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Purchasing realized absorptive capacity as the gateway to sustainable supply chain management

ABSTRACT

Purpose: Companies' ability to build sustainable supply chains and achieve strategic sustainability objectives largely depends on their supply network characteristics and the nature of the relationships with strategic suppliers. This poses the question of how purchasing departments can help to translate this sustainability commitment into performance benefits. We focus the attention on buyer-supplier information sharing practices and study how the availability of information interplays with the realized absorptive capacity of the purchasing department (PRAC) to positively impact performance (operational, environmental and social).

Design/methodology/approach: We collected data from 305 procurement executives in four European countries and tested our hypotheses empirically using structural equation modeling. Mediation analysis is used to test the effect of PRAC on the relationship between buyer-supplier information sharing and performance.

Findings: The results show that increasing buyer-supplier information sharing is sufficient to obtain a positive impact on operational performance. To improve purchasing sustainability performance, instead, companies need to develop their PRAC to adequately transform and exploit external information and identify opportunities in the environmental and social areas. Thanks to these purchasing capabilities, organizations can overcome potential trade-offs between different performance dimensions.

Originality: In the context of collaborative buyer-supplier relationships, this study is the first proposing purchasing knowledge management capabilities (i.e., PRAC) as a key factor to improve multiple performance dimensions. Additionally, it captures different sustainability

aspects, concluding that organizations can improve purchasing operational, environmental, and social performance by implementing appropriate information sharing mechanisms with suppliers and developing their PRAC.

Keywords: *Buyer-supplier relationships; Information sharing; Purchasing realized absorptive capacity; Operational performance; Sustainability performance*

1. Introduction

The fast-changing competitive environment puts firms under considerable pressure to adapt and continuously improve their operations and supply chains. Most business sectors are highly dynamic and subject to uncertainty in terms of volumes, technologies, demand trends, and institutional context (Wong et al., 2011). The ability to compete in a dynamic environment increasingly implies acknowledging and pursuing multiple objectives in terms of efficiency, effectiveness, and sustainability (Markman and Krause, 2016). Not only firms need to satisfy customers' requirements, but they should also respond to stakeholders' requests for environmentally and socially sustainable operations (Mani and Gunasekaran, 2018). In the last decades, more and more firms have integrated sustainability into their business strategy (Wu et al., 2014). Nonetheless, the linkage between commitment to sustainability and classic operational performance is not yet fully explored, with a significant emphasis on the role of suppliers (Miemczyk and Luzzini, 2019). In order to improve performance, sustainability commitment needs to be operationalized effectively within firms and across their supply networks (Villena and Gioia, 2018).

While most research focuses on external stakeholders' actions and sustainability adoption, internal organizational capabilities have been somehow disregarded (Riikkinen et al., 2017). Despite the breadth of sustainability literature, further empirical evidence is needed to understand how firms might overcome the potential trade-offs between sustainability and operational performance. In this study, we investigate both the external and internal facets of organizational capabilities, which might play a key role in sustainability deployment and trade-off management.

On the one hand, the firm's ability to generate a sustained competitive advantage largely depends on suppliers, who are by now recognized as a fundamental source of value creation

and not merely a way to cut costs out of the supply chain (Hartmann et al., 2012). With purchasing to turnover ratios over 60% in many industries (CAPS, 2021), suppliers are key providers of goods and services within the focal firm's extended supply chain. Both research and practice offer plenty of evidence that buyer-supplier collaboration can create a competitive advantage by combining buyer's and supplier's expertise. Examples range from P&G's open innovation strategy to Toyota supply base management and Intel-Dell collaborative innovation initiatives (Saenz et al., 2014). Consequently, the simultaneous achievement of operational and sustainability performance is fundamentally bounded by the capacity to integrate and deploy buying firms' and suppliers' skills in new ways that overcome the classic trade-offs reported by previous studies (Gimenez et al., 2012). Several studies investigated the link between buyer-supplier collaborative practices and TBL outcomes, exploring the role of buyer-supplier interactions in overcoming potential sustainability trade-offs (e.g., Longoni et al., 2019; Nunes et al., 2020). Results provide mixed evidence, defining a research gap to further explore (e.g., Golicic and Smith, 2013; Miemczyk and Luzzini, 2019).

On the other hand, we intend to address the gap regarding internal organizational capabilities. In order to exploit the synergies between their own and suppliers' expertise, companies should be able to identify and use external knowledge in combination with their operations. This ability has been referred to as absorptive capacity (AC) (Cohen and Levinthal, 1990). It has been studied widely as a promoter of innovation (Kostopoulos et al., 2011; Saenz et al., 2014), but to a lesser extent in connection to sustainability (Riikkinen et al., 2017). A company's AC depends on the individuals at the interface between organizational units or the external environment. As a consequence, previous research has clearly identified the purchasing department as a key actor in fostering the firm AC (Kauppi et al., 2013; Saenz et al., 2014; Riikkinen et al., 2017). Purchasing is, by definition, a boundary-spanning department that

coordinates and connects multiple units across the purchasing process and constitutes the virtual interface between the firm and its supply base (Patrucco et al., 2017). As such, it represents a context where AC can develop naturally. For this reason, we aim to investigate the purchasing department's ability to transform and exploit knowledge to promote environmental and social sustainability practices without compromising operational performance.

In other words, this study intends to address the following research question:

How do buyer-supplier information sharing and purchasing absorptive capacity affect the triple-bottom-line performance of the purchasing department?

We advance that buyer-supplier information sharing is key to meeting the challenges related to sustainability and trade-off management. Integrating complementary knowledge from strategic suppliers and working with them effectively is a necessary condition for performance improvement. Furthermore, we propose the purchasing realized absorptive capacity (PRAC) as an important mediator of the information sharing-performance relationship: only by translating into practice the value created through the collaboration can the buying firm ensure compelling results from suppliers.

Overall, our study will offer valuable insights for firms operating in those dynamic environments where the set-up of effective and sustainable supply chains requires the tight integration of buyers and suppliers. By doing this, we contribute to different streams of literature. First, we contribute to the sustainable supply chain management literature by shedding light on the concurrent role of buyer-supplier information sharing and PRAC. Second, only a handful of studies explored AC in the operations and supply chain management context, particularly in the purchasing context: we contribute to the measurement validation and advance the theoretical debate. Third, we introduce buyer-supplier information sharing as an important antecedent of PRAC, which, in turn, mediates the information sharing-performance relation.

To develop our argument, we first provide in Section 2 the relevant literature about trade-offs in sustainable supply chain management and purchasing absorptive capacity. We then develop the hypotheses about the expected relationships between key constructs of information sharing, PRAC, and performance. In Section 4, we introduce the research design, along with the survey instrument, measures, data collection, and preparation. In Section 5, we describe the outcomes of hypothesis testing, and in Section 6, we discuss the theoretical and managerial implications. Finally, Section 7 draws our conclusions and presents the research limitations and directions for further studies.

2. Literature review

2.1 Sustainability trade-offs in the upstream supply chain

The sustainability outcomes of firms' own operations and supply chain have been the subject of a broad body of literature, encompassing environmental, social, and economic performance dimensions (Nunes et al., 2020). Due to the preferable moral imperative associated with sustainability (Zhu and Lai, 2019) and its positive connections with overall firm financial performance (Whelan et al., 2021), firms are integrating environmental and social criteria into day-to-day practices and decision-making (Marshall et al., 2019). Over the past two decades, sustainable supply chain management emerged and an approach integrating environmental, social, and economic goals across a focal firm's supply chain processes (Carter and Rogers, 2008).

Sustainability outcomes encompass the adoption of environmentally and socially responsible practices as well as the achievement of environmental, social, or economic performance (Koberg and Longoni, 2019). Practices usually refer to investments in control and prevention and the adoption of management systems and certifications (van Donk et al., 2010).

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Performance is generally defined in terms of the triple-bottom-line (TBL): Environmental performance considers efficiency in resource utilization, recycling, and reduction of pollution, waste, and emissions (Rao and Holt, 2005); social performance considers human rights, labor practices, and impact on local communities (Yawar and Seuring, 2017); economic performance can be operationalized in terms of market, operational or accounting-based metrics (Golicic and Smith, 2013). This multiplicity of objectives further complicates when considering the reduced managerial visibility into the supply network (Villena and Gioia, 2018), the focal firm's diluted power across multiple supply chain tiers (Hoejmose et al., 2013), and the divergent sustainability expectations across geographies (Wu and Pullman, 2015). As a result, preventing negative environmental and social outcomes and improving sustainability performance in modern supply chains remains a challenge (Koberg and Longoni, 2019).

This study focuses on the upstream portion of the supply chain, i.e., the management of the relationship between a focal company and its suppliers. Current studies show how much firms struggle to integrate environmental and social principles into their supply chains and to overcome potential trade-offs (Sodhi and Tang, 2018; Longoni et al., 2019; Nunes et al., 2020). Monitoring and managing supplier relationships is key to implementing sustainability practices and hedging against potential risks (Kim et al., 2021). Well-known cases from the past, such as Nike, BP, Nestlé, and Apple, are examples of supplier-related sustainability issues that buyers could not anticipate (Lee and Vachon, 2016). However, companies are still surprised today by the misconduct in their supply chains, as it appears in both research and practice (Villena and Gioia, 2018; The Guardian, 2021). Sustainable supply chain management literature clearly acknowledges that the integration of the supply chain through mechanisms such as monitoring, information sharing, and collaboration can lead to TBL performance improvement (Miemczyk and Luzzini, 2019; Marshall et al., 2019; Kumar et al., 2021; Negri et al., 2021).

Yet, empirical research investigating the relationship between buyer-supplier interactions and TBL outcomes still provides mixed evidence. It is outside the scope of this study to conduct a systematic literature review, but empirical evidence is available about the link between a wide array of procurement practices and the TBL. These practices include information sharing, monitoring, and collaboration (e.g., Luzzini et al., 2015; Marshall et al., 2019; Kumar et al., 2021), power (e.g., Marshall et al., 2019), incentives (e.g., Pakdeechoho and Sukhotu, 2018), top management commitment (e.g., Kumar and Rahman, 2016), supplier development (e.g., Yawar and Seuring, 2018), and risk management (e.g., Miemczyk and Luzzini, 2019). Recent literature reviews offer an interesting summary of the upstream management of supply chains and sustainability (e.g., Johnsen et al., 2017; Koberg and Longoni, 2019; Negri et al., 2021). For example, some studies show that buyer-supplier collaboration might simultaneously improve sustainability and cost performance (e.g., Miemczyk and Luzzini, 2019) but do not consider the operational performance. Other studies report potentially conflicting results between performance dimensions (e.g., Golicic and Smith, 2013). Yusuf et al. (2020) report a positive and significant relationship between sustainable supply chain management practices (which incorporate information sharing and collaboration with suppliers) on both operational and sustainability performance, although they do not isolate the contribution of sustainable procurement nor the effects on different performance dimensions. Thanks to an encompassing meta-analysis, Geng et al. (2017) show that supplier integration can positively affect operational and environmental performance, with no significant link with social performance (possibly due to lack of empirical studies in the field).

All in all, although we have evidence showing that certain inter-organizational purchasing practices can have positive TBL outcomes, we still do not fully understand why. In other words, the mechanisms through which buyer-supplier relationship management can

overcome the classic sustainability trade-offs are not fully explored. For these reasons, in the next section, we introduce a central construct in our study (i.e., purchasing realized absorptive capacity - PRAC) as a key intervening mechanism in the practices-performance relationship-oriented towards TBL results.

2.2 Purchasing absorptive capacity

Studies have shown why and how sharing information and collaboration with suppliers can improve performance across all three bottom lines (Gimenez et al., 2012). Furthermore, given the value creation potential of suppliers, previous studies highlight how buyer-supplier collaborations targeting environmental and/or social outcomes can be an effective strategy towards the TBL (Luzzini et al., 2015). However, due to the increasing complexity and fragmentation of supply chains, knowledge is dispersed across different actors, complicating the identification of viable solutions from a holistic sustainability perspective. Therefore, acquiring and exploiting new knowledge is extremely important to generate continuous learning and respond to emergent market conditions (Eisenhardt and Martin, 2000) that consider sustainability a central construct.

Absorptive capacity (AC) is defined as the “*ability of a firm to recognize the value of new, external knowledge, assimilate it, and apply it to commercial ends*” (Cohen and Levinthal, 1990, p. 128). Thus, AC goes far beyond the research and development (R&D) intensity and investment (Zhang et al., 2018). It refers to how firms acquire, develop, and assimilate new knowledge to reach a competitive advantage (Revilla et al., 2013).

Different operationalizations of AC have been proposed in the literature. Among the most common and tested, authors have distinguished *acquisition* (i.e., recognize and acquire new external knowledge), *assimilation* (i.e., analyze and interpret the external knowledge),

transformation (i.e., internalize and convert the external knowledge, combining it with the existing one), and *exploitation* (i.e., use this knowledge to improve outputs) (Zahra and George, 2002). The first two components, *acquisition* and *assimilation* are commonly grouped into *potential* AC, reflecting the firm's ability to incorporate new external knowledge. Instead, *transformation* and *exploitation* constitute *realized* AC, which refers to the firm's ability to leverage existing and acquired knowledge to improve its output (Zahra and George, 2002; Jansen et al., 2005; Todorova and Durisin, 2007). Alternative formulations of AC, such as the one proposed by Tu et al. (2006), focus on four knowledge components of AC, namely *workers' knowledge*, *managers' knowledge*, *communication network*, *communication climate*, and *knowledge scanning*.

