reveal the role and necessity of inter-organizational relationships if pursuing improved sustainability performance outcomes. In this section, we present the analysis of each particular case as well as the theoretical outcomes and research contributions.

6.1. Braskem

Following the proposed framework, we will analyze how the development of sustainability-oriented innovations can affect the relationships in Braskem's supply chain based on three major factors: i) resource investments, ii) collaboration, and iii) governance mechanisms.

Based on empirical data, we suggest that the green PE developed by Braskem has a more reactive focus. It is a unique product with which the company intends to reach new markets and create a better image related to their plastics production. The knowledge necessary for development and design of this new product was internally exploited; however, to create and promote the new products, the value chain has experienced many changes with the entrance of new suppliers and buyers and new relationships created between them.

Considering evidence of coordination and collaboration, we observed that there is a preponderance of formal mechanisms regulating ethanol negotiations once ethanol is acquired in spot markets, and the relationship is resumed following the code of conduct for sugarcane suppliers that aim to ensure compliance with social and environmental requirements.

Some items of collaboration were limited in our observations, e.g. knowledge sharing in projects and product development. Although ethanol and sugarcane suppliers cooperate for logistics planning and sharing information about the production phases necessary for LCA, there is a lack of collaboration and data sharing, which would have to be developed further. Respondents in interviews mentioned the difficulties of working with suppliers that are more powerful than Braskem. It is important to highlight that Braskem, even being the main customer of ethanol suppliers in Brazil, represents less than 10% of the suppliers' total production. This also limits the implementation of further reaching governance mechanisms, which stayed at a more formal level (Gulati and Singh, 1998).

Regarding resource investments, the company had the knowledge for producing bioplastic from sugarcane since 1970, but only in the last years did it become relevant due to an appreciation of sustainable alternatives in the plastics market (Alvarez-Chávez et. al, 2012; European Bioplastics, 2012). The interest of clients enabled partnership development and joint investments in technology to refine the bioplastic (catalyst). Braskem has a comparative advantage in terms of access to ethanol since Brazil is the world's largest producer of sugarcane. This abundance of natural resources allowed exploiting, while limiting the risk of technical resource investments, such as in the plastics production technology.

Existing resources and capabilities can be identified, such as knowledge on bioplastic production, access to the ethanol market, geographic location, and long-term relationships with buyers (from the traditional plastics industry). New capabilities were developed during the process of collaboration through joint investments, knowledge sharing, and partnering for promoting the product. By presenting the label "*I'm green,*" Braskem established a communication platform with the end consumers, seeking to create added value to its clients' products and, at same time, managing its risks in relation to image or greenwashing.

Machado (2010) states that when companies develop sustainable products, there are implications related to the consumers' satisfaction that go beyond the conventional concerns with price and quality. Braskem's clients assume that the advantage of the green PE is that beyond the sustainable product appeal, they are more likely to buy renewably-sourced PE (the green PE) than biodegradable PE as long as it keeps the same characteristics of the traditional plastics. Therefore, it fits into the existing plastics recycling infrastructure in Europe and Asia (Alvarez-Chaves et al., 2012; Machado, 2010).

Table 3 summarizes the main evidence of relationship integration in the supply chain based on green PE production strategies.

6.2. Mercur

The engagement in social issues has been part of Mercur's organizational culture and contributed substantially to Mercur's business model transition. Following the context that Adams et al. (2016) presented for sustainability-oriented innovations, we can see that Mercur has pursued *organizational transformation* and embedded sustainability into its business model, even presenting

Table 3
Integration of sustainability strategies in Braskem's green PE supply chain.

Relationship construct	Operationalization	Case-specific information
Resource investments	- Relation-specific assets: site specificity (geographic location proximity); - Physical asset specificity: partnerships with particular exchanges; co-specialized resources - Human asset specificity: mutual experiences; particular communication, knowledge and routines	Brazil is the world's largest producer of sugar cane. Proximity to producers of ethanol (São Paulo state); innovation and technology development in ethanol catalysts; suppliers' interest in developing a new internal market besides fuel
Collaboration	- Communication and information sharing - Investment in specific relationships - Planning and logistics integration	- Cooperation with suppliers: logistics integration and information sharing - Collaboration with clients: information and knowledge sharing, joint problem solving, shared responsibility for market development.
Governance mechanisms	- Formal coordination mechanisms	Contracts; international certifications; code of conduct; information sharing

some characteristics of *systems building*.

