Characteristics of supplier performance measurement systems in collaborative innovation projects: the role of the purchasing department

Andrea Patrucco
Department of Marketing and Logistics – College of Business, Florida International University, Miami, Florida, USA
Federico Frattini
School of Management, Politecnico di Milano, Milan, Italy, and
Anthony Di Benedetto
Department of Marketing and Supply Chain Management – Fox School of Business, Temple University, Philadelphia, Pennsylvania, USA

Abstract

Purpose – In the wake of the growing popularity of the open innovation approach, leveraging suppliers as external sources of innovation has attracted increasing interest from scholars and practitioners. Successful supplier involvement largely depends on an effective performance measurement process, but both supply chain management and innovation management literature have paid limited attention to this aspect. This paper aims to fill this gap by illustrating how companies measure the performance of the suppliers involved in their innovation projects and what role is played by the purchasing department.

Design/methodology/approach – This study interviews project stakeholders from nine different organizations acting as focal companies in the supply chains of various industries. This paper complements this on-field information with a vast amount of data collected from secondary project documents. Structured data coding and analysis allow us to discuss how companies redesign their performance measurement systems to ease the collaboration with suppliers in innovation and what factors underly these decisions.

Findings – The findings show that, in many cases, supplier performance measurement systems deviate from their typical characteristics to support collaboration in innovation projects. They integrate quantitative and qualitative measures, include contributions from different project stakeholders and are oriented toward high visibility and transparency with suppliers. A more substantial redesign of these systems is favored when purchasing is assigned to strategic project responsibilities and possesses higher absorptive capacity.

Originality/value – The results complement the knowledge for the supply chain management field, where supplier performance measurement systems have been discussed in the context of traditional buyer-supplier relationships, but not comprehensively in innovation projects and not considering the role of purchasing. Findings also contribute to the innovation management literature, which has mostly focused on what aspects need to be measured for innovation partners, rather than how to manage the performance measurement process in practice.

Keywords Performance measurement, Purchasing, Supplier involvement, Open innovation, Supplier-manufacturer relationships, Absorptive capacity, Buyer-supplier relationships

Paper type Research paper

1. Introduction

In modern times, organizations operate in turbulent environments, characterized by an increased uncertainty level, especially with respect to customer demand and requirements (Zimmermann *et al.*, 2020). In this sense, the generation of product innovations is the primary means through which companies improve their products and strengthen their competitive advantage over time (Pisano, 2015). They can happen in many forms such as cost reductions, product improvements, line extensions, new markets, new uses, new category entries and new-to-the-world products and they are

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introduced into the markets through the management of innovation projects (Kahn, 2018).

In the current competitive scenario, companies rarely innovate by themselves. In line with the Open Innovation (OI) paradigm, innovation generation is a collaborative process carried out with the participation of internal and external knowledge sources that become critical for innovation projects' success (Chesbrough, 2003). As companies operate in global supply chain networks, several studies highlight the relevance of supply chain actors in this "open" process (Zimmermann *et al.*, 2016). Among the different supply chain partners, suppliers represent high-potential sources of innovation. They own complementary industry know-how, participate in supply chain dynamics and are accustomed to buyer needs and requests as a buyer-supplier relationship is already in place (Narasimhan and Narayanan, 2013). For these reasons, integrating suppliers in innovation projects has emerged as a critical management task, so that the internal resources of the buying firm can be combined with suppliers' knowledge and capabilities (Bellamy *et al.*, 2014).

Different aspects of supplier involvement in innovation projects have been analyzed in the literature, e.g. time and extent of involvement; integration mechanisms and collaboration tools used throughout the collaboration; alternate organizational configurations; and sound practices for knowledge sharing (Soosay *et al.*, 2008; Suurmond *et al.*, 2020). However, this stream of research has paid limited attention to the management of the performance measurement and management process; it supports the identification of the partners to be involved and, ultimately, eases the collaboration with suppliers in innovation projects (Pekkola and Ukko, 2016).

In the context of traditional buyer-supplier relationships, a carefully designed supplier performance measurement system (SPMS) represents an essential prerequisite for successful relationship outcomes (Maestrini *et al.*, 2018a). Buying companies customize their SPMSs in light of several variables such as the type of goods/services purchased and/or the suppliers' characteristics (Bourne *et al.*, 2018). If SPMSs are critical in day-to-day activities, they become even more important in the context of OI projects involving suppliers. As suppliers become a source of knowledge and innovation generation, designing a comprehensive system for scouting, selecting and assessing these partners is essential to project success.

From a theoretical standpoint, most of the supply chain management (SCM) literature about SPMS in innovation projects has been focused on a specific evaluation phase such as selection (Choy *et al.*, 2004) or collaboration performance evaluation (Le Dain *et al.*, 2011) and contributions are mostly conceptual. Given this lack of empirical evidence and the practical relevance of the topic, this paper aims to explore more in-depth how companies can manage the selection and evaluation activities for suppliers involved in collaboration at the innovation project level.

This first objective can be formalized through the following research question (*RQ1*):

RQ1. What are the characteristics of SPMS in the context of collaborative innovation projects?