In general, extant research consistently identified AC as a relevant factor in enhancing supply chain performance (Azadegan, 2011; Flatten et al., 2011; Zacharia et al., 2011; Saenz et al., 2014). Authors have shown how AC can improve efficiency (Dyer and Hatch, 2006); increase product quality, profitability, and productivity (Chen et al., 2009); lower labor and production costs while increasing financial resource efficiency (Revilla et al., 2013); and expand manufacturing capabilities (Zhang et al., 2018). Nevertheless, only a few studies provide evidence on the positive effect of AC on sustainability performance (e.g., Riikkinen, 2017).

While AC has been mainly studied in the organizational theory context, previous works have proposed adaptations to the operations and supply chain management context (Tu et al., 2006; Patel et al., 2012; Setia and Patel, 2013; Rojo et al., 2018). In line with the definition above, Rojo et al. (2018, p. 638) adopt the definition of *operational* absorptive capacity as "the acquisition, assimilation, transformation, and exploitation of operations and supply chain knowledge". In line with this approach, we follow a more recent stream of literature and focus

our attention on the purchasing department. The purchasing department represents the linkage between a firm and the external environment (Ehrgott et al., 2011), and it is a crucial gatekeeper of knowledge and capabilities (Kauppi et al., 2013). Consequently, some scholars have studied AC in relation to the firm's purchasing department (Schiele, 2007; Kauppi et al., 2013; Saenz et al., 2014; Riikkinen et al., 2017).

On the one hand, the purchasing department coordinates the processes of scouting and selecting suppliers and later acts as the relational broker between suppliers and other organizational units. On the other hand, purchasing employees work internally by mixing and coordinating the skills and expertise from different departments that are necessary for the relationship with suppliers. As such, purchasing becomes a key enabler of AC.

Another important insight deriving from AC literature is the need to consider different dimensions of AC as separate concepts and constructs. Indeed, authors have shown that *potential* and *realized* AC might have different effects, as they represent fundamentally different abilities (e.g., Riikkinen et al., 2017). Knoppen et al. (2022) introduce a cumulative process model of AC, showing that one component can lead to another. However, extant literature reveals a limited understanding of the antecedents and consequences of the individual components of AC. Most of the research conducted so far considers AC as an aggregate construct, without differentiating between the creation (potential AC) and the utilization of knowledge (realized AC) (Setia and Patel, 2013; Riikkinen et al., 2017; Khan et al., 2019). Given our intention to study TBL performance, we focus our attention on the realized component of AC since it reflects the transformation and exploitation of knowledge and is expected to enhance a firm's performance and develop a competitive advantage (Setia and Patel, 2013; Flatten et al., 2015; Kahn et al., 2019). Therefore, in the remainder of the manuscript, we will refer to purchasing realized absorptive capacity (PRAC) as our target concept.

The next section elaborates on specific hypotheses about the expected result of buyer-supplier information sharing on operational and sustainability performance. We then introduce PRAC as a critical mediator in the information sharing-performance relationship.

3. Research model and hypotheses

As illustrated in the previous sections, the combination of existent literature streams supports the connection between information sharing, absorptive capacity, and purchasing performance. The present work aims to explore these connections more in detail through hypotheses elaborated in the following.

3.1 Information sharing in buyer-supplier relationships and operational performance

Due to the increasing complexity and knowledge fragmentation of supply chains, collaborative initiatives between supply chain actors often take place (Pagell, 2004; Flynn et al., 2009; Caridi et al., 2014). Among the forms of cooperation and collaboration, information sharing represents one of the most recurrent (Prajogo and Olhager, 2012) as it reflects the efforts to improve supply chain visibility and real-time information exchange (Kembro et al., 2017). Information sharing refers to the exchange of important information between parties (Heide and Miner, 1992), and it has been receiving significant consideration in the buyer-supplier literature (e.g., Lee et al., 2000; Lee and Kim, 2009; Ding et al., 2011; Wacker et al., 2016; Lee and Ha, 2018; Newell et al. 2019). Examples of information shared between buyers and suppliers include inventory, demand forecast, production schedules, processes, and capacity (Ding et al., 2011). Parties share information with each other expecting in return an improvement in their overall competitiveness (Wu, 2008; Singh and Power, 2009; Newell et al., 2019). The underlying idea is that, by sharing information, the overall supply chain visibility increases, and firms have access to knowledge that may not be available within the firm (Kulangara et al., 2016), which

supports them in making accurate decisions and implementing corrective actions. Also, the availability of real-time and up-to-date information makes the supply chain more reactive and responsive to the demand: the exchange of information facilitates the understanding and the fulfillment of the agreed requirements between suppliers and buyers (in terms, for example, of delivery time and quality), and smoothens the production and transportation processes as well as the related costs (He et al., 2017). Moreover, information sharing can also foster a more rapid identification and solution to problems (He et al., 2017). Literature on operations and supply chain management has recognized information sharing as a key element for achieving efficiency, reducing costs, improving ordering processes, increasing operational and financial performance, and thus enhancing competitive advantage (Lee et al., 2000; Barratt, 2004; Paulraj et al., 2008; Lee and Kim, 2009; Ding et al., 2011; Ha et al., 2011; Wacker et al., 2016; Lee and Ha, 2018).

In this study, we focus on key operational performance in addition to cost. Indeed, while most of the current literature on buyer-supplier relationships measured operational performance utilizing cost indicators (e.g., Carter and Rogers, 2008; Cao and Zhang, 2011; Liu et al., 2020), we detect a dearth of studies relying on service level dimensions (Zacharia et al., 2011; Benton et al., 2020). Greater information sharing improves alignment and synergies between buyer and supplier (He et al., 2017) and implies a clearer understanding of the product or service specifications. In addition, it enables interactive performance measurement and management, which goes beyond the transactional command-and-control management of supply chain relationships (Koufteros et al., 2014). Therefore, we expect that information sharing positively affects cost performance as well as other dimensions, such as quality and delivery (Singh and Power, 2009; Ding et al., 2011; He et al., 2017), in line with recent literature (e.g., Dey et al., 2015; Maestrini et al., 2018; Patrucco et al., 2020).

Thus, the first hypothesis we formulate is the following:

H1. Higher information sharing in buyer-supplier relationships positively impacts purchasing operational performance (cost, quality, and delivery).

3.2 Information sharing in buyer-supplier relationships and sustainability performance

A more recent stream of research has addressed the role of information sharing in buyer-supplier relationships specifically related to sustainability (Woo et al., 2016; Riikkinen et al., 2017; Pakdeechoho and Sukhotu, 2018). In the last two decades, increasing attention has been posed to the environmental and social dimensions, in addition to the economic one, in line with the TBL view of sustainability (Esfahbodi et al., 2016; Katiyar et al., 2018). Nonetheless, the literature on buyer-supplier interactions and TBL outcomes still provides mixed evidence (Vachon and Klassen, 2006; Margolis et al., 2011; Hollos et al., 2012; Gimenez et al., 2012; Feng et al., 2020; Geng et al., 2017) and the mechanisms through which buyer-supplier relationship management can overcome potential trade-offs between operational and sustainability performance are not fully explored (Jacobs et al., 2010; MacCarthy et al., 2013; Lam et al., 2016). Furthermore, extant sustainable supply chain management literature mainly focused on environmental performance (Woo et al., 2016; Geng et al., 2017; Bian and Zhao, 2020; Feng et al., 2020), while social performance continues receiving limited attention (Mani et al. 2020). Few studies have recently started to address the social dimension specifically (e.g., Chin et Tat, 2015; Paulraj et al., 2017; Yawar and Seuring, 2018; Kumar et al., 2021). Recent social scandals in major companies and the increasing customer consciousness revealed how poor social performance is directly translated into a tainted brand image and poor economic performance (Hajmohammad and Vachon, 2016). As a result, there is a call for increased

attention to social performance (Marshall et al., 2015; Mani et al., 2018; Zhu and Lai, 2019; Godwin et al., 2020).

Further investigation is needed to clarify whether supply chain sustainability initiatives can be beneficial or harmful to operational performance (Geng et al., 2017). Commitment to sustainability promotes the need for firms to collaborate with supply chain partners, particularly with suppliers (Blome et al., 2014; Luzzini et al., 2015; Esfahbodi et al., 2016). In order to comply with sustainability responsibilities, firms need to involve upstream partners in the form of information sharing, alignment, and integration (Kumar and Rahan, 2016; Bian and Zhao, 2020; Kumar et al., 2021). It is extremely problematic to achieve supply chain sustainability without supplier involvement and support (Kumar and Rahan, 2016; Kumar et al., 2021), and information has been defined as one of the drivers for achieving sustainable supply chain performance (Hassini et al., 2012; Woo et al., 2016). The exchange of information facilitates sustainability goal achievements by fostering synergies among parties, reducing the overall effort, and exploiting the common knowledge to develop comprehensive solutions (Daily and Huang, 2001). Through information sharing, firms can achieve knowledge integration, higher willingness to change, reduced uncertainty, and distribution of risks related to sustainability investments (Klassen and Vachon, 2003; Pagell and Wu, 2009), which, in turn, support the development of sustainability initiatives and lead to increased sustainability performance (Rao and Holt, 2005; Kumar and Rahan, 2016; Woo et al., 2016; Kumar et al., 2021). For these reasons, we expect that information sharing positively affects sustainability performance (environmental and social), in line with the latest studies (e.g., Giannakis et al., 2020; Adesanya et al., 2020).

We thus formulate our second hypothesis:

H2. Higher information sharing in buyer-supplier relationships positively impacts purchasing sustainability performance (environmental and social).

3.3 The mediating effect of purchasing realized absorptive capacity

As discussed above, the relationship between information sharing and performance has been widely explored, but a limited number of works investigated the intervening mechanisms. In this study, we examine one specific mechanism, namely purchasing absorptive capacity, and analyze its role in explaining *how* information sharing in buyer-supplier relationships can improve performance. Successful buyer-supplier cooperation and the achievement of superior performance are strictly related to how firms acquire and process knowledge (Meinlschmidt et al., 2016), a concept reflected in the notion of absorptive capacity.

In particular, we argue that information sharing can drive purchasing realized absorptive capacity (PRAC), enabling synergetic performance outcomes. Several studies suggest that AC-related abilities mediate between selected antecedents and supplier performance (Carter, 2005; Modi and Mabert, 2007), including operational performance (Kahn, Maltz, and Mentzer, 2006). Braunschneidel and Suresh (2009) show how internal and external integration should be followed up by market-based learning to improve flexibility and agility. Similarly, Saenz et al. (2014) show that AC allows companies to capitalize on the potential available from compatible partners, enhancing efficiency and innovation in a buyer-supplier context. We hypothesize that PRAC (the ability to transform and exploit knowledge) is stimulated by information sharing between buyer and supplier. Information sharing can lead to knowledge development (Kotabe et al., 2011; Kulangara et al., 2016), foster inter-organizational learning and greater understanding (Paulraj et al., 2008), and, therefore, represents one of the most important drivers

of supply chain performance (Kulangara et al., 2016). Nonetheless, information sharing alone may not be enough. It is essential that supply chain parties own the ability to use such information to create value and enhance supply chain performance (Newell et al., 2019; Hsu et al., 2021).

To translate the potential benefits of knowledge exchange that are typical of buyer-supplier relationships into realized benefits, firms need to match complementary skills and create actionable knowledge. Exploratory learning must be complemented by transformation and exploitation before enhancing performance (Cohen & Levinthal, 1990; Volberda et al., 2010). Therefore, it would be short-sighted to suggest that buyers simply exchange information with suppliers and expect them to deliver superior performance. Instead, we expect that information sharing affects operational performance through PRAC.

Based on these arguments, we believe that PRAC enables firms to leverage information sharing between buyer and supplier and enhance the operational performance that suppliers deliver to the buying firm. Accordingly, we formulate our third hypothesis:

H3. PRAC positively mediates the relationship between information sharing and purchasing operational performance.

To incorporate a TBL perspective, we complement our hypothesis concerning operational performance with environmental and social performance. Very few studies assess the impact of purchasing absorptive capacity on environmental and social capabilities (Riikkinen et al., 2017). However, other studies suggest that organizational AC does relate to sustainability performance (Dzhengiz and Niesten, 2020; Lu et al., 2021). For example, companies with higher AC have been found more proactive to environmental innovations (Xie et al., 2019), also in connection with stakeholder management (Dentoni et al., 2016). Borland

et al. (2016) argue that managers with an eco-centric mindset scan the environment for sustainability knowledge and are more likely to develop environmental competencies, put their knowledge to use, and in turn drive environmental performance. Furthermore, the development of environmental capabilities requires an adaptation of routines and practices to adapt to sustainable development goals (Inigo et al., 2017). In the form of knowledge transformation and exploitation, AC has been explicitly associated with environmental capabilities, given the need to integrate complex, external, and cross-disciplinary environmental knowledge (Delmas et al., 2011; Abareshi and Molla, 2013). Riikkinen et al. (2017) argue that sustainability is strongly context-dependent because environmental characteristics and impacts differ across geographical locations. Therefore, environmental concerns can only be addressed by transforming and exploiting salient environmental knowledge. Because purchasing professionals are subject to multiple messages from various stakeholders (such as suppliers, internal and external customers, and industry associations, e.g., Zhu and Sarkis, 2007), they are likely developing a more holistic understanding of complex performance objectives and potential sustainability trade-offs.