The establishment of sustainability values guiding strategies and practices benefited from a strong influence of the personal values of Mercur's CEO. The relevant role played by this individual became evident throughout the numerous interviews conducted. He is highly respected by everyone in the company and because the decision to change the business model was something also very personal, employees felt motivated, even inspired by such conduct. These factors were essential in relational and organizational innovations that Mercur has created.

By looking from the perspective of our model in terms of resource investments, we could verify that the company has invested, at first, in intangible resources such as trust, commitment, and tacit knowledge internally and also along the supply chain. Regarding tangible resources, Mercur used its historical interaction with the local community and stakeholders as a channel for new product creation. For example, Mercur invited educators, school directors, and physical therapists to meet in the company's learning space and debate about new demands regarding children learning processes and the existing tools utilized. Mercur created a social lab where consumers and community members are invited to share needs and experiences and suggest solutions that the company's products can provide for their problems.

> *"So why am I going to do market research? I rather prefer to call some groups of people that use our products and ask them how useful they are. We did this with schools' managers, and you cannot imagine how positive it was. We are trying to create a collaborative and trusting environment to promote these interactions. From this, we create innovations and the best solutions for those needs." (Mercur's CEO)*

The internal changes in Mercur's business model also reflected external relations with local communities and SC members. Mercur picked its strategic suppliers to work in a more integrated way, which included packaging, rubber, and cloth suppliers, and service providers such as sewing and logistics operators.

For these strategic suppliers, Mercur improved its communication channels in order to better present its new managerial orientation and disseminate sustainability values along the supply chains. The company developed its sustainability strategies in different formats according to its needs for interaction and collaboration with suppliers.

In order to develop local suppliers, Mercur began to gradually reduce suppliers from distant regions while organizing meetings with local and regional suppliers. Mercur's suppliers are usually small and medium-sized companies, and therefore the company faced the necessity of support in managerial knowledge and environmental compliance. Another reason to develop closer relationships with small suppliers is to ensure the reduction of financial dependence on Mercur. The company now has a policy in place preventing suppliers' sales from Mercur exceeding 30% of their total revenue.

The company also has objectives to reduce GHG emissions of all its activities. Since 2011 the company promotes specific meetings with all its logistics service providers and develops specific sustainability strategies for all activities that involve Mercur's products. In addition to the existing projects that are already running, Mercur intends to start with a reverse logistics policy and future application of LCA in special products, such as rubber.

Thus, based on the reports of the representatives of Mercur, its suppliers, and service providers, we observed that in the upstream of the company's supply chain there is an orientation for long-term relationships, collaborative projects, information exchange, and supplier development (as presented in Table 4).

6.3. Cross-case analysis

Based on discussions about the cases, we can observe the influence of innovation orientation and sustainability on inter-organizational relationship integration along supply chains. Boons and Lüdeke-Freund (2013) state that through business models designed for sustainability, companies have a clear understanding that there is a need to create value propositions for its products and processes, including how the existing relationships are managed and how to generate value and link the customers.

The cases clearly show that sustainability has different meanings and purposes. Braskem has a line of sustainable products (Gmelin and Seuring, 2015) and is more focused on generating value for its customers, thereby ensuring a competitive advantage

Table 4
Integration of sustainability strategies in Mercur's supply chain.