We should also consider that, in most organizations, a structured process for supplier performance measurement and management is likely in place already (Maestrini *et al.*, 2018a). So, when planning a collaboration with suppliers in innovation projects, the issue for buying companies ultimately becomes *how* to redesign and *what* to review in the SPMS lifecycle typically adopted in the traditional relationship setting, for it to be suitable to support supplier involvement in innovation projects (Giannakis, 2007).

When exploring how organizations could perform this activity effectively, considering the role of purchasing and, in particular, purchasing absorptive capacity (AC; Zahra and George, 2002) seems particularly important. On one hand, the innovation management literature emphasizes the importance of growing internal absorptive capacity for effective knowledge appropriability when collaborating with external sources of innovation (Ritala and Hurmelinna-Laukkanen, 2013). On the other, the SCM literature, in line with the evolution of purchasing as a strategic department for companies (Barney, 2012), asserts that purchasing has a central role in collaborative innovation projects with the supplier, supporting efficient and effective management of supplier relationships, thus maximizing the value created through the collaboration (Castaldi *et al.*, 2011; Kauppi *et al.*, 2013; Saenz *et al.*, 2014).

Therefore, the second objective of this study is to understand the extent to which purchasing impacts the design and management of SPMS in collaborative innovation projects. This can be formalized through the following research question (*RQ2*):

RQ2. Does purchasing influence the characteristics of SPMS in collaborative innovation projects?

The paper is organized as follows. Section 2 provides an overview of the literature on collaborative innovation with suppliers and the performance measurement system's role at the innovation project level. Then, the research framework is presented in Section 3. Section 4 describes the sample of case studies used in the paper, while Section 5 summarizes the results of the inductive empirical analysis. Section 6 discusses the implications of the case studies' findings, while Section 7 offers contributions and guidelines for future research.

2. Theoretical background

2.1 Suppliers involvement in innovation projects

OI can be defined as:

> A paradigm that assumes that firms can and should use external ideas, as well as internal ideas and internal and external paths to market, as firms look to advance their technology (Chesbrough, 2003, p. 24).

This approach to innovation forces companies to increasingly team up with other companies to access new knowledge and technologies, commercialize new products or sense the latest technological developments (West and Bogers, 2014; Bogers *et al.*, 2017; Von Krogh *et al.*, 2018).

From an SCM perspective, focal companies should build a successful innovation network that allows each individual network partner to access resources otherwise inaccessible (Bastl *et al.*, 2013). Often, relationships in supply chain innovation networks take the form of collaborative innovation projects (Zimmermann *et al.*, 2016), where companies involve external partners (i.e. customers and/or suppliers) in the innovation project team. In this context, suppliers represent one of the most powerful sources of knowledge to be exploited (Bellamy *et al.*, 2014) and supplier involvement one of the most

adopted practices in collaborative innovation projects (Cooper, 2019).

Supplier involvement entails the integration of suppliers' knowledge and capabilities in innovation projects to leverage strategic and operational alignment between the parties, ease knowledge transfer and increase project performance (Zhao *et al.*, 2014; Jajja *et al.*, 2017).

Companies that combine their innovation efforts with those of their suppliers typically bring products to market faster, giving them a competitive advantage (Wagner, 2012; Narasimhan and Narayanan, 2013). The inevitable risks and costs of developing new products or services are also spread among a wide network of stakeholders. Then, due to their specific expertise, suppliers are often able to suggest product improvements that are unlikely to occur to internal teams (Lu *et al.*, 2017). Several studies in the supply chain and innovation management fields confirm the positive effects of the integration of supplier knowledge at the project level on innovation performance (Hoegl and Wagner, 2005; Song and Di Benedetto, 2008; Hong and Hartley, 2011; Yan and Dooley, 2014; Cheng and Krumwiede, 2018; Najafi-Tavani *et al.*, 2018). However, involving suppliers in innovation projects requires strong coordination efforts and makes the project more complex to manage (Wagner and Hoegl, 2006). Successful supplier involvement requires the implementation of appropriate coordination and knowledge integration mechanisms (Lawson and Potter, 2012; Tsai and Hsu, 2014; Rosell *et al.*, 2017) such as definition and delegation of responsibilities (Koufteros *et al.*, 2007; Johnsen, 2011), agreement on complementary competences (Salvador and Villena, 2013), communication tools (Yan and Dooley, 2013) and formal risks and benefits sharing approaches (Yan and Nair, 2016).

Among the different integration mechanisms, the supply chain and innovation management literature have placed less emphasis on performance measurement and management, despite its importance in practice (Winter and Lasch, 2016). As collaborative innovation with suppliers can sometimes result in failures (Potter and Lawson, 2013), the ability to appropriately select and evaluate the performance of OI partners is a prerequisite to ultimately enhance project performance.

2.2 The role of supplier performance measurement system for successful supplier involvement

A Performance Measured System (PMS) can generally be defined as the set of metrics used to quantify both the efficiency and effectiveness of actions to support strategy implementation at various levels (Neely *et al.*, 1995). It supports two specific functions: decision-making and motivation (Hald and Ellegaard, 2011). In particular, an SPMS includes the set of metrics used to quantify both the efficiency and effectiveness of suppliers' actions (Luzzini *et al.*, 2014). From a process perspective, it should support the company decisions of scouting and selecting suitable partners, evaluate operational performance once a relationship is in place and identifying areas of improvement and corrective initiatives (Maestrini *et al.*, 2018b).