Context dependence, the need to translate stakeholder pressures into actionable knowledge, and the TBL mindset can also explain why PAC can drive social sustainability. However, social sustainability is also less tangible and relies on less codifiable know-how (Pinkse et al., 2010), which is a possible explanation for the scarcity of empirical evidence around it. Furthermore, because social sustainability does not relate to products and manufacturing processes per se, knowledge transformation and exploitation capabilities (i.e., PRAC) are considered even more important in terms of incorporating labor protection and ethical conduct into operational practices within the firm and across the supply chain (Riikkinen et al., 2017). This is ensured, for example, by enforcing the code of conduct at the supplier's

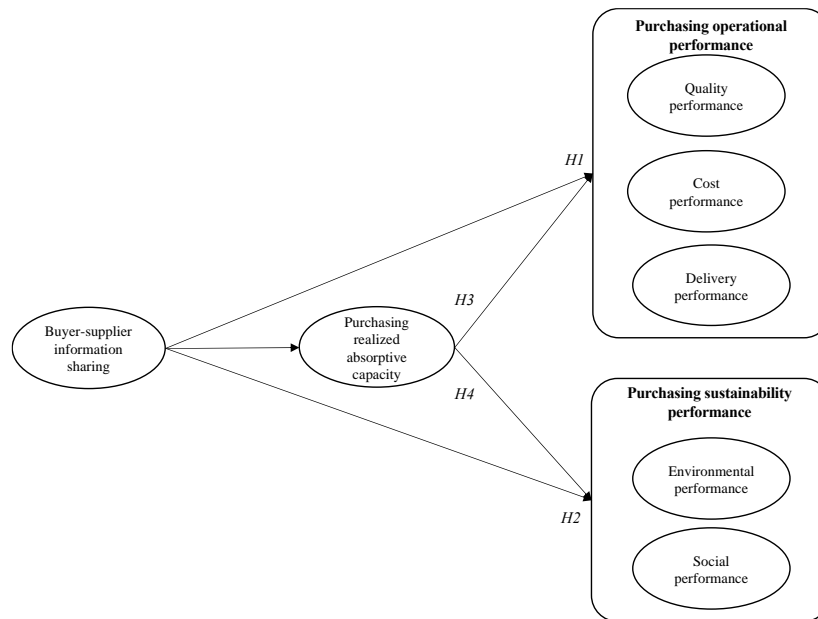
site, recognizing higher than market prices, engaging with the local community in supply markets, and using mediated forms of power (Marshall et al., 2019).

In sum, the purchasing department is one of the firm's key areas facing high pressure to promote sustainability (Riikkinen et al., 2017). Given the emphasis on a supply chain perspective as a condition for true sustainability, purchasing departments are on the front line to promote and transfer ethical guidelines to upstream supply chain tiers (Luzzini et al., 2015; Villena and Gioia, 2018). Therefore, while purchasing is subject to the traditional pressures towards efficiency and service, it has also become a key sustainability catalyzer (Johnsen et al., 2018). Thus, we hypothesize the following:

H4. PRAC positively mediates the relationship between information sharing and purchasing sustainability performance.

Overall, we expect that, thanks to the mediating role of PRAC, information sharing between buyer and supplier can simultaneously improve multiple performance dimensions, such as operational and sustainability, conciliating the three dimensions of the TBL (Jacobs et al., 2010; MacCarthy et al., 2013; Lam et al., 2016). *Figure 1* shows the conceptual model reflecting the hypotheses discussed above.

Figure 1. Research model



4. Methodology

4.1 Survey development and sample

To test the relationships in the research model, we used the data collected from a broad international project focused on investigating purchasing strategies, practices, organizations, and performance of companies in different industries. Data were collected in four different countries (Finland, Germany, Ireland, and Italy) during 2014 and 2015. The questionnaire collects data about four areas. The first two collect general information about the company and the main characteristics of the purchasing department. The remaining two sections asked to focus on a purchasing category directly managed by the respondent and captured information related to the nature of supplier relationships, main practices adopted, and obtained performance at the category level. The survey was originally developed in English, as were the institutional item scales. It was then translated to local languages following the translation, review, adjudication, pre-testing, and documentation procedure (TRAPD; Harkness et al., 2004).

Finally, pilot tests were conducted in each country to refine the questions and items included.

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The researchers' team decided to include both manufacturing and service industries, and a random sample of companies in these industries was drawn from each country-level database (Fonecta in Finland, Dun and Bradstreet in Germany, the Bill Moss Partnership in Ireland, and AIDA in Italy). Only companies with at least 50 employees were included in the sample. All countries followed the same data collection procedures to ensure consistency. After the random sampling, a suitable respondent was identified in each organization through the company website, LinkedIn, or direct company contact. Each respondent was approached via phone first, and the electronic survey was only sent to those who agreed to participate. The databases across the four countries included a total of 20,515 companies that fit our sampling criteria. Of these, 3,068 were selected through random sampling; 3,059 were directly contacted (some companies did not match the criteria after sampling, for example, had moved abroad or were not part of the specified industry anymore); and 1,105 were reached via phone (for those not reached, either a suitable respondent was never located in the company, or the appropriate respondent never answered our calls despite a minimum of three attempts made). A total of 656 companies agreed to participate, and out of these, 305 useable responses were received, thus yielding a 10% response rate of the total sample and a 46% response rate of those who agreed to respond. *Table 1* reports the main data characteristics. Due to the broadness of the questionnaire, earlier publications have used the same data. However, the constructs and the relationships included in the model are unique to the study and original compared to the existing literature, and the use of this data does not suffer from any "data reuse" practice (van Raaj, 2018).

Table 1. Sample descriptive

Descriptive	Freq.	%	Descriptive	Freq.	%
<i>Country</i>			<i>Industry Sector</i>		
Italy	99	32.5	Manufacturing	234	76.7
Germany	70	23	Information technology	23	7.6
Finland	84	27.5	Finance and insurance	19	6.2
Ireland	52	17	Professional services	29	9.5
<i>Purchasing categories</i>			<i>Respondent position</i>		
Raw materials	125	41	Purchasing director	53	17.4
Components and supplies	90	29.5	Purchasing manager	153	50.2
IT services	28	9.2	Senior, Project buyer	34	11.1
Logistics services	16	5.2	Buyer, Purchasing agent	28	9.2
Office equipment and supplies	19	6.2	Other	32	10.5
Maintenance and cleaning	27	8.9	Missing	5	1.6
<i>Employees</i>					
Medium (50–249)	150	49.1			
Large (250–1000)	78	25.6			
Very large (> 1000)	75	24.6			
Missing	2	0.7			
Total	305	100		305	100

4.2 Measures

We used the extant literature to measure latent variables included in the research framework, and we operationalized a set of seven constructs and four control variables. *Appendix A* presents, for each construct, its description and corresponding main references.

Buyer-supplier information sharing captures those practices aimed at increasing integration with suppliers through higher supply chain visibility (e.g., Narasimhan and Kim, 2002). For this purpose, we adapted previously proposed measures of information sharing as part of supplier integration efforts (e.g., Flynn et al., 2010; Wong et al., 2011). Respondents were asked to rate how much their company shares cost information with major suppliers, shares production schedule information with major suppliers in real-time, requires major suppliers to share cost information, and requires major suppliers to contribute to the company's cost and quality improvements. Respondents were asked to answer each question using a Likert scale ranging from 1 (“Totally disagree”) to 7 (“Totally agree”).

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Purchasing realized absorptive capacity measures the ability of the purchasing department to transform external knowledge and exploit it to create a competitive advantage (Todorova and Durisin, 2007). In line with previous literature (e.g., Kotabe et al., 2011; Setia and Patel, 2013), PRAC is conceptualized as a second-order construct that includes the transformation and exploration capabilities of the purchasing department. Particularly, for *transformation capabilities*, respondents were asked to rate if their purchasing department and employees 1) consider the consequences of changing external market demands in terms of new products and services; 2) record and store newly acquired knowledge for future reference; 3) quickly recognize the value of new external ideas to existing knowledge; 4) hardly shared practical experiences; 5) are slow to grasp opportunities from new external knowledge. For *exploitation capabilities*, respondents were asked to rate if their purchasing department and employees 1) have a clear division of roles and responsibilities; 2) constantly consider how to exploit knowledge better; 3) have difficulty contributing to new products and services implemented by the company; 4) have a common language regarding our company's products and services.

The approach to measuring *purchasing operational performance* is adapted from the production competence framework proposed by the operations management literature (e.g., Gonzalez-Benito, 2007; Vachon and Klassen, 2008) and includes items related to purchasing cost and quality and level of service. To measure quality aspects, we asked the respondents to rate to what extent category performance met management's expectations for what concerns the 1) features and functionality; 2) durability; 3) reliability; 4) fit of the specifications of the purchased products or services. To measure quality aspects, we asked the respondents to rate to what extent category performance met management's expectations for what concerns the 1) productivity of purchasing resources; 2) inventory levels; 3) cost of the purchased products or

services. To measure service aspects, we asked the respondents to rate to what extent category performance met management's expectations for what concerns the 1) fulfillment of agreed schedules by suppliers; 2) fulfillment of agreed delivery terms by suppliers; 3) supplier flexibility to adapt capacity for the purchased products or services.

Finally, *purchasing sustainability performance* incorporates the environmental and social performance constructs adapted from previous literature (e.g., Montabon et al., 2007; Hollos et al., 2012). Specifically, to measure environmental performance, we asked the respondents to rate to what extent category performance met management's expectations for what concerns the 1) supplier ability to meet agreed environmental performance goals and ensuring that purchased products/services 2) contain green attributes and 3) do not contain environmentally undesirable substance. To measure social performance, we asked the respondents to rate to what extent category performance met management's expectations for what concerns the 1) enforcement of a code of conduct for suppliers; 2) the implementation of independent audits of ethical performance of suppliers, and 3) the use of more stringent ethical and social mandates than required in host countries. Respondents were asked to answer all the questions using a Likert scale ranging from 1 to 7.

In addition to the main constructs in the model, we included several control variables over supplier operational and sustainability performance: the type of industry (i.e., manufacturing vs. service), the company size (small vs. big according to the EU classification), the country (i.e., Italy vs. Germany vs. Ireland vs. Finland), and the nature of the category purchased (i.e., direct materials vs. office supplies vs. services) were operationalized through dummy variables.

4.3 Bias control

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Potential biases were considered in the survey and protocol design and the data analysis. Several approaches (direct contact by phone, multiple mailings, and the assurance to share results) were used to ensure a high response rate and avoid non-response bias (Frohlich, 2002). Non-response bias was checked through independent sample t-tests between early, late, and non-respondents on control variables such as the number of employees and revenues. We observed no significant differences between the groups on these key firm characteristics, suggesting that non-response bias is not a significant concern for the study. We also ran non-parametric tests in each survey country to compare the valid respondent group to the sample in the country. These tests confirmed that no significant differences existed in the distribution of company size (number of employees) and the distribution of industries (ISIC code).

Further, we reduced social desirability bias by assuring confidentiality (Handley and Benton, 2012) and by formulating questions related to the company processes and behaviors rather than focusing on the direct personal behavior of the respondent.

The study was conducted to minimize common method bias, following the recommendations of Podsakoff et al. (2003). This was ensured in several ways. First of all, the questionnaire was labeled as a comprehensive research project to understand purchasing strategies, practices, and performance on an international basis. Therefore, no reference to the model in *Figure 1* was provided, and respondents' attention was not drawn to the relationships being targeted in this study. Second, questions were organized in different sections, preventing respondents from developing their theories about possible cause-effect relationships. Third, some items were reverse coded (i.e., TANSF4, TRANSF5, EXPL3, EXPL4 in *Appendix A*) to balance positively and negatively worded items. Finally, the common latent factor technique was applied using the performance constructs and the related items. Through this analysis, we found that the common latent variable had a linear estimate of 0.656 (and it was significant for

all the observed variables). This value indicates a variance of 43%, which is below the threshold of 50%. Based on how the survey procedure was designed and these additional tests, we can conclude that common method bias does not represent a concern for our study.

4.4 Data analysis approach

The presented hypotheses were tested using covariance-based structural equation modeling (CB-SEM). Since the objective of our research is theory-testing and confirmation, we decided to adopt CB-SEM as it is more suitable when the research objective is prediction and theory development (Astrachan et al., 2014). The model was tested using the maximum likelihood (ML) estimation method (White, 1982), as ML is able to provide more realistic indexes of overall fit and less biased parameter values for paths that overlap with the actual model, as compared to other methods such as partial least squares and weighted least squares (Lowry and Gasking, 2014). Furthermore, the ML estimation assumes that the variables in the model are (conditionally) multivariate normal, which is valid for our dataset according to the Doornik-Hansen ($p > \chi^2 = 0.106$) and Henze-Zirkler tests ($p > \chi^2 = 0.137$).

In order to evaluate the model's viability, we used several fit indexes (Hu and Bentler, 1999). We checked that the ratio between the chi-square goodness-of-fit statistic and the degrees of freedom in the model was below the cut-off value of 3 (Hooper and Coughlan, 2008). We also verified two of the indexes recommended by Hu and Bentler (1999): the comparative fit index (CFI) and the Root Mean Square Error of Approximation (RMSEA). CFI values closer to 1 indicate a good fit (with a value > 0.9 considered a satisfactory threshold) while, for RMSEA, a value lower than 0.08 can be considered acceptable.

Finally, to verify the mediation effect of the *purchasing RAC*, we assessed the reliability of our results by testing the significance of the indirect effect through bootstrapping analysis with 97.5% bias-corrected confidence intervals (Hayes, 2009).