Relationship construct	Operationalization	Case-specific information
Resource Investments	- Complementary resource endowments (ability to identify and evaluate potential complementarities) - Knowledge sharing routines - Inter-organizational learning - Reputation	- Long-term relationships with community (good reputation) - Experience exchange with stakeholders who are sources of innovation
Collaboration	- Communication and information sharing - Joint development projects (cross-functional and technology integration) - Development of joint practices in sustainability programs - Values and social norms sharing - Social ties (trust, commitment)	- Creation of virtual spaces for supplier meetings for joint problem solving as well as information sharing; Development of more sustainable projects and products: packaging design, GHG emission monitoring, proper disposal of waste, recycling initiatives - Engagement with suppliers in specific projects linked to sustainability management: GHG emissions inventory (logistics operators); support and training for environmental management systems - Meetings with strategic suppliers (dialogues about ethical values and environmental impacts of suppliers' impacts on the chain) - Development of joint strategies focused on reduction of GHG suppliers' activities impacts
Governance mechanisms	Formal and informal mechanisms	- Joint definition of contractual terms - Long-term contracts with clauses reviewed periodically - Bureaucratic contractual issues reduced due to long-standing relationships and established trust.

in the market (Seuring, 2011). The relationships developed along the supply chain were systematically integrated so that collaboration behavior could emerge and promote inter-organizational resource synergy and creation, which is in line with the argument made by Busse (2016) that suppliers' orientation towards sustainability positively influences buyer's performance (Seuring and Müller, 2008a; Pullman et al., 2009).

On the other hand, Mercur focused its strategies on modifying its business model based on sustainable values and invested in developing solid relationships with its employees in order to promote all internal structural changes. Posteriorly, Mercur worked with suppliers in collaborative projects and dedicated significant investments to develop local suppliers. In Mercur's case, we observe that cultural and sustainable values have influenced the company's identity and the interpretation of its role in its business sector. These values and orientation towards sustainability have considerably influenced inter-organizational relationships along the supply chain (Paulraj et al., 2008; Gold et al., 2010).

Against the overall framework proposed in the theory section, there would also have to be insights on the sustainability outcomes achieved in the two case studies. As we did not operationalize these outcomes, we do not provide further detailed accounts of the outcomes achieved. Both companies are operating economically, while they also improved towards the environmental and social dimensions. This is most straightforward for the Braskem case, where green plastics-related innovation is at the core of environmental demands. Mercur, as mentioned in sections 6, and 7, had more focus on connecting with partners and local communities, thereby achieving social goals. Hence, outcomes on all three dimensions where achieved, while a more in-depth account is beyond the scope of this paper.

7. Discussion and conclusion

The core contribution of this paper is the presentation of a framework for linking sustainable-oriented innovations and relationship management in sustainable supply chains. This can be positioned in related research on sustainable supply chain management as well as sustainable innovation. On the sustainable SCM side, we position our research as a contribution to the much discussed relationship aspects. In many of the major frameworks proposed in related research (Seuring and Müller, 2008a, b; Pagell and Wu, 2009) as well as recent literature reviews (Gimenez and Tachizawa, 2012; Touboulic and Walker, 2015), related arguments are posited. However, a concrete operationalization of relationship management is still lacking. This is the particular research gap we address in this paper. In detail, linking resource investments, collaboration, and governance allows a comprehensive analysis, where the cases provide some initial evidence of the applicability of this framework.

We specify inter-organizational relationships in sustainable supply chains. While relationships are an important part of the research on sustainable supply chain management (Pagell and Wu, 2009; Beske and Seuring, 2014), the three elements, i.e. resource investments (Blome et al., 2014; Huq et al., 2014), collaboration (Touboulic and Walker, 2015; Beske et al., 2014), and governance structures (Pilbeam et al., 2012), have so far been treated separately. Combining them into one analytic framework allows a deeper analysis as is illustrated in the case studies. This drives the further comprehension of relationships in sustainable supply chain management. We admit, and did so already earlier in the paper, that the interrelation among these three constructs of inter-organizational relationships are not fully explored and analyzed. This links back to, for example, Klassen and Vachon (2003), who specify that collaboration might drive technological resource investments, e.g. into cleaner production. Yet, the interrelations among the constructs are quite complex and would demand further research.

By analyzing the two supply chains of Braskem and Mercur we could see different realities regarding operational aspects, supply chain structure, and the strategic orientation for sustainability (compare to Akhavan and Beckmann, 2016). A clear characteristic is related to the strategies used for sustainability-oriented innovations that have influenced focal companies' decisions reflecting supply chain relationship developments.