Several factors motivate buying companies to invest in the design of a sound SPMS. At the strategic level, when companies aim to design a supply network in line with a desired supply chain strategy, having a structured and rigorous SPMS in place helps to select, evaluate and retain only the most suitable partners (Gosling *et al.*, 2010). There is a link between supplier (external) performance and company (internal) performance at the operational level; supplier decisions can impact several buying company activities such as stock management, production planning, cash flow management and product quality, thus indirectly affecting overall business results (Sharma, 2013). Thus, a sound SPMS can avoid selecting a wrong supplier – that may heavily affect an organization's operations – and identify undesired trends in supplier performance in a timely manner (Sharma, 2013; Wetzstein *et al.*, 2016). At the relational level, a reliable SPMS has the dual role of regulator and stimulator for the relationship (Maestrini *et al.*, 2018a), as it represents a tool for controlling suppliers' activities but also for increasing the buyer's knowledge about its partners and, consequently, its ability to design and propose actions for improvement (Arvidsson and Melander, 2020; Patrucco *et al.*, 2020).

Although this discussion mostly refers to traditional buyer-supplier relationships, these factors become even more significant in collaborative innovation projects. The approach to supplier performance measurement and management can be considered a strategic enabler for a successful supplier collaboration (Soosay *et al.*, 2008; Soosay and Hyland, 2015). A sound SPMS allows the buyer to identify the world-class partners to be involved and evaluate their performance during project execution, with the objective to obtain the best possible innovation outcome (Le Dain *et al.*, 2011; Melander and Tell, 2014). A chronological review of the most relevant literature (Table 1) shows that this topic has not been comprehensively studied, as previous research has focused either on a specific phase (i.e. supplier selection or supplier performance evaluation) and/or proposed purely theoretical models. This represents a significant gap that this paper seeks to address.

2.3 The role of purchasing for effective collaborative innovation with suppliers

Research shows that purchasing can profoundly impact a firm's financial performance (Chen *et al.*, 2004; Gonzalez-Benito, 2007) and companies' purchasing departments have increasingly been recognized as strategic peers to their marketing and manufacturing counterparts (Søgaard *et al.*, 2019). In an increasing number of organizations, purchasing is managed as a strategic department, with the responsibility of managing the supply network and supplier relationships (Lawson *et al.*, 2009). This means executing activities such as identifying suitable suppliers, assessing and selecting according to defined criteria, negotiating prices and conditions and evaluating their performance (Revilla and Knoppen, 2015).

When suppliers increasingly become involved in collaborative innovation projects, purchasing should also acquire additional responsibilities (Schiele, 2010). A crucial capability for companies involved in OI is to capture external knowledge that flows between organizations, allowing them to be more successful at innovation compared with those that innovate by relying exclusively on their resources (Cassiman and Valentini, 2016). This capability is often referred to as absorptive capacity (AC), defined as "the ability of a firm to recognize the value of new, external information, assimilate it

Table 1 Focus of the paper – chronological overview of research into SPMS in collaborative innovation projects

Author(s)	Selection	Performance evaluation	Main contributions
Ellram (1990)	X		Inclusion of long-term and qualitative factors when selecting partners for collaboration
McCutcheon *et al.* (1997)		X	Combination of relational and technical aspects to evaluate supplier contribution to innovation
Handfield *et al.* (1999)	X		Identification of a relationship between the supplier selection approach and the timing of supplier involvement
Dowlatshahi (2000)	X		Inclusion of long-term strategic partnership as key qualitative criteria for facilitating design interface
De Toni and Nassimbeni (2001)		X	Framework for measuring supplier's co-design effort
Nassimbeni and Battain (2003)		X	Proposal of an analytical approach to assess supplier contribution to buyer's innovation
Dulmin and Mininno (2003)	X		Use of multicriteria approach for supplier selection in co-design
Emden *et al.* (2006)	X		Combination of technical, strategic and relational alignment for supplier selection
Goffin *et al.* (2006)	X		Importance of supplier innovation capabilities as a key attribute in strategic partnerships
Hoegl and Wagner (2005)	X		List of soft and operational criteria for supplier selection
Schiele (2006)	X		Proposal of relevant criteria to identify innovative suppliers
Cousins and Lawson (2007)		X	Development of innovation-focused supplier measures as a prerequisite for supplier integration
Humphreys *et al.* (2007)	X		Evaluation of supplier suitability for involvement in innovation with reference to design skills
Van Echtelt *et al.* (2008)	X		Distinction between strategic and operational "arenas" when evaluating suppliers' involvement suitability
Le Dain *et al.* (2011)	X	X	Design of an integrated framework for supplier selection and evaluation for collaborative design
Koufteros *et al.* (2012)	X		Assessment of supplier new product development, quality and cost capabilities for effective collaborative innovation
Bunduchi (2013)	X		Discussion of alternate approaches to supplier selection in innovation projects
Melander and Tell (2014)	X		Comparison of supplier selection approaches in technologically uncertain projects
Winter and Lasch (2016)	X	X	Proposal of criteria for assessing supplier innovation and potential contribution to buyer's innovation
Arvidsson and Melander (2020)	X		Analysis of the role of trust in supplier selection decisions in technologically uncertain projects