5. Results

5.1 Constructs validity and reliability

In *Table 2*, we provide the results for the confirmatory factor analysis (CFA). To increase the model's statistical power without decreasing the construct's theoretical validity, the variables IS1, TRANSF1, TRANSF5, EXPL1, EXPL4, OP1, and OP6 were dropped as a result of the CFA. The measurement model fit indicators were found to be satisfactory ($\chi^2 = 477.73$; $\chi^2/\text{d.f.} = 2.42$; RMSEA = 0.068; CFI = 0.927; TLI = 0.914). We assessed convergent validity through significant loadings from all scale items on the hypothesized constructs as well as through the average variance extracted (AVE), Composite Reliability (CR), Cronbach Alpha (CA), and McDonald Omega (MO) (Anderson and Gerbing, 1988). All the loadings are significant according to the t-values. CA, CR, and MO values range between 0.743 and 0.976 – with the suggested threshold being > 0.7 – and AVE ranges between 52.8% and 79.7% – with the suggested threshold being 50%. This, overall, confirms the robustness of the construct measurement approach.

As an additional test for discriminant validity (*Table 3*), we compared the squared correlation between two latent constructs to their AVE estimates (Fornell and Larcker, 1981). Following this test, the AVE for each construct should be higher than the squared correlation between each pair of constructs. This condition is valid for all the constructs.

Table 2. Constructs' validity

	Loading	T-value	CR	CA	MO	AVE
Buyer-supplier information sharing						
IS2	0.767	15.8	0.839	0.743	0.775	0.640
IS3	0.943	22.9				
IS4	0.665	11.2				
IS1	Dropped					
Purchasing transformation capabilities						
TRANSF1	0.660	17.9	0.769	0.751	0.758	0.528
TRANSF2	0.734	22.6				
TRANSF3	0.780	26.1				
TRANSF4	Dropped					
TRANSF5	Dropped					
Purchasing exploitation capabilities						
EXPL2	0.710	10.9	0.801	0.788	0.818	0.672
EXPL3	0.916	19.6				
EXPL1	Dropped					
EXPL4	Dropped					
Purchasing realized absorptive capacity (second-order construct)						
TRANSF	0.896	21.3	0.869	0.796	0.808	0.768
EXPL	0.857	15.3				
Purchasing operational performance						
OP2	0.8521	43.2	0.976	0.902	0.911	0.567
OP3	0.8495	42.5				
OP4	0.8125	38.8				
OP5	0.7308	25.3				
OP7	0.6872	21.1				
OP8	0.6295	17.9				
OP9	0.6392	13.3				
OP10	0.7150	24.8				
OP1	Dropped					
OP6	Dropped					
Purchasing environmental performance						
ENV1	0.902	61.4	0.878	0.861	0.868	0.709
ENV2	0.919	64.3				
ENV3	0.684	33.2				
Purchasing social performance						
SOC1	0.859	51.3	0.922	0.889	0.893	0.797
SOC2	0.906	69.3				
SOC3	0.912	71.9				

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Table 3. Correlation matrix (square root of the AVE for the latent variable shown in italics on the diagonal; *** p-value < 0.001; ** p-value < 0.01; * p-value < 0.05)

	1	2	3	4	5
1. Buyer-supplier information sharing	<i>0.800</i>				
2. Purchasing realized absorptive capacity	0.498***	<i>0.876</i>			
3. Purchasing operational performance	0.344***	0.501***	<i>0.753</i>		
4. Purchasing environmental performance	0.144*	0.467***	0.474***	<i>0.842</i>	
5. Purchasing social performance	0.126*	0.415***	0.311***	0.552***	<i>0.893</i>

5.2 Path analysis

As a first step of our analysis, we tested the direct effect of *buyer-supply information sharing* on performance, which is reported in *Figure B1* in *Appendix B*. Without the mediator, buyer-supplier information sharing has a positive impact on purchasing *operational performance* ($\beta=0.376$, $p < 0.001$), as well as on sustainability performance ($\beta=0.231$, $p < 0.01$ for *environmental performance*, $\beta=0.210$, $p < 0.01$ for *social performance*). Therefore, we find support for our hypothesis *H1* and *H2*.

Next, we introduced PRAC as mediator in the model. *Table 4* shows the structural model results, including standardized path coefficients, with the significance based on two-tailed t-tests for our hypotheses. Also in this case, the measurement model fit indicators were found to be satisfactory ($\chi^2 = 498.6$; $\chi^2/\text{d.f.} = 2.49$; RMSEA = 0.07; CFI = 0.922; TLI = 0.910).

Table 4. SEM Path analysis (***) p-value < 0.001; ** p-value < 0.01; * p-value < 0.05; ^{NS} p-value > 0.05; values of t-statistics shown in brackets)

	Purchasing realized absorptive capacity	Purchasing operational performance	Purchasing environmental performance	Purchasing social performance
<i>Independent variables</i>				
Buyer-supplier information sharing	0.348***(4.11)	0.382***(3.85)	0.118 ^{NS} (1.05)	0.156 ^{NS} (1.49)
Purchasing realized absorptive capacity	-	0.487***(4.71)	0.566***(6.62)	0.511***(4.47)
R²	<i>0.471</i>	<i>0.504</i>	<i>0.331</i>	<i>0.314</i>

As we can see, higher *buyer-supplier information sharing* leads to better purchasing operational performance ($\beta=0.382$, $p< 0.001$), while the direct effect is no more statistically significant in the case of sustainability performance for both *environmental* ($\beta=0.118$, $p> 0.05$) and *social* ($\beta=0.156$, $p> 0.05$) dimensions.

For what concerns the mediating role of PRAC, we can see that *buyer-supplier information sharing* positively affects PRAC ($\beta=0.348$, $p< 0.001$) which, in turn, significantly affects purchasing *operational* ($\beta=0.487$, $p< 0.001$), *environmental* ($\beta=0.566$, $p< 0.001$), and *social* ($\beta=0.511$, $p< 0.001$) performance. To verify the statistical significance of this mediation effect, we followed some of the most recent recommendations (e.g., Rungtusanatham et al., 2014), and we tested the indirect effects in the model through bootstrapping analyses by considering bias-corrected and accelerated confidence intervals (97.5%). According to this approach, a mediation occurs if the derived confidence interval does not contain zero. The results are reported in *Table 5*.

As the indirect effects are statistically significant for operational, environmental and social performance, and their confidence intervals do not contain the zero, we can accept our

hypotheses *H3* and *H4* about the mediation role of *PRAC*. As for the dummy control variables, no one resulted as significant.

Table 5. Test for mediation (***) p-value < 0.001; ** p-value < 0.01; * p-value < 0.05; ^{NS} p-value > 0.05; values of t-statistics shown in brackets)

	<i>Direct effects</i>	<i>Indirect effects</i>	<i>Total effects</i>	<i>Bootstrapping confidence intervals for indirect effects</i>	
Purchasing realized absorptive capacity <-- Buyer-supplier information sharing	0.348*** (4.09)	-	0.348*** (4.09)		
Purchasing operational performance <-- Buyer-supplier information sharing	0.382*** (3.84)	0.169*** (3.52)	0.551*** (5.13)	0.124	0.209
<-- Purchasing realized absorptive capacity	0.487*** (4.70)	-	0.487*** (4.70)		
Purchasing environmental performance <-- Buyer-supplier information sharing	0.118 ^{NS} (1.06)	0.197*** (4.68)	0.315*** (3.78)	0.119	0.249
<-- Purchasing realized absorptive capacity	0.567*** (6.61)	-	0.567*** (6.61)		
Purchasing social performance <-- Buyer-supplier information sharing	0.156 ^{NS} (1.48)	0.178*** (3.37)	0.334*** (3.64)	0.116	0.214
<-- Purchasing realized absorptive capacity	0.511*** (4.48)	-	0.511*** (4.48)		

5.3 Robustness checks: endogeneity and relationship between purchasing performance

Additional robustness tests were performed to refine the results further. First, we wanted to ensure that the tested model was not affected by endogeneity problems. To check this aspect, we tested an alternative model where *PRAC* is used as an antecedent of *buyer-supplier information sharing*. The path estimates of the resulting model are included in *Figure B2* (*Appendix B*). As the fit indices of this model are worse ($\chi^2 = 592.23$; $\chi^2/\text{d.f.} = 2.96$; RMSEA =

0.08; CFI = 0.898; TLI = 0.882), we can conclude that the research model in *Figure 1* has better explanatory power.

Second, the model presents multiple performance outcomes that are correlated with each other (see *Table 3*). Particularly, we can notice a correlation between purchasing operational performance and environmental performance (0.474, $p < 0.001$), between operational performance and social performance (0.331, $p < 0.001$), and between environmental performance and social performance (0.552, $p < 0.001$). To verify that the model was not affected by multicollinearity, we then looked at the covariance matrix of the residuals of the performance items (reported in *Table C1* in *Appendix C*). As no significant correlations between residuals are present in the matrix, we can conclude that multicollinearity does not affect the model.

Last, due to the ample literature that relates sustainability performance to operational performance (e.g., Yu et al., 2014), we also tested a model including such relationships between the purchasing performance constructs. As we can see from the path estimates (reported in *Figure B3* in *Appendix B*), we have a positive relationship between purchasing environmental and operational performance ($\beta = 0.356$, $p < 0.001$), but not between social and operational performance ($\beta = 0.084$, $p > 0.05$). However, the goodness of fit indicators for this model are once again worse compared to the main research model ($\chi^2 = 599.34$; $\chi^2/\text{d.f.} = 2.97$; RMSEA = 0.077; CFI = 0.896; TLI = 0.881).

6. Discussion and main contributions

We can now discuss and interpret the results obtained through the model testing. By accepting *H1*, our analysis reveals that buyer-supplier information sharing positively affects operational performance in terms of cost, quality, and delivery, which is in line with previous literature

about outcomes of supplier collaboration initiatives to increase supply chain information visibility (e.g., Lee et al., 2000; Barratt, 2004; Paulraj et al., 2008; Lee and Kim, 2009; Ding et al., 2011; Ha et al., 2011; Wacker et al., 2016; Lee and Ha, 2018). Although sharing valuable know-how can be risky and increase the necessary relational investments, relying on higher information sharing improves coordination and the level of trust in buyer-supplier relationships, which is likely to generate significant improvements in purchasing performance on several operational dimensions (i.e., cost, quality, and level of service). This positive impact holds in both models (without and with PRAC as the mediator), which means that companies can benefit from higher performance outcomes independently from the transformation and exploitation capabilities of the purchasing department.

Regarding *H2*, we find that information sharing is positively related to sustainability performance without considering PRAC in the model. When adding the mediator, the direct effect of information sharing loses significance. This result suggests that the increase in information exchange between suppliers and buyers indirectly contributes to increase sustainability performance. This positive impact is explained by the purchasing department capability to transform and exploit this information (PRAC; Riikkinen et al., 2017), to create value and enhance sustainability performance (Newell et al., 2019; Hsu et al., 2021).

Finally, by accepting *H3* and *H4*, our analyses formally recognize the PRAC as a key gateway to obtain higher purchasing performance on multiple dimensions (i.e., operational and sustainability). While investments to increase visibility and integration with suppliers are certainly necessary, they may not be sufficient to improve performance. In this regard, our results show that, when the objective is to increase operational performance, a higher PRAC is a “nice to have” capability, as companies can exploit the higher availability of information directly to improve purchasing costs, quality and level of service, but also indirectly, thanks to

the purchasing department's ability to use this information to create new opportunities for operational performance improvements. Instead, when the objective is to increase sustainability performance, a higher PRAC is a "must have" capability, as the improvement of social and environmental performance in purchasing is mostly explained by the PRAC. The purchasing department can transform the information and knowledge exchanged with the suppliers into opportunities to improve environmental (e.g., selecting suppliers with higher ability to meet environmental goals; buying from suppliers able to offer products or services that contain green attributes, etc.) and social (e.g., enforcing supplier code of conducts; implementing audits on suppliers' ethical behaviors) performance. This result nicely complements existing conceptualizations that relate PAC to purchasing maturity (e.g., Schiele et al., 2007), as we show that the purchasing department characteristics embedded into PRAC (such as its organizational set-up, knowledge sharing mechanisms, and relational links) are key factors to explain simultaneous improvements on multiple performance dimensions following increased information exchange.

Ultimately, our results empirically support the argument that collaborative relationships can create value without necessarily leading to trade-offs (Longoni et al., 2019; Nunes et al., 2020). Thanks to transformation and exploitation capabilities of their purchasing departments, companies can invest in collaboration initiatives to increase supply chain visibility and obtain, in return, an improvement on both purchasing operational and sustainability performance, a key objective for supply chain to remain competitive in today's fast-changing and uncertain environment (Markman and Krause, 2016). Our robustness checks further confirm this conclusion, as they also highlight a positive relationship between purchasing environmental and operational performance (De Giovanni, 2012; Yoo et al., 2019)

These results provide several contributions to theory and practice that are summarized in the following.

6.1 Main theoretical contributions

These results contribute the existing SCM literature in four areas. In the context of collaborative supply chain relationships, we complement existing studies that focus the attention on information exchange as a form of buyer-supplier collaboration but only analyze their impact on relationship specific variables (Ha et al., 2011) and/or operational performance (Li et al., 2014; He et al., 2017). Our study represents one of the first attempts to analyze the relationship between information sharing practices with suppliers and environmental and social performance.