The second link positions the paper into the sustainable innovation literature. The body of literature on this topic (e.g. Boons and Lüdeke-Freund, 2013) has not yet addressed supply chain aspects. This makes a first connection, where we would encourage further research at this intersection. Here, we find corroboration that product and process-related innovation are important in driving a sustainable economy. This served as a theoretical basis for selecting the cases but is not conceptualized further. Yet, we open the door for connecting these streams of research in the future.

Many companies have invested in product-related innovations. These are easier to be implemented (often by creating a product line), and they typically yield faster revenue returns without substantial changes needed in a company's structure. So would these innovations really promote sustainability values in business or would it be a solution for new markets and to promote a corporate image? In this case, we ask ourselves, what are the real benefits these innovations would generate beyond the firms' boundaries? According to Van den Bergh et al. (2011), solutions based on “technological fixes” have provided only temporary or partial solutions for sustainability problems in society.

Resource investments, collaboration, and governance are a triple base for sustainability embeddedness, internally and along the supply chain. When going back to the framework, the expected result from the inter-organizational relationships would be improved sustainability performance outcomes (Beske and Seuring, 2014). We consider these outcomes as value generated, not only for economic purposes but also social and environmental, for the companies and or its customers. Thus, the value here is intrinsic to business, also embedded in companies' internal relations, in community development, and especially in consumers' awareness about their consumption habits (Bocken et al., 2014).

Relating these achievements to sustainable supply chain management literature and considering Seuring and Müller's (2008a, b) proposition that one way to establish effective sustainable supply chain management is through strategies applied to sustainable products, we conclude that this is rarely plausible without strong partner relationships (also Beske and Seuring, 2014). Closer and integrated relationships along the supply chain are critical for developing valuable inter-organizational resources and capabilities that yield improved sustainability performances, which is well in line with a recent demand for future research by Govindan et al. (2016).

On the theory side, one limitation might come from the fact that we aimed rather for an inclusive framework, in our case linking SOI and sustainable SCM. Such demand is frequently raised in related research on sustainable SCM (Pagell and Wu, 2009; Pagell and Shevchenko, 2014; Beske and Seuring, 2014). We argue that a sound balance between theory development and feasible empirical analysis has been achieved and that the rich data from the cases including interviews from suppliers and customers allows such insight. This links theory and empirical data in a well-grounded manner. Additionally, data from emerging economies is still rare in sustainable supply chain management related research. Particularly the social uncertainties (Hall et al., 2011) holds for the Brazilian business environment, where some measures towards cleaner production are enforced, but their impact on companies

and local communities still remains unclear, which is in line with findings presented by, for example, Hall and Matos (2010) and Silvestre (2015).

The cases outlined provide in-depth insights into the innovation strategies of two companies. This has, of course, the shortcoming of providing evidence of two cases only. A wider set of empirical research would be required, which might be further case studies. Yet, it might also be viable to operationalize the three core relationship management constructs further, so that they could be tested in large-scale empirical research applying a survey methodology. A second limitation of the empirical approach is coming from the fact that a case company based in a single country permits only research and comparison against this respective context. It would be interesting to analyze how such relationship management issues would be dealt with in different environments.

We present empirical research that applies a framework to the context of two companies in Brazil. Data from emerging economies is still lacking in sustainable supply chain management related research. While this is partly a limitation of our research, it also contributes to the data gap and is an attempt towards broadening the empirical basis of SSCM. This provides a foundation on which future studies can develop and broaden the empirical scope accordingly.

For future research, we propose including the integration of sustainable business models in supply chains (Boons and Lüdeke-Freund, 2013). Investigating the role of cultural attributes, organizational capabilities, and manager values and passion for sustainability on innovation and sustainability improvement would greatly contribute to this study and the field of sustainable supply chain management.

The managerial implications of the research provide evidence that it is fruitful for companies to invest in sustainable innovation, whether through product or organizational innovation, along their supply chains. As the managers of Braskem and Mercur revealed, their personal commitment to sustainability and initiating change can and should contribute to employees' motivation and productivity, that is, if properly diffused.

In conclusion, the paper elaborates a framework linking sustainability-oriented innovation to sustainable supply chain management. Particular emphasis is placed on the management of inter-organizational relationships, which are the core constructs operationalized and discussed against the two case studies presented. This lays the foundation for future research connecting these streams of literature.

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