and apply it to commercial ends is critical to its innovative capacity" (Cohen and Levinthal, 1990, p. 128). AC consists of several interrelated knowledge management dimensions, namely, exploration, assimilation, transformation and exploitation (Zahra and George, 2002). Recent SCM literature has increasingly focused attention on studying the AC of the purchasing department, as purchasing is the gatekeeper for knowledge and capabilities coming from suppliers in collaborative relationships (Revilla *et al.*, 2013; Saenz *et al.*, 2014). In the context of supplier involvement, companies should invest in growing purchasing absorptive capacity (Schiele, 2007), so that purchasing can act as a facilitator for effective supplier knowledge integration (Revilla and Knoppen, 2015; Rosell *et al.*, 2017). With their expertise, purchasing can assure an alignment between internal development activities and development activities at suppliers; verify that supplier's technical competencies are exploited; monitor that supplier performance is in line with expectations (Wynstra *et al.*, 2003; Mikkelsen and Johnsen, 2019). Purchasing has responsibilities for existing supplier relationships in day-to-day activities and possesses high knowledge of the supply market's characteristics. Therefore, it can provide critical support in the selection and evaluation of the best partners for collaborative innovation projects (Melander and Tell, 2014; Arvidsson and Melander, 2020) and it plays a central role in supplier performance measurement and management throughout the innovation project.

3. A conceptual framework for supplier performance measurement system in innovation projects

In line with the discussion of the previous section and to explore further the factors for successful involvement of suppliers in collaborative innovation projects, this research focuses on a properly designed and implemented SPMS and the purchasing department's characteristics and responsibility to enable this appropriate design and implementation.

According to Hald and Ellegaard (2011) and Maestrini *et al.* (2018c), the SPMS lifecycle comprises decisions to be taken at three levels: *design* of the PMS, where key objectives to be measured are defined and performance measures are selected; *implementation* of the PMS, where systems and procedures are instituted to collect and process the data that enable measurements to be made regularly; *use* of the PMS, where performance data are collected, reviewed and acted upon.

In the *design* stage, critical choices are made about the type of indicators to be measured (Giannakis, 2007). Traditional measures include cost, quality, time, flexibility, innovation and sustainability indicators (Luzzini *et al.*, 2014); each area can be assigned a different weight in obtaining the overall evaluation (Pekkola and Ukko, 2016).

In the *implementation* stage, there is first the need to define the decision-makers for each measure, that is, who is responsible for data collection, analysis and evaluation of the indicators (Dey *et al.*, 2015). This process can imply collaboration, interaction and agreement with different parts of the organization (Maestrini *et al.*, 2018a), thus requiring a certain level of cross-functionality. Further, companies can adopt specific tools such as IT systems (Choy *et al.*, 2004), to support data collection and analysis.

In the *use* stage, the frequency of measurement needs to be defined, together with the level of information sharing. Several studies have discussed how real-time communication of performance represents a driver of improvement (Prahinski and Benton, 2004; Prahinski and Fan, 2007; Yan and Dooley, 2014; Maestrini *et al.*, 2018b); this, in the context of collaborative relationships within innovation projects, represents a particularly relevant aspect.

In line with Patrucco *et al.* (2020), these SPMS lifecycle decisions should be defined for three different phases in the supplier performance measurement and management process:

1 *supplier qualification* (i.e. identification of suitable suppliers to be included in the supply base);
2 *supplier selection* (i.e. identification, among the qualified suppliers, of the one(s) able to provide the best supply conditions compared to the requirements); and
3 *supplier performance evaluation* (i.e. assessment of performance for suppliers with active contracts).

In the context of collaborative innovation, companies look for suppliers to be involved so that they can contribute, with their knowledge and capabilities, to the success of the innovation project. Therefore, they are likely to make SPMS lifecycle choices specific for the innovation project, to identify the best partners to collaborate with and measure their performance. In line with Le Dain *et al.* (2011), Bunduchi (2013) and Arvidsson and Melander (2020), two of the previous phases are particularly important and may push companies to develop SPMS with characteristics customized to the context of innovation projects. These are:

- supplier selection, which aims to select the most suitable partner to be involved in the project, in light of their capability to provide an innovative component/service, considering the potential contribution to the project organization and performance.
- supplier evaluation, which aims to assess the supplier performance during and after the collaboration, considering the actual contribution to the project organization and performance.