In the context of knowledge management in supply chains, we contribute by providing a new perspective on the role of PAC in buyer-supplier relationships. Although the existing literature acknowledges the role of purchasing as a knowledge integrator at the boundary of the firm and its supply base (e.g., Luzzini et al., 2015; Patrucco et al., 2017), it rarely formalizes such role into formal abilities. We do so by focusing on PRAC. In line with recent AC literature, we show that information sharing can be considered an antecedent of PRAC, further building on the idea that AC is a cumulative ability that requires first the acquisition and then the exploitation of knowledge (Knoppen et al., 2022). This work clearly identifies PRAC – and transformation and exploitation capabilities – as the intervening mechanism that regulates the relation between buyer-supplier information sharing and performance (operational and environmental).

In the context of sustainable supply chains, we contribute to the previous literature focused on exploring the organizational mechanisms through which collaboration can improve

environmental or social outcomes without compromising operational performance (e.g., Mani and Gunasekaran, 2018; Mani et al., 2018). Several studies have investigated the effects of sustainable supply chain management practices on multiple performance dimensions (e.g., Koberg and Longoni, 2019). Still, very few have provided an explanation of the underlying mechanisms leading to this performance improvement and this study does so by considering two elements (information sharing and AC) that rarely have been related to sustainability aspects. Furthermore, our findings explicitly respond to the call for increased attention to the social dimension of sustainability (Mani et al., 2018; Godwin et al., 2020).

Finally, in the context of performance management in supply chains, we contribute to the debate about how to reconcile conflicting performance dimensions, such as environmental practices/performance vs. operational performance (e.g., Riikkinen et al., 2017; Yoo et al., 2019; Hossan Chowdhury and Quaddus 2021; Samad et al. 2021). In this regard, while the purchasing department has been traditionally subject to pressures towards operational performance, our study presents it as a company area that can also act as a key sustainability catalyzer (Johnsen et al., 2018) without necessarily compromising operational performance (Kleindorfer et al., 2005; Besiou and Van Wassenhove, 2015).

6.2 Managerial implications

These results have several managerial implications. First, we deem our results relevant for managers engaged in collaborative efforts with their supply chain partners. For a firm's success, managers need to recognize the key role of their suppliers and support an active sharing of information with them. Purchasing and supply chain departments are increasingly expected to support corporate sustainability initiatives by aligning supply chain strategies and the ongoing management of suppliers. Our study shows that inter-organizational capabilities are crucial to

achieving TBL outcomes, emphasizing the importance of relational practices enabling information sharing and co-value creation. However, it is also essential to understand the limitation of a collaborative buyer-supplier relation in the absence of effective elaboration and exploitation of external knowledge. The simple investment in higher exchange of information is not enough if not complemented with the capabilities of integrating, processing, and building on such information. Therefore, managers should promote collaborative practices with supply chain partners but also foster such capabilities within their organizations. In particular, by emphasizing the role of PRAC, we offer managers evidence that transformation and exploitation represent the key knowledge management capabilities that purchasing department must develop to drive significant performance improvement.

The results of our research also encourage managers to walk the path to supply chain sustainability, which should not be seen as a mere compromise to operational performance. Thanks to an adequate PRAC, companies can use external information and knowledge to create competitive advantage in the operational, environmental, and social areas, moving away from a myopic, single-dimension optimization approach.

7. Conclusions, limitations, and future developments

Using survey data from 305 procurement professionals, the present paper analyses the relationships between buyer-supplier information sharing, supplier's operational performance, sustainability performance, and the role that the absorptive capacity of purchasing employees plays in favoring the collaboration-performance relationship. We found that information sharing indeed can simultaneously lead to an operational and sustainability performance increase. These outcomes are better explained through the lens of PRAC, that acts as a gateway to leverage the benefits deriving from inter-organizational information exchange.

Despite the contributions listed above, we can reflect on some limitations that might open avenues for further research. First, the generally significant effects that we could test might be contingent on some context-dependent variables. Even though we controlled for the potential effects of sample heterogeneity regarding country, industry, size, and type of category, further studies can benefit from a broader investigation of these and other contingencies. Future works might replicate our analysis to confirm its reliability and further enrich our knowledge of potentially moderating effects we did not investigate, possibly exploiting larger sub-samples and multi-group analyses. For purchasing research, it might be particularly interesting to test our model across different groups of purchasing categories, in line with portfolio management literature (Luzzini et al., 2012).

Second, our research is survey-based, consistently with the target research gap and hypotheses. Despite their validity over time, the relatively old age of the dataset calls for a confirmation of the tested relationships with more recent data. In replicating the study, future research could consider if exogenous factors (e.g., market characteristics, technology evolution, COVID-19 emergency) have impacted the presented results.

Third, although we show the positive effect of information sharing and PRAC on performance, previous research and anecdotal evidence show how hard developing partnerships and knowledge management capabilities is. A qualitative approach (e.g., case study research) could provide a more in-depth understanding of how firms can develop PRAC, implement knowledge and information sharing mechanisms with suppliers, what the challenges are, when inertia may arise, and how it could be mitigated.

Finally, our study does not investigate in-depth the correlation between multiple purchasing performance dimensions. In line with the recent stream of literature investigating how to overcome potential trade-offs between different performance dimensions (De Giovanni,

2012; Hu et al., 2014), future studies could explore the longitudinal, reciprocal relationship between performance.

References

- Abareshi, A., & Molla, A. (2013). Greening logistics and its impact on environmental performance: an absorptive capacity perspective. *International Journal of Logistics Research and Applications*, 16(3), 209-226.
- Adesanya, A., Yang, B., Iqdara, F. W. B., & Yang, Y. (2020). Improving sustainability performance through supplier relationship management in the tobacco industry. *Supply Chain Management: An International Journal*, 25(4), 413-426.
- Anderson, J. C., & Gerbing, D. W. (1988). Structural equation modeling in practice: A review and recommended two-step approach. *Psychological bulletin*, 103(3), 411.
- Astrachan, C. B., Patel, V. K., & Wanzenried, G. (2014). A comparative study of CB-SEM and PLS-SEM for theory development in family firm research. *Journal of Family Business Strategy*, 5(1), 116-128.
- Azadegan, A. (2011). Journal of Supply Chain Management. *Journal of Supply Chain Management*, 47(2), 49–64.
- Barratt, M. (2004). Understanding the meaning of collaboration in the supply chain. *Supply Chain Management*, 9(1), 30–42.
- Benton, W. C., Prahinski, C., & Fan, Y. (2020). The influence of supplier development programs on supplier performance. *International Journal of Production Economics*, 230(August 2018), 107793.
- Besiou, M., & Van Wassenhove, L. N. (2015). Addressing the challenge of modeling for decision-making in socially responsible operations. *Production and Operations Management*, 24(9), 1390-1401.
- Bian, J. & Zhao, X. (2020). Competitive environmental sourcing strategies in supply chains. *International Journal of Production Economics*, 230, 107891.
- Borland, H., Ambrosini, V., Lindgreen, A., & Vanhamme, J. (2016). Building theory at the intersection of ecological sustainability and strategic management. *Journal of Business Ethics*, 135(2), 293-307.
- Braunschneidel, M. J., & Suresh, N. C. (2009). The organizational antecedents of a firm's supply chain agility for risk mitigation and response. *Journal of Operations Management*, 27, 119–140.
- Cao, M., & Zhang, Q. (2011). Supply chain collaboration: Impact on collaborative advantage and firm performance. *Journal of Operations Management*, 29(3), 163–180.
- CAPS (2021). The Metrics of Supply Management: A Cross-Industry Report. <https://www.capsresearch.org/library/?linkedReportID=920> (accessed on January 12, 2022).
- Caridi, M., Moretto, A., Perego, A., and Tumino, A. (2014). The benefits of supply chain visibility: A value assessment model. *International Journal of Production Economics*, 151, 1-19.
- Carter, C. R. (2005). Purchasing social responsibility and firm performance. *International Journal of Physical Distribution and Logistics Management*, 35(3/4), 177–194.
- Carter, C. R., & Rogers, D. S. (2008). A framework of sustainable supply chain management: moving toward new theory. *International Journal of Physical Distribution and Logistics Management*, 38(5), 360-387.
- Chen, D., Newbury, W., & Park, S. H. (2009). Improving sustainability: An international evolutionary framework. *Journal of International Management*, 15(3), 317–327.
- Chin, T.A. & Tat, H.H. (2015). Does gender diversity moderate the relationship between supply chain management practice and performance in the electronic manufacturing services industry? *International Journal of Logistics: Research and Applications*. 18 (1), 35–45.
- Cohen, W. M., & Levinthal, D. A. (1990). Absorptive capacity: A new perspective on learning and innovation. *Administrative Science Quarterly*, 35(1), 128–152.
- Daily, B. F., & Huang, S.-C. (2001). Sustainability through human resource factors Achieving sustainability through attention to human resource factors in environmental management. *International Journal of Operations & Production Management*, 21(12).
- Difrancesco, R.M., Luzzini, D. and Patrucco, A.S. (2022), "Purchasing realized absorptive capacity as the gateway to sustainable supply chain management", *International Journal of Operations & Production Management*, Vol. ahead-of-print No. ahead-of-print. <https://doi.org/10.1108/IJOPM-10-2021-0627>

- De Giovanni, P. (2012). Do internal and external environmental management contribute to the triple bottom line? *International Journal of Operations and Production Management*, 32(3), 265–290.
- Dentoni, D., Bitzer, V., & Pascucci, S. (2016). Cross-sector partnerships and the co-creation of dynamic capabilities for stakeholder orientation. *Journal of business ethics*, 135(1), 35-53.
- Delmas, M., Hoffmann, V. H., & Kuss, M. (2011). Under the tip of the iceberg: Absorptive capacity environmental strategy, and competitive advantage. *Business & Society*, 50(1), 116–154.
- Dey, P. K., Bhattacharya, A., Ho, W., & Clegg, B. (2015). Strategic supplier performance evaluation: A case-based action research of a UK manufacturing organisation. *International Journal of Production Economics*, 166, 192-214.
- Ding, H., Guo, B., & Liu, Z. (2011). Information sharing and profit allotment based on supply chain cooperation. *International Journal of Production Economics*, 133(1), 70–79.
- Dyer, J. H., & Hatch, N. W. (2006). Relation-specific capabilities and barriers to knowledge transfers: creating competitive advantage through network relationships. *Strategic Management Journal*, 27(8), 701–719.
- Dzhengiz, T., & Niesten, E. (2020). Competences for environmental sustainability: A systematic review on the impact of absorptive capacity and capabilities. *Journal of business ethics*, 162(4), 881-906.
- Ehrgott, M., Reimann, F., Kaufmann, L., & Carter, C. (2011). Social sustainability in selecting emerging economy suppliers. *Journal of Business Ethics*, 98(1), 99–119.
- Eisenhardt, K. M., & Martin, J. A. (2000). Dynamic capabilities: what are they?. *Strategic management journal*, 21(10-11), 1105-1121.
- Esfahbodi, A., Zhang, Y., & Watson, G. (2016). Sustainable supply chain management in emerging economies: Trade-offs between environmental and cost performance. *International Journal of Production Economics*, 181, 350–366.
- Feng, T., Jiang, Y., & Xu, D. (2020). The dual-process between green supplier collaboration and firm performance: A behavioral perspective. *Journal of Cleaner Production*, 260, 121073.
- Flatten, T., Adams, D., & Brettel, M. (2015). Fostering absorptive capacity through leadership: A cross-cultural analysis. *Journal of World Business*, 50(3), 519–534.
- Flatten, T. C., Greve, G. I., & Brettel, M. (2011). Absorptive capacity and firm performance in SMEs: The mediating influence of strategic alliances. *European Management Review*, 8(3), 137–152.
- Flynn, B. B., Huo, B., & Zhao, X. (2010). The impact of supply chain integration on performance: A contingency and configuration approach. *Journal of operations management*, 28(1), 58-71.
- Fornell, C., & Larcker, D. F. (1981). Evaluating structural equation models with unobservable variables and measurement error. *Journal of marketing research*, 18(1), 39-50.
- Frohlich, M. T. (2002). Techniques for improving response rates in OM survey research. *Journal of Operations Management*, 20(1), 53-62.
- Geng, R., Mansouri, S. A., & Aktas, E. (2017). The relationship between green supply chain management and performance: A meta-analysis of empirical evidences in Asian emerging economies. *International Journal of Production Economics* 183, 245–258.
- Geyi, D. G., Yusuf, Y., Menhat, M. S., Abubakar, T., & Ogbuke, N. J. (2020). Agile capabilities as necessary conditions for maximising sustainable supply chain performance: An empirical investigation. *International Journal of Production Economics*, 222, 107501.
- Giannakis, M., Dubey, R., Vlachos, I., & Ju, Y. (2020). Supplier sustainability performance evaluation using the analytic network process. *Journal of cleaner production*, 247, 119439.
- Gimenez, C., Sierra, V., & Rodon, J. (2012). Sustainable operations: Their impact on the triple bottom line. *International Journal of Production Economics*, 140(1), 149-159.
- Golicic, S. L., & Smith, C. D. (2013). A meta-analysis of environmentally sustainable supply chain management practices and firm performance. *Journal of supply chain management*, 49(2), 78-95.
- Difrancesco, R.M., Luzzini, D. and Patrucco, A.S. (2022), "Purchasing realized absorptive capacity as the gateway to sustainable supply chain management", *International Journal of Operations & Production Management*, Vol. ahead-of-print No. ahead-of-print. <https://doi.org/10.1108/IJOPM-10-2021-0627>