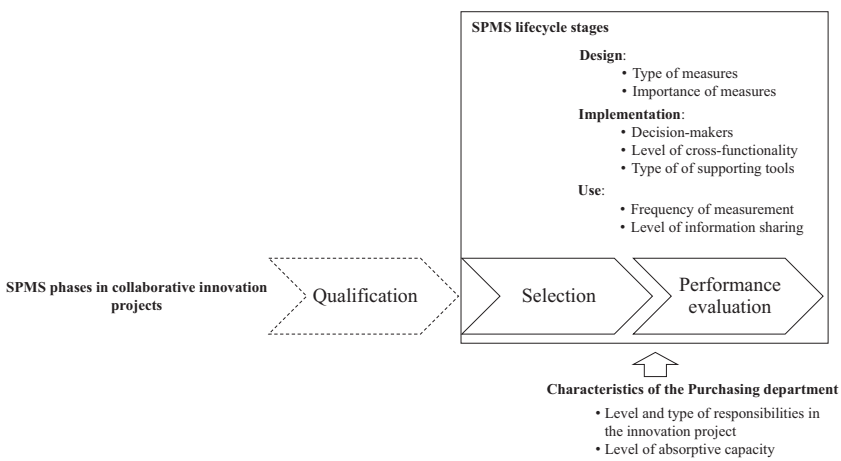
To explain the SPMS design, implementation and use choices made by companies, one must consider the role of purchasing. In collaborative innovation projects with suppliers, purchasing can be assigned different roles and responsibilities (Wynstra *et al.*, 2003), thus having the ability to influence (and lead) these decisions. Nevertheless, successful buyer-supplier collaborations are strictly related to how firms acquire and process knowledge, i.e. the notion of AC (Revilla and Knoppen, 2015). So, together with the role assigned to purchasing, the purchasing AC is also an essential factor to be considered. It can influence how companies manage the information collected through the SPMS and so the decisions related to the SPMS lifecycle.

These elements are summarized in the theoretical framework reported in Figure 1.

4. Research methodology

Given the lack of studies focused on SPMS in collaborative innovation involving suppliers and that existing knowledge on this topic seems highly fragmented (i.e. Table 1), we adopted an in-depth qualitative case study approach to inductively develop new knowledge about the aspects connected with SPMS lifecycle decisions in this context, using consistent patterns of data and applying replication logics. This is an appropriate method to provide an in-depth understanding of the unit of analysis (Voss, 2010). It has been used successfully in the SCM literature for discussing SPMS decisions (Dey *et al.*, 2015) and the challenges connected to collaborative

Figure 1 Research framework



buyer-supplier relationships in innovation (Van Echtelt *et al.*, 2008).

4.1 Selection of companies

To identify suitable companies to be studied, we applied a theoretical sampling approach (Pagell and Wu, 2009). In building the sample, three key features were considered.

First, we wanted to include industries where innovation represents a significant competitive priority and where firms are required to frequently introduce product innovations over time, making innovation projects a recurrent event for these organizations (Wagner and Hoegl, 2006).

Second, we decided to include multinational organizations that are also focal companies in their supply chains, i.e. those organizations that usually govern the supply chain, provide the direct contact to the customer and design the product or service offered (and so, drive the innovation; Seuring and Müller, 2008). These companies represent a useful unit of analysis as they are more likely than smaller firms to design and implement structured SPMSs. Also, they rely on a global supply network and it is in these contexts where collaborations with suppliers in innovation projects are more likely to be found.

An initial list of 23 potential companies meeting these criteria was built, using both personal contacts of the research team and newspaper articles, articles in the business press and presentations at conferences and workshops, to identify evidence on supplier collaboration practices.

Each company was contacted and given information about the objectives of the study to understand if they managed a recent (i.e. within the past three years) collaborative innovation project involving suppliers, which could be used for the purpose of this study. In total, 15 of them provided potentially interesting cases, but only nine of them were ultimately selected. We excluded the remaining six cases because they could not assure access to secondary documents about supplier performance measurement and management decisions (essential to complement interviews with key informants) and also because theoretical saturation was reached.

Before conducting direct interviews, we provided more details about the content we wanted to analyze (i.e. the aspects included in the research model in Figure 1) and a sample of key questions to be asked. All nine companies confirmed their willingness to be involved in the study and provide us contacts of suitable respondents.

Table 2 summarizes the characteristics of the companies involved in the research.

From a descriptive perspective, the sample can be considered suitable for the objective of the study. Companies included are heterogenous for the type of industry and country of origin and they satisfy the selection criteria previously explained. In the different projects, the focus of the collaboration with the suppliers was different in nature (three cases refer to knowledge – exchange on a service, three cases on a system, one case on a component, two cases on a material), but they were all involved in the provision of a strategic good or service (Kraljic, 1983).

In three of the nine cases (Aer, Auto and Con), suppliers were asked to both design and develop a new solution collaboratively to be incorporated in the innovation project. In five other cases (Elct, Housy, Whigo, ChA and ChB), suppliers were asked to contribute to the innovation project by adapting existing components. In one case (Fod), the supplier was only asked to design how a new solution would have been integrated into the innovation under development, but the development of the innovation was handed over to an external partner.

From a grounded theory perspective, this sample can also be considered suitable. Our data collection looked for both code and meaning saturation (Gentles *et al.*, 2015). Code saturation is usually reached through nine interviews while meaning saturation requires 16–24 interviews (Hennink *et al.*, 2017); both these conditions are valid in our case.

4.2 Data collection

Data collection took place between 2017 and 2018 through a four-step process.

Step 1. A relationship was first established with a senior manager of the company, who was briefed through a phone call about the objectives of the project and the main information to be collected. During this call, we asked the manager to link us to the people more involved in the supplier selection and performance evaluation activities for the projects (if different from them), to set a face-to-face interview.

Step 2. Direct interviews with these respondents (a minimum of 2 people for each company) were organized and conducted on-field or through Skype and lasted between 1.5 and 3 h. A semi-structured interview protocol was designed and shared with the interviewees before the meetings (see Appendix 1 for the full protocol). All interviews involved at least two authors to compare perceptions and avoid bias. To prevent information loss, notes taken by researchers and recordings were used when permitted.

Step 3. During the interviews, several informants referred and/or showed us documents to exemplify SPMS decisions. Following the interviews, we developed a list of reports and documentation that would be useful to receive to complement the qualitative information collected. These documents included full proposal submitted by suppliers; supplier selection worksheets, examples of supplier performance dashboards, project summary reports and platform screenshots (as reported in Table 2). All the companies agreed to provide them and these sources were integrated with interview information.

Step 4. The final step consisted of following up with the interviewees, by email or phone call to double-check all the relevant aspects were adequately understood.

4.3 Data analysis and coding approach

The data were prepared for analysis following the procedure suggested by Miles and Huberman (1994). Validity and reliability were also considered, consistently with Gibbert *et al.* (2008).

Given that we did not force the interviewees to follow the interview protocol strictly, data were first categorized and reorganized (i.e. decomposed and aggregated, to highlight the characteristics reported in the research models and facilitate case comparison) according to the main areas we wanted to explore (i.e. characteristics of the collaborative innovation project; characteristics of the SPMS during the collaborative innovation project; characteristics and role of purchasing). Then, they were contextualized (read in light of macro-information related to the company such as the characteristics of the supply chain, the organizational structure, the technology uncertainty of the environment), to understand the case characteristics better.

Table 2 Case study characteristics (name of companies is anonymized for confidentiality reasons)

	Country	Industry	Sales (billion $; approx.)	Employees (approx.)	Role of the interviewees[a]	Brief description of the collaborative innovation project with suppliers	Additional supporting documents analyzed
Aer	Italy	Aerospace and defense	12	45,000	Project manager (1); head of purchasing (2)	Design and development of an advanced control system for a new defense helicopter model	Tender documents; supplier selection scorecard; evaluation report and supplier dashboard
Auto	Germany	Automotive	94	125,000	Head of strategic sourcing and indirect spend (1); marketing brand manager (2)	Design and development of an innovative online marketing campaign to support the company product rebranding project	Pre-screening evaluation; main proposal evaluation; an example of notification report and supplier dashboard (supplier and buyer views)
Elct	China	Consumer electronics	160	100,000	Head of purchasing (1); purchasing manager (2)	Development of a customized demand management software to support the launch of a new line of house devices	Vendor evaluation matrix; an example of notification report and vendor semester evaluation (buyer view)
Housy	Italy	House systems	1.4	7,000	Head of purchasing (1); head of quality (2)	Development of a low emission energy converter for heating systems	Supplier assessment form; supplier quality dashboard
Whigo	USA	White goods	20.7	100,000	Head of quality and supplier development (1); head of strategic sourcing (2)	Development of a low consumption compressor for refrigerators	Supplier rating system; example of the evaluation report and supplier KPIs dashboard
Fod	Italy	Food	10.3	33,000	Head of purchasing (1); purchasing manager (2)	Design of a new warehouse track and tracing technology for the real-time monitoring of new line of products	Vendor selection matrix; supplier relationship management dashboard and supplier portal report
Con	USA	Construction	12	20,000	ead of procurement (1); strategic material manager (2); quality manager (3)	Design and development of a flexible and more resistant pipe spool-type for plant construction	Supplier evaluation forms; supplier on-site assessment checklist; supplier evaluation report and supplier quality dashboard
ChA	Germany	Chemicals	14.2	16,000	North America purchasing director (1); product manager (2)	Development of a new type of resin able to offer lightweight and stronger mechanical properties, to realize a fiber-reinforced thermoplastic composite	Supplier selection worksheet and supplier dashboard
ChB	Belgium	Chemicals	1.9	3,600	Purchasing performance and quality director (1); product manager (2)	Development of a new corrosive flux paste to support energy savings in cooling/heating systems in buildings and automotive	Supplier evaluation worksheet and supplier performance report

Note: [a]In the text, quotation will be referred to the company and the number associated to the interviewee

At this point, a within-case analysis was performed. We structured and coded the data collected in line with the framework presented in Figure 1. The information provided by the interviewees was enough to systematically organize the data into the two relevant phases of the SPMS activities (selection and performance evaluation), describe them in the characteristics of each lifecycle stage (design, implementation, use) and profile the characteristics of purchasing. The secondary documents were useful to refine this coding and to understand several technicalities related to SPMS lifecycle choices. For example, the availability of tendering and proposal documents, as well as supplier scorecards, allowed us to clearly understand the metric included, their complexity and relative importance. Additionally, consulting supplier evaluation reports provided a better overview of the quality of information communicated to the supplier, the frequency and the people contributing to the realization of this type of document.

Finally, we applied explanation-building procedures to understand the variations introduced to SPMS in the context of collaborative innovation projects and if a relationship with purchasing characteristics existed. This generated the cross-case analysis, with the intent to compare the pattern that emerged in each case study and formulate a valid explanation to our research questions.

5. Case findings

In this section, we report the main findings of the case study analysis. We first discuss results about the characteristics of the selection phase, then we present the topic of performance evaluation. Finally, we focus on the reasons why a PMS has different characteristics when used to measure the performance of suppliers in collaborative innovation projects, compared with standard SPMS. In doing that, we use quotes taken directly from the interviewees [1].