- Gonzalez-Benito, J. (2007). A theory of purchasing's contribution to business performance. *Journal of Operations Management*, 25(4), 901-917.
- Ha, B. C., Park, Y. K., & Cho, S. (2011). Suppliers' affective trust and trust in competency in buyers: Its effect on collaboration and logistics efficiency. *International Journal of Operations and Production Management*, 31(1), 56-77.
- Hajmohammad, S. & Vachon, S. (2016). Mitigation, avoidance, or acceptance? Managing supplier sustainability risk. *Journal of Supply Chain Management* 52 (2), 48-65.
- Handley, S. M., & Benton, W. C. Jr. (2012). The influence of exchange hazards and power on opportunism in outsourcing relationships. *Journal of Operations Management*, 30(1-2), 55-68.
- Harkness, J., Pennell, B., & Schoua-Glusberg, A. (2004). Survey questionnaire translation and assessment. In Presser, S. Rothgeb, J.M, Couper, M.P., Lessler, J.T., Martin, E., Martin, J. and Singer, E. (Eds.). *Methods for Testing and Evaluating Survey Questionnaires*. Hoboken, NJ, pp. 453-473.
- Hartmann, E., Kerkfeld, D., & Henke, M. (2012). Top and bottom line relevance of purchasing and supply management. *Journal of purchasing and supply management*, 18(1), 22-34.
- Hassini, E., Surti, C., & Searcy, C. (2012). A literature review and a case study of sustainable supply chains with a focus on metrics. *International Journal of Production Economics*, 140(1), 69-82.
- Hayes, A. F. (2009). Beyond Baron and Kenny: Statistical mediation analysis in the new millennium. *Communication monographs*, 76(4), 408-420.
- He, Y., Sun, H., Ni, W., & Ng, S. C. H. (2017). Re-examining the effects of supplier integration on operations performance: a relational view. *International Journal of Operations and Production Management*, 37(12), 1702-1721.
- Heide, J. B., & Miner, A. S. (1992). The Shadow of the Future: Effects of Anticipated Interaction and Frequency of Contact on Buyer-Seller Cooperation. In *Source: The Academy of Management Journal* 35(2).
- Højmoose, S. U., Grosvold, J., & Millington, A. (2013). Socially responsible supply chains: power asymmetries and joint dependence. *Supply Chain Management: An International Journal*, 18(3), 277-291.
- Hollos, D., Blome, C., & Foerstl, K. (2012). Does sustainable supplier co-operation affect performance? Examining implications for triple bottom line. *International Journal of Production Research*, 50(11), 2968-2986.
- Hooper, D., Coughlan, J., & Mullen, M. R. (2008). Structural equation modelling: Guidelines for determining model fit. *Electronic journal of business research methods*, 6(1), 53-60.
- Hossan Chowdhury, M.M. & Quaddus, M.A. (2021). Supply chain sustainability practices and governance for mitigating sustainability risk and improving market performance: A dynamic capability perspective, *Journal of Cleaner Production*, 278, 123521.
- Hsu, H. Y., Hwang, M. H., & Chiu, Y. S. P. (2021). Development of a strategic framework for sustainable supply chain management. *AIMS Environmental Science*, 8(6), 532-552.
- Hsu, C. C., Kannan, V. R., Tan, K. C., & Leong, G. K. (2008). Information sharing, buyer-supplier relationships, and firm performance: A multi-region analysis. *International Journal of Physical Distribution and Logistics Management*, 38(4), 296-310.
- Hu, L. & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling*, 6(1), 1-55.
- Inigo, E. A., Albareda, L., & Ritala, P. (2017). Business model innovation for sustainability: Exploring evolutionary and radical approaches through dynamic capabilities. *Industry and Innovation*, 24(5), 515-542.
- Jacobs, B. W., Singhal, V. R., & Subramanian, R. (2010). An empirical investigation of environmental performance and the market value of the firm. *Journal of Operations Management*, 28(5), 430-441.
- Jansen, J. J., Van Den Bosch, F. A., & Volberda, H. W. (2005). Managing potential and realized absorptive capacity: how do organizational antecedents matter?. *Academy of management journal*, 48(6), 999-1015.
- Difrancesco, R.M., Luzzini, D. and Patrucco, A.S. (2022), "Purchasing realized absorptive capacity as the gateway to sustainable supply chain management", *International Journal of Operations & Production Management*, Vol. ahead-of-print No. ahead-of-print. <https://doi.org/10.1108/IJOPM-10-2021-0627>

- Johnsen, T. E., Miemczyk, J., & Howard, M. (2017). A systematic literature review of sustainable purchasing and supply research: Theoretical perspectives and opportunities for IMP-based research. *Industrial Marketing Management*, 61, 130-143.
- Johnsen, T. E., Howard, M., & Miemczyk, J. (2018). Purchasing and supply chain management: A sustainability perspective. Routledge.
- Khan, Z., Lew, Y. K., & Marinova, S. (2019). Exploitative and exploratory innovations in emerging economies: The role of realized absorptive capacity and learning intent. *International Business Review*, 28(3), 499–512.
- Katiyar, R., Meena, P. L., Barua, M. K., Tibrewala, R., & Kumar, G. (2018). Impact of sustainability and manufacturing practices on supply chain performance: Findings from an emerging economy. *International Journal of Production Economics*, 197(April 2017), 303–316.
- Kauppi, K., Brabdon-Jones, A., Ronchi, S., & van Raaij, E. (2013). Tools without skills: Exploring the moderating effect of absorptive capacity on the relationship between e-purchasing tools and category performance. *International Journal of Operations and Production Management*, 33(7), 828–857.
- Kembro, J., Näslund, D., & Olhager, J. (2017). Information sharing across multiple supply chain tiers: A Delphi study on antecedents. *International Journal of Production Economics*, 193, 77-86.
- Kim, S., Foerstl, K., Schmidt, C. G., & Wagner, S. M. (2021). Adoption of green supply chain management practices in multi-tier supply chains: Examining the differences between higher and lower tier firms. *International Journal of Production Research*, 1-18.
- Klassen, R. D., & Vachon, S. (2003). Collaboration and evaluation in the supply chain: The impact on plant-level environmental investment. *Production and operations Management*, 12(3), 336-352.
- Kleindorfer, P. R., Singhal, K., & Van Wassenhove, L. N. (2005). Sustainable operations management. *Production and operations management*, 14(4), 482-492.
- Knoppen, D., Saris, W., Moncagatta, P. (2022). Absorptive capacity dimensions and the measurement of cumulativeness. *Journal of Business Research*, 139, 312-324.
- Koberg, E., & Longoni, A. (2019). A systematic review of sustainable supply chain management in global supply chains. *Journal of cleaner production*, 207, 1084-1098.
- Kostopoulos, K., Papalexandris, A., Papachroni, M., & Ioannou, G. (2011). Absorptive capacity, innovation, and financial performance. *Journal of Business Research*, 64(12), 1335-1343.
- Kotabe, M., Jiang, C. X., & Murray, J. Y. (2011). Managerial ties, knowledge acquisition, realized absorptive capacity and new product market performance of emerging multinational companies: A case of China. *Journal of World Business*, 46(2), 166–176.
- Koufteros, X., Vergheze, A. J., & Lucianetti, L. (2014). The effect of performance measurement systems on firm performance: A cross-sectional and a longitudinal study. *Journal of Operations Management*, 32(6), 313-336.
- Kulangara, N. P., Jackson, S. A., & Prater, E. (2016). Examining the impact of socialization and information sharing and the mediating effect of trust on innovation capability. *International Journal of Operations and Production Management*, 36(11), 1601–1624.
- Kumar, D., & Rahman, Z. (2016). Buyer supplier relationship and supply chain sustainability: Empirical study of Indian automobile industry. *Journal of Cleaner Production*, 131, 836–848.
- Kumar, G. Meena, P., Difrancesco, R.M. (2021). How do collaborative culture and capability improve sustainability? *Journal of Cleaner Production*, 291. In press.
- Lam, H. K. S., Yeung, A. C. L., Cheng, T. C. E., & Humphreys, P. K. (2016). Corporate environmental initiatives in the Chinese context: Performance implications and contextual factors. *International Journal of Production Economics*, 180, 48–56.
- Lee, C. H., & Ha, B. C. (2018). The impact of buyer-supplier relationships' social capital on bi-directional information sharing in the supply chain. *Journal of Business and Industrial Marketing*, 33(3), 325–336.
- Difrancesco, R.M., Luzzini, D. and Patrucco, A.S. (2022), "Purchasing realized absorptive capacity as the gateway to sustainable supply chain management", *International Journal of Operations & Production Management*, Vol. ahead-of-print No. ahead-of-print. <https://doi.org/10.1108/IJOPM-10-2021-0627>

- Lee, H.L., Padmanabhan, V. and Whang, S. (1997). Information distortion in a supply chain: the bullwhip effect. *Management Science*, Vol. 43 No. 4, pp. 546-558.
- Lee, H. L., So, K. C., & Tang, C. S. (2000). The Value of Information Sharing in a Two-Level Supply Chain. In *Source: Management Science*, 46(5).
- Lee, K. H., & Kim, J. W. (2009). Current status of CSR in the realm of supply management: The case of the Korean electronics industry. *Supply Chain Management*, 14(2), 138–148.
- Lee, K. H., & Vachon, S. (2016). *Business value and sustainability*. Palgrave Macmillan UK.
- Li, Y., Ye, F., & Sheu, C. (2014). Social capital, information sharing and performance: Evidence from China. *International Journal of Operations & Production Management*.
- Liu, W., Yan, X., Si, C., Xie, D., & Wang, J. (2020). Effect of buyer-supplier supply chain strategic collaboration on operating performance: evidence from Chinese companies. *Supply Chain Management*, 25(6), 823–839.
- Longoni, A., Pagell, M., Shevchenko, A., & Klassen, R. (2019). Human capital routines and sustainability trade-offs: The influence of conflicting schemas for operations and safety managers. *International Journal of Operations & Production Management*, 39(5), 690-713.
- Lowry, P. B., & Gaskin, J. (2014). Partial least squares (PLS) structural equation modeling (SEM) for building and testing behavioral causal theory: When to choose it and how to use it. *IEEE transactions on professional communication*, 57(2), 123-146.
- Lu, J., Mahmoudian, F., Yu, D., Nazari, J. A., & Herremans, I. M. (2021). Board interlocks, absorptive capacity, and environmental performance. *Business Strategy and the Environment*, 30(8), 3425-3443.
- Luzzini, D., Brandon-Jones, E., Brandon-Jones, A., & Spina, G. (2015). From sustainability commitment to performance: The role of intra-and inter-firm collaborative capabilities in the upstream supply chain. *International Journal of Production Economics*, 165, 51-63.
- Luzzini, D., Caniato, F., Ronchi, S., & Spina, G. (2012). A transaction costs approach to purchasing portfolio management. *International Journal of Operations & Production Management*, 32(9).
- MacCarthy, B. L., Lewis, M., Voss, C., & Narasimhan, R. (2013). The same old methodologies? Perspectives on OM research in the post-lean age. *International Journal of Operations and Production Management*, 33(7), 934–956.
- Maestrini, V., Luzzini, D., Caniato, F., Maccarrone, P., & Ronchi, S. (2018). The impact of supplier performance measurement systems on supplier performance. *International Journal of Operations & Production Management*, 38(11), 2040-2061.
- Mani, V., & Gunasekaran, A. (2018). Four forces of supply chain social sustainability adoption in emerging economies. *International Journal of Production Economics*, 199, 150-161.
- Mani, V., Gunasekaran, A., & Delgado, C. (2018). Enhancing supply chain performance through supplier social sustainability: An emerging economy perspective. *International Journal of Production Economics*, 195, 259-272.
- Mani, V., Jabbour, C. J. C., & Mani, K. T. N. (2020). Supply chain social sustainability in small and medium manufacturing enterprises and firms' performance: Empirical evidence from an emerging Asian economy. *International Journal of Production Economics*, 227(January), 107656.
- Margolis, Joshua D., Elfenbein, Hillary Anger, Walsh, James P. (2011). Does it Pay to Be Good. And Does it Matter? a Meta-analysis of the Relationship between Corporate Social and Financial Performance. Available at: SSRN: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=1866371
- Markman, G. D., & Krause, D. (2016). Theory building surrounding sustainable supply chain management: Assessing what we know, exploring where to go. *Journal of supply chain management*, 52(2), 3-10.
- Marshall, D., McCarthy, L., Heavey, C., McGrath, P. (2015). Environmental and social supply chain management sustainability practices: construct development and measurement. *Production Planning & Control* 26 (8), 673–690.
- Difrancesco, R.M., Luzzini, D. and Patrucco, A.S. (2022), "Purchasing realized absorptive capacity as the gateway to sustainable supply chain management", *International Journal of Operations & Production Management*, Vol. ahead-of-print No. ahead-of-print. <https://doi.org/10.1108/IJOPM-10-2021-0627>