5.1 Supplier selection in collaborative innovation projects

Regarding the design stage, two critical elements emerge from all the cases (see also Appendix 1 with details about the within-case study findings).

First, there is always a large number of parameters considered in the selection decision. The strategic nature of the good or service provided by the supplier is sufficient to require a multi-parameter approach when selecting a suitable supplier for traditional relationships. When choosing the partner to be involved in innovation activities, this aspect is even more critical:

> We are selecting the company providing us part of the innovation we want to bring to the market [. . .] we want to be sure we collect all the information to make the best choice (Aer2).

Several companies selected the partner upon evaluation of at least six parameters. We also observed companies using as many as 15 (Housy) or 16 (Whigo) indicators:

> Sometimes collecting the information for a reliable evaluation of all the selection criteria can be time-consuming and frustrating [. . .] but we are all aware of this when we agree that these are the criteria we want to use (Whigo1).

Further, due to the difficulty of measuring innovation aspects, qualitative aspects are also included. They can include the evaluation of the supplier project management abilities (like in the Con and Housy cases) and/or their innovation orientation, other than their technical skills.

> Evaluating the technical aspects tells us if the supplier is able to give us the innovation we are looking for [. . .] as integrating suppliers in the project team requires efforts and time, we are interested in selecting suppliers with the potential to provide further innovation in the future (ChA2).

Second, when several parameters or performance areas are included, economic aspects are often not predominant:

> In this type of collaboration, it is not the best price maker who wins the contract, but the one who shows us to be a value-adding source for the project, from multiple perspectives (Con1).

Examining the implementation stage, we notice that the purchasing department is rarely the sole decision-maker. Aer represents an exception: "[. . .] purchasing people have competencies and empowerment to arrive at a selection decision that is trusted by the project team" (Aer2). In all other cases, purchasing is usually responsible for the operational aspects of the evaluation (e.g. organizing data for calculating the parameters, realizing summary report), but the final selection decisions are taken jointly with the project team or directly delegated to them.

"Salespeople will be those working directly with the supplier and using their service [. . .] they want to make the final decision" (Elct1).

This finding relates to a second important aspect, that is, cross-functionality. All cases show the involvement of two or more departments for this phase because "it is only by including different competencies and perspectives that we are able to select the best choice" (Auto1).

In terms of supporting tools, a surprising discovery was the low use of automated proposal evaluation applications. In almost all cases, the final decision was obtained using Excel worksheets: "they are easy to be managed and shared" (Housy2).

Finally, regarding the use, an interesting aspect is the fact that, in some cases, the evaluation was made in two steps; to screen the potential partners by asking some of them to provide a preliminary vision of the innovation (Auto and Elct) or simply to integrate the "paper" evaluation after visiting the supplier's site (Con).

For all cases, suppliers submitting a proposal were always provided with feedback on how they were assessed and why the company reached the final decisions. This provided full transparency on parameters used and their values because:

> Sending suppliers a detailed report with numbers is a way to show them how professional was our evaluation approach [. . .] and it is a way to tell them what they have to do to improve and become a source of innovation for future projects (ChB1).

5.2 Supplier performance evaluation in collaborative innovation projects

Concerning the design stage, two interesting aspects can be highlighted as well (see also Appendix 2 with details about the within-case study findings).

First, there are cases where more indicators than usual are monitored because:

> "Collaboration in NPD project is multifaceted and, to understand if the supplier is performing as expected, we need to design a comprehensive dashboard of key performance indicators [. . .] also because not all the time we have the data and information to calculate all of them" (Fod1); for others, instead, the traditional ones are kept because "we designed it to be effective for measuring suppliers in both traditional and collaborative relationships" (Aer2).

Second, in this phase, it seems less relevant to assign different weights to the different indicators, as:

> Once part of the project, a supplier must meet expectations for all the relevant aspects we want to measure, as each of them can affect overall project performance in the same way (ChB2).

Regarding the implementation stage, the situation is slightly different. Decision-makers, in this case, seem to be defined at the indicator level more than at the supplier level, as in the Housy, Whigo and Fod cases:

> Quality is the department that has more contact with the supplier in the project and direct access to data for calculating the indicators [. . .] they are the one telling how the supplier is performing in each area (Whigo2).

However, cross-functionality is still present, with the purchasing department intensively involved even when they are not the owner of the performance evaluation activity. Instead, there is more technological support, as all the cases were shown to use an internal platform to control and update supplier performance:

> If you need data updated monthly and for each intermediate milestone, as they need to be shared effectively with your partners, investing in a good platform is definitely value for money (ChA1): in most cases, the internal

platform is an enabler for increasing the frequency of measurement, as well as the amount of information shared with suppliers about their performance.

Additionally, while the frequency of measurement seems similar to that in the context of traditional relationships, the depth of the information about performance shared with suppliers is higher:

> We only give our supplier access to their performance dashboard if they are involved in our project [. . .] this is the best way to push them to improve if they are underperforming or to keep the same standard when their evaluation is great (Auto1).