- Marshall, D., McCarthy, L., Claudy, M., & McGrath, P. (2019). Piggy in the middle: How direct customer power affects first-tier suppliers' adoption of socially responsible procurement practices and performance. *Journal of business ethics*, 154(4), 1081-1102.
- Meinlschmidt, J., Foerstl, K., & Kirchoff, J. F. (2016). The role of absorptive and desorptive capacity (ACDC) in sustainable supply management: A longitudinal analysis. *International Journal of Physical Distribution and Logistics Management*, 46(2), 177-211.
- Miemczyk, J., & Luzzini, D. (2019). Achieving triple bottom line sustainability in supply chains. *International Journal of Operations & Production Management*, 39(2), 238-259.
- Modi, S. B., & Mabert, V. A. (2007). Supplier development: Improving supplier performance through knowledge transfer. *Journal of Operations Management*, 25, 42-64.
- Montabon, F., Sroufe, R., & Narasimhan, R. (2007). An examination of corporate reporting, environmental management practices and firm performance. *Journal of operations management*, 25(5), 998-1014.
- Narasimhan, R., & Kim, S. W. (2002). Effect of supply chain integration on the relationship between diversification and performance: evidence from Japanese and Korean firms. *Journal of operations management*, 20(3), 303-323.
- Negri, M., Cagno, E., Colicchia, C., & Sarkis, J. (2021). Integrating sustainability and resilience in the supply chain: A systematic literature review and a research agenda. *Business Strategy and the Environment*, 30(7), 2858-2886.
- Newell, W. J., Ellegaard, C., & Esbjerg, L. (2019). The effects of goodwill and competence trust on strategic information sharing in buyer-supplier relationships. *Journal of Business and Industrial Marketing*, 34(2), 389-400.
- Nunes, M. F., Lee Park, C. & Laureano Paiva E. (2020). Can we have it all? Sustainability trade-offs and cross-insurance mechanisms in supply chains. *International Journal of Operations & Production Management*.
- Pagell, M., & Wu, Z. (2009). Building a more complete theory of sustainable supply chain management using case studies of 10 exemplars. *Journal of Supply Chain Management*, 45(2).
- Pakdeechoho, N., & Sukhotu, V. (2018). Sustainable supply chain collaboration: Incentives in emerging economies. *Journal of Manufacturing Technology Management*, 29(2), 273-294.
- Patel, P. C., Terjesen, S., & Li, D. (2012). Enhancing effects of manufacturing flexibility through operational absorptive capacity and operational ambidexterity. *Journal of Operations Management*, 30(3), 201-220.
- Patrucco, A. S., Luzzini, D., & Ronchi, S. (2017). Achieving innovation through supplier collaboration: the role of the purchasing interface. *Business Process Management Journal*, 23(6), 1270-1289.
- Patrucco, A. S., Moretto, A., Luzzini, D., & Glas, A. H. (2020). Obtaining supplier commitment: antecedents and performance outcomes. *International Journal of Production Economics*, 220, 107449.
- Paulraj, A., Chen, I.J., Blome, C. (2017). Motives and performance outcomes of sustainable supply chain management practices: a multi-theoretical perspective. *Journal of Business Ethics* 145, 239-258.
- Paulraj, A., Lado, A. A., & Chen, I. J. (2008). Inter-organizational communication as a relational competency: Antecedents and performance outcomes in collaborative buyer-supplier relationships. *Journal of Operations Management*, 26(1), 45-64.
- Pinkse, J., Kuss, M. J., & Hoffmann, V. H. (2010). On the implementation of a 'global' environmental strategy: The role of absorptive capacity. *International Business Review*, 19(2), 160-177.
- Podsakoff, P., MacKenzie, S., Lee, J., & Podsakoff, N.P. (2003). Common method biases in behavioral research: A critical review of the literature and recommended remedies. *Journal of Applied Psychology*, 88(5), 879-903.

Difrancesco, R.M., Luzzini, D. and Patrucco, A.S. (2022), "Purchasing realized absorptive capacity as the gateway to sustainable supply chain management", *International Journal of Operations & Production Management*, Vol. ahead-of-print No. ahead-of-print. <https://doi.org/10.1108/IJOPM-10-2021-0627>

- Prajogo, D., Chowdhury, M., Yeung, A. C., & Cheng, T. C. E. (2012). The relationship between supplier management and firm's operational performance: A multi-dimensional perspective. *International journal of production economics*, 136(1), 123-130.
- Prajogo, D., & Olhager, J. (2012). Supply chain integration and performance: The effects of long-term relationships, information technology and sharing, and logistics integration. *International Journal of Production Economics*, 135(1), 514-522.
- Rao, P., & Holt, D. (2005). Do green supply chains lead to competitiveness and economic performance?. *International Journal of Operations & Production Management*, 25(9), 898-916.
- Revilla, E., Sáenz, M. J., & Knoppen, D. (2013). Towards an empirical typology of buyer-supplier relationships based on absorptive capacity. *International Journal of Production Research*, 51(10), 2935–2951.
- Riikinen, R., Kauppi, K., & Salmi, A. (2017). Learning Sustainability? Absorptive capacities as drivers of sustainability in MNCs' purchasing. *International Business Review*, 26(6), 1075-1087.
- Rojo, A., Stevenson, M., Lloréns Montes, F. J., & Perez-Arostegui, M. N. (2018). Supply chain flexibility in dynamic environments: The enabling role of operational absorptive capacity and organisational learning. *International Journal of Operations and Production Management*, 38(3), 636–666.
- Rungtusanatham, M., Miller, J. W., & Boyer, K. K. (2014). Theorizing, testing, and concluding for mediation in SCM research: tutorial and procedural recommendations. *Journal of Operations Management*, 32(3), 99-113.
- Saenz, M. J., Revilla, E., & Knoppen, D. (2014). Absorptive capacity in buyer–supplier relationships: empirical evidence of its mediating role. *Journal of Supply Chain Management*, 50(2).
- Samad, S., Nilashi, M., Almulihi, A., Alrizq, M., Alghamdi, A., Mohd, S., & Azhar, S. N. F. S. (2021). Green Supply Chain Management practices and impact on firm performance: The moderating effect of collaborative capability. *Technology in Society*, 67, 101766.
- Schiele, H. (2007). Supply-management maturity, cost savings and purchasing absorptive capacity: Testing the procurement–performance link. *Journal of purchasing and supply management*, 13(4), 274-293.
- Setia, P., & Patel, P. C. (2013). How information systems help create OM capabilities: Consequents and antecedents of operational absorptive capacity. *Journal of Operations Management*, 31(6), 409-431.
- Singh, P. J., & Power, D. (2009). The nature and effectiveness of collaboration between firms, their customers and suppliers: A supply chain perspective. *Supply Chain Management*, 14(3), 189–200.
- Sodhi, M. S., & Tang, C. S. (2018). Corporate social sustainability in supply chains: a thematic analysis of the literature. *International Journal of Production Research*, 56(1-2), 882-901.
- Teece, D. J., Pisano, G., & Shuen, A. (1997). Dynamic capabilities and strategic management. *Strategic management journal*, 18(7), 509-533.
- The Guardian (2021). Supermarkets drop Brazilian beef products linked to deforestation. Available at: <https://www.theguardian.com/environment/2021/dec/16/supermarkets-drop-brazilian-beef-products-linked-to-deforestation> (accessed on December 20, 2021).
- Todorova, G., & Durisin, B. (2007). Absorptive capacity: Valuing a reconceptualization. *Academy of management review*, 32(3), 774-786.
- Tu, Q., Vonderembse, M. A., Ragu-Nathan, T. S., & Sharkey, T. W. (2006). Absorptive capacity: Enhancing the assimilation of time-based manufacturing practices. *Journal of Operations Management*, 24(5), 692–710.
- Vachon, S., & Klassen, R. D. (2006). Extending green practices across the supply chain: The impact of upstream and downstream integration. *International Journal of Operations and Production Management*, 26(7), 795–821.
- Vachon, S., & Klassen, R. D. (2008). Environmental management and manufacturing performance: The role of collaboration in the supply chain. *International journal of production economics*, 111(2), 299-315.
- Difrancesco, R.M., Luzzini, D. and Patrucco, A.S. (2022), "Purchasing realized absorptive capacity as the gateway to sustainable supply chain management", *International Journal of Operations & Production Management*, Vol. ahead-of-print No. ahead-of-print. <https://doi.org/10.1108/IJOPM-10-2021-0627>

- van Donk, D. P., van der Vaart, T., Awaysheh, A., & Klassen, R. D. (2010). The impact of supply chain structure on the use of supplier socially responsible practices. *International Journal of Operations & Production Management*, 30(12), 1246-1268.
- van Raaij, E. M. (2018). Déjà lu: On the limits of data reuse across multiple publications. *Journal of Purchasing and Supply Management*, 24(3), 183-191.
- Villena, V. H., & Gioia, D. A. (2018). On the riskiness of lower-tier suppliers: Managing sustainability in supply networks. *Journal of Operations Management*, 64, 65-87.
- Volberda, H. W., Foss, N. J., & Lyles, M. A. (2010). Absorbing the concept of absorptive capacity: How to realize its potential in the organization field. *Organization Science*, 21(4), 931-951.
- Wacker, J. G., Yang, C., & Sheu, C. (2016). A transaction cost economics model for estimating performance effectiveness of relational and contractual governance: Theory and statistical results. *International Journal of Operations and Production Management*, 36(11), 1551-1575.
- Whelan, T., Atz, U., & Casey Clark, C. F. A. (2021). ESG and Financial Performance. Centre for Sustainable Business, NYU.
- White, H. (1982). Maximum likelihood estimation of misspecified models. *Econometrica: Journal of the Econometric Society*, 50(1), 1-25.
- Wong, C. Y., Boon-Itt, S., & Wong, C. W. (2011). The contingency effects of environmental uncertainty on the relationship between supply chain integration and operational performance. *Journal of Operations management*, 29(6), 604-615.
- Woo, C., Kim, M. G., Chung, Y., & Rho, J. J. (2016). Suppliers' communication capability and external green integration for green and financial performance in Korean construction industry. *Journal of Cleaner Production*, 112, 483-493.
- Wu, W. P. (2008). Dimensions of social capital and firm competitiveness improvement: The mediating role of information sharing. *Journal of management studies*, 45(1), 122-146.
- Wu, T., Wu, Y. C. J., Chen, Y. J., & Goh, M. (2014). Aligning supply chain strategy with corporate environmental strategy: A contingency approach. *International Journal of Production Economics*, 147, 220-229.
- Wu, Z., & Pullman, M. E. (2015). Cultural embeddedness in supply networks. *Journal of Operations Management*, 37, 45-58.
- Xie, X., Zhu, Q., & Wang, R. (2019). Turning green subsidies into sustainability: How green process innovation improves firms' green image. *Business Strategy and the Environment*, 28(7), 1416-1433.
- Yawar, S. A., & Seuring, S. (2017). Management of social issues in supply chains: a literature review exploring social issues, actions and performance outcomes. *Journal of Business Ethics*, 141(3), 621-643.
- Yawar, S. A., & Seuring, S. (2018). The role of supplier development in managing social and societal issues in supply chains. *Journal of Cleaner Production*, 182, 227-237.
- Yu, W., Chavez, R., Feng, M. and Wiengarten, F. (2014), Integrated green supply chain management and operational performance, *Supply Chain Management*, Vol. 19 No. 5/6, pp. 683-696.
- Yusuf, Y., Menhat, M. S., Abubakar, T., & Ogbuke, N. J. (2020). Agile capabilities as necessary conditions for maximising sustainable supply chain performance: An empirical investigation. *International Journal of Production Economics*, 222, 107501.
- Zacharia, Z. G., Nix, N. W., & Lusch, R. F. (2011). Capabilities that enhance outcomes of an episodic supply chain collaboration. *Journal of Operations Management*, 29(6), 591-603.
- Zahra, S. A., & George, G. (2002). Absorptive capacity: A review reconceptualization, and extension. *The Academy of Management Review*, 27(2), 185-203.
- Zhang, C., Viswanathan, S., & Henke Jr, J. W. (2011). The boundary spanning capabilities of purchasing agents in buyer-supplier trust development. *Journal of Operations Management*, 29(4), 318-328.
- Difrancesco, R.M., Luzzini, D. and Patrucco, A.S. (2022), "Purchasing realized absorptive capacity as the gateway to sustainable supply chain management", *International Journal of Operations & Production Management*, Vol. ahead-of-print No. ahead-of-print. <https://doi.org/10.1108/IJOPM-10-2021-0627>

- Zhang, M., Zhao, X., & Lyles, M. (2018). Effects of absorptive capacity, trust and information systems on product innovation. *International Journal of Operations and Production Management*, 38(2), 493–512.
- Zhu, Q. & Lai, K.H. (2019). Enhancing supply chain operations with extended corporate social responsibility practices by multinational enterprises: social capital perspective from Chinese suppliers. *International Journal of Production Economics* 213, 1–12.
- Zhu, Q., & Sarkis, J. (2007). The moderating effects of institutional pressures on emergent green supply chain practices and performance. *International journal of production research*, 45(18-19), 4333-4355.

APPENDIX A. Items included in the questionnaire

Table A1. Construct measures

First-order construct	Adapted from...	Label	Indicators (corresponding to the survey questions)	Mean	SD
<i>Buyer-supplier information sharing</i>	Flynn et al. (2010) Wong et al. (2011)	<i>IS1</i>	We share our cost information with our major suppliers of this category	3.05	1.35
		<i>IS2</i>	We require cost information sharing by our major suppliers in this category	3.78	1.46
		<i>IS3</i>	We require major suppliers in this category to contribute to (our company) cost/quality improvement	4.45	1.32
		<i>IS4</i>	We share real time production schedule information with major suppliers in this category	3.47	1.51
<i>Purchasing transformation capabilities</i>	Setia and Patel (2013)	<i>TRANSF1</i>	Our department considers the consequences of changing external market demands in terms of new products and services	4.30	1.05
		<i>TRANSF2</i>	Employees record and store newly acquired knowledge for future reference	3.91	1.12
		<i>TRANSF3</i>	Our department quickly recognize the value of new external ideas to existing knowledge	4.12	1.06
		<i>TRANSF4</i>	Employees hardly share practical experiences (reverse coded)	3.56	1.21
		<i>TRANSF5</i>	We are slow to grasp the opportunities for our department from new external knowledge (reverse coded)	3.41	1.16
<i>Purchasing exploitation capabilities</i>		<i>EXPL1</i>	Our department has a clear division of roles and responsibilities	4.34	1.32
		<i>EXPL2</i>	We constantly consider how to better exploit knowledge	4.20	1.12
		<i>EXPL3</i>	Our department has difficulty contributing to new products and services implemented by the company (reverse coded)	3.31	1.28
		<i>EXPL4</i>	Employees have a common language regarding our company's products and services	4.36	1.10
<i>Purchasing operational performance</i>	Gonzalez-Benito (2007) Vachon and Klassen (2008)	<i>OP1</i>	Features and functionality of purchased products or services	4.32	0.79
		<i>OP2</i>	Durability of purchased products or services	4.32	0.87
		<i>OP3</i>	Reliability of purchased products or services	4.31	0.91
		<i>OP4</i>	Fit between purchasing specifications and purchased products or services (e.g. high finish, uniformity, consistent delivery)	4.32	0.83
		<i>OP5</i>	Productivity of purchasing resources	4.35	0.93
		<i>OP6</i>	Low inventory levels	4.25	0.95
		<i>OP7</i>	Low cost of purchases (e.g. purchasing price, transportation)	4.19	1.12
		<i>OP8</i>	Fulfilment of agreed schedules by suppliers	4.15	0.91
		<i>OP9</i>	Fulfilment of agreed delivery terms by suppliers (e.g. quantity, quality, format)	3.93	1.05
		<i>OP10</i>	Supplier flexibility to adapt capacity to our needs	4.23	0.89
<i>Purchasing environmental performance</i>	Montabon et al. (2007) Hollos et al. (2012)	<i>ENV1</i>	Supplier ability to meet agreed environmental performance goals	3.85	1.01
		<i>ENV2</i>	Ensuring that purchased products/services contain green attributes (e.g. recycled or reusable items)	3.75	1.04
		<i>ENV3</i>	Ensuring that purchased products/services do not contain environmentally undesirable substance (e.g. hazardous or toxic materials)	4.09	1.19
		<i>SOC1</i>	Enforcement of a code of conduct for suppliers	3.84	1.17

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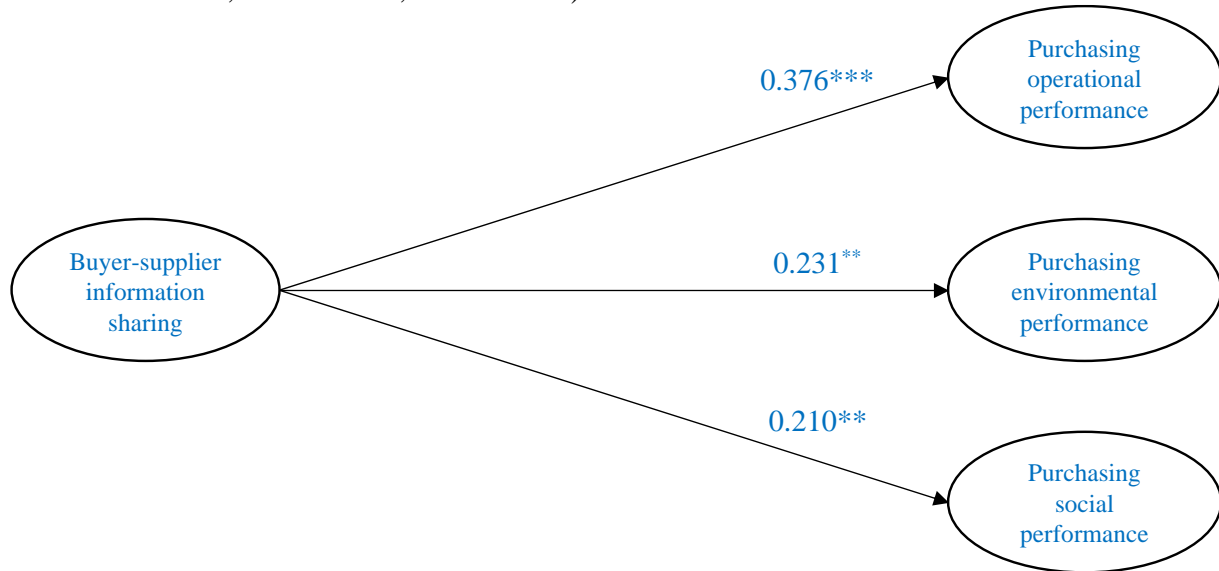
<i>Purchasing social performance</i>		<i>SOC2</i>	Use of independent audits of ethical performance of suppliers	3.55	1.13
		<i>SOC3</i>	Use of more stringent ethical and social mandates than required in host countries	3.63	1.11

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APPENDIX B. Additional model testing

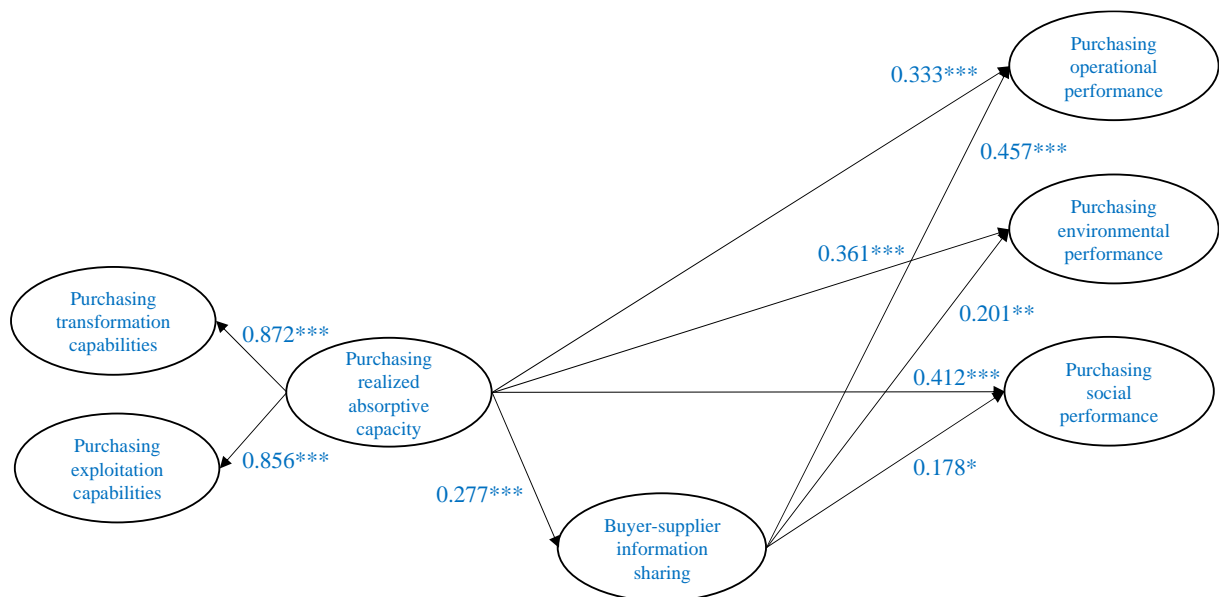
Alternative model 1: model without PRAC as the mediator

Figure B1. Path estimates – model without PRAC as the mediator (***) p-value < 0.001; ** p-value < 0.01; * p-value < 0.05; ^{NS} p-value > 0.05; goodness of fit: $\chi^2 = 246.47$; $\chi^2/\text{d.f.} = 2.12$; RMSEA = 0.056; CFI = 0.958; TLI = 0.951)



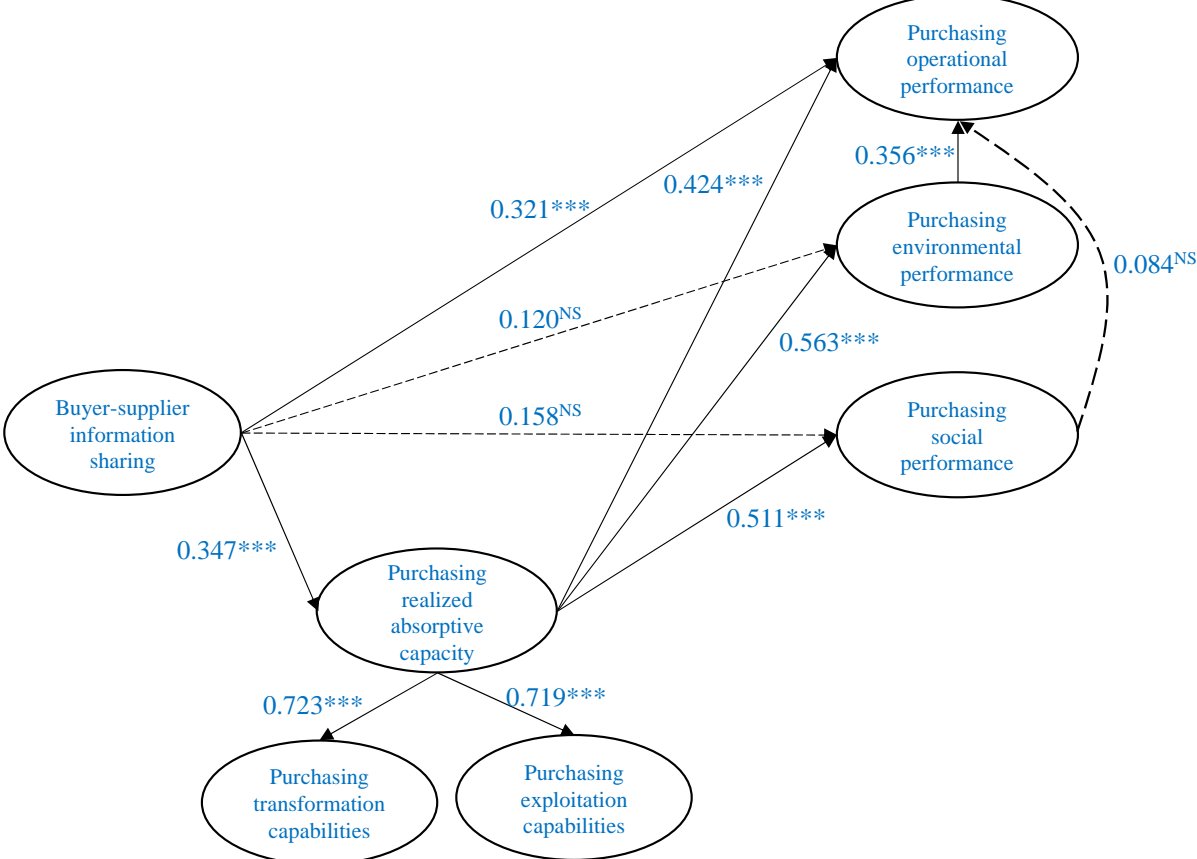
Alternative model 2: model with PRAC as an antecedent of buyer-supplier information sharing

Figure B2. Path estimates – model with PRAC as an antecedent (***) p-value < 0.001; ** p-value < 0.01; * p-value < 0.05; ^{NS} p-value > 0.05; goodness of fit: $\chi^2 = 592.23$; $\chi^2/\text{d.f.} = 2.96$; RMSEA = 0.08; CFI = 0.898; TLI = 0.882)



Alternative model 3: model with relationships between sustainability and operational performance

Figure E1. Path estimates – model with relationships between purchasing sustainability and operational performance (**p-value < 0.001; ** p-value < 0.01; * p-value < 0.05; ^{NS} p-value > 0.05; goodness of fit: $\chi^2 = 599.34$; $\chi^2/d.f. = 2.97$; RMSEA = 0.077; CFI = 0.896; TLI = 0.881)



APPENDIX C. Correlation matrix of residuals

Table C1. Correlation matrix of residuals – performance items

	<i>OP2</i>	<i>OP3</i>	<i>OP4</i>	<i>OP5</i>	<i>OP7</i>	<i>OP8</i>	<i>OP9</i>	<i>OP10</i>	<i>ENV1</i>	<i>ENV2</i>	<i>ENV3</i>	<i>SOC1</i>	<i>SOC2</i>	<i>SOC3</i>
<i>OP2</i>	0													
<i>OP3</i>	0.106	0												
<i>OP4</i>	0.027	0.035	0											
<i>OP5</i>	-0.057	-0.063	-0.045	0										
<i>OP7</i>	-0.08	-0.09	-0.062	0.121	0									
<i>OP8</i>	-0.078	-0.05	-0.045	0.049	0.07	0								
<i>OP9</i>	-0.092	-0.06	-0.01	-0.015	0.024	0.119	0							
<i>OP10</i>	-0.035	-0.053	0.01	-0.009	0.01	0.112	0.103	0						
<i>ENV1</i>	-0.003	-0.042	0.01	-0.008	0.078	0.023	0.05	0.023	0					
<i>ENV2</i>	-0.054	-0.078	-0.007	-0.041	0.017	0.043	0.056	0.003	0.004	0				
<i>ENV3</i>	0.094	0.096	0.114	0.119	0.131	0.163	0.134	0.105	-0.017	-0.002	0			
<i>SOC1</i>	0.039	0.021	0.053	0.052	0.083	0.02	0.03	0.15	0.011	0.011	0.118	0		
<i>SOC2</i>	-0.009	-0.049	-0.042	-0.024	0.058	-0.099	-0.048	0.019	-0.006	-0.012	-0.032	-0.003	0	

<i>SOC3</i>	-0.046	-0.013	-0.039	0.038	0.094	-0.027	0.021	0.012	-0.016	0.012	-0.022	-0.007	0.006	0
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