5.3 Purchasing department characteristics and supplier performance measurement system lifecycle decisions in innovation projects

Table 3 reports the main evidence for what concerns the variation experienced by the companies when comparing SPMS in the context of collaborative innovation projects and traditional relationships.

In several cases, the SPMS lifecycle choices were radically changed for selection and/or performance evaluation. In line with our second research question, we try to interpret this variation by considering the characteristics of the purchasing department, in terms of role and responsibility in the project and level of AC. Table 4 provides an overview of these purchasing characteristics for our cases.

For the selection phase, in those cases where the changes were more evident (i.e. a variation of at least two of the lifecycle stages, as in the Aer, Auto, Housy, Elct, ChA and ChB cases), the more customized approach was always related to purchasing having a more strategic role (and responsibilities) in the project. Due to higher involvement, purchasing people were able to design "a more detailed technical evaluation" (Elct2) and "suggest innovation-related criteria to assess supplier technological alignment" (Aer1). During implementation, purchasing is assigned even more decision-making responsibilities than in the context of traditional relationships (as in the Auto and ChA case) and act in coordination with other project stakeholders. Finally, in the use stage, purchasing can favor a more in-depth execution of the process (e.g. introducing pre-screening, as in the Auto case) and/or giving suppliers higher visibility (e.g. by sharing the evaluation reports, as in the ChA case).

For the performance evaluation phase, the situation for the cases with higher variations (i.e. Elct, Housy, Whigo and ChB) is similar. Purchasing contributed to the design of a more comprehensive performance evaluation dashboard. In most cases, this adaptation was made to enrich the number of aspects to be measured (e.g. impact on project performance for Elct and ChB; continuous improvement efforts for Whigo; risk management aspects for Housy). During implementation, purchasing should take ownership of monitoring supplier performance and inform the project manager in case of issues. In the case of Housy and Whigo, "purchasing realizes the assessment with our quality department, as they are more sensitive about the severity of underperforming on technical aspects" (Housy2). Finally, also for the use stage of the performance evaluation, higher purchasing responsibility drives an increase in the level of visibility and information sharing with the suppliers:

> When you decide to make your supplier the key actor of your project, you need to agree on how to measure them and make sure they rely on all the information they need to perform at their best (Whigo2).

Table 4 also shows that all the cases that adopted different and more robust approaches for their SPMS during the collaborative innovation projects are characterized by a medium-high AC of the purchasing department. In this sense, an adequate level of purchasing AC seems to be a precondition for assigning them higher responsibilities in the projects. The companies characterized by lower variation introduced in their SPMS (i.e. Fod and Con) are also those where purchasing has a marginal role and a relatively low AC:

> "We would like to be involved more in strategic processes, including innovation initiatives with suppliers [. . .] but we first have to grow our internal skills [. . .] how other departments perceive our role needs to change as well" (Con1).

6. Discussion

6.1 The characteristics of the supplier performance measurement system lifecycle in collaborative innovation projects

The cases provide interesting evidence with respect to SPMS lifecycle choices in the context of collaborative innovation projects (Table 5).

First, our cases and the ensuing analysis confirmed that, within this type of collaboration, the qualification phase is not a relevant aspect to be considered, as no one specifically performed it or redesigned it for the purpose of the innovation project, consistent with Le Dain *et al.* (2011) and Winter and Lasch (2016).

Focusing the attention on the selection and performance evaluation phases, our case analysis allowed us to identify a key distinctive element for each SPMS lifecycle stage (with reference to Figure 1).

For SPMS design, we have to consider the type of measures included. SPMSs are one of the key drivers for establishing long-term supplier relationships (Maestrini *et al.*, 2018a). In this perspective, measures usually extend beyond the traditional cost and quality aspects (Luzzini *et al.*, 2014; Pekkola and Ukko, 2016). Particularly when the objective is to successfully involve and collaborate with supplier on "unique" innovation activities, the buying company needs to plan an effort to include a comprehensive set of metrics that allows:

- the selection of the best partner to collaborate with; and
- an effective measurement of their contribution to the final outcome and project performance (Winter and Lasch, 2016).

Although our cases do not provide a unique framework (as the specific indicators to be included may vary from the industry and the buying situations), they show that to be effective, selection and evaluation criteria should integrate both qualitative and quantitative measures. Case evidence also supports the idea that, in the context of collaborative innovation projects, the SPMS design stage needs to assess the suitability of criteria used in the traditional relationship setting (Humphreys *et al.*, 2007). This does not mean that these criteria must be necessarily changed. Still, a moment where the traditional metrics are questioned as enablers of informed

Table 3 Summary of case study findings: variation of SPMS lifecycle decisions in collaborative innovation projects (numbers after the brackets refer to the interviewee, in line with Table 2)

Company	Design	Implementation	Use
Aer			
Selection	"We measured supplier innovation capabilities and potential . . . this is something we usually don't do" (1)	"The final decision must be taken with the approval from one manager in the project team" (1)	"We provided the suppliers a short report explaining why they were not selected and where they should improve for the future" (1)
Performance evaluation	No variation		
Auto			
Selection	"As they [the supplier] will be integrated into our team . . . we need to assess, somehow, their organizational readiness" (1)	No variation	"In these cases, only some suppliers are invited to submit a full proposal . . . we screen the best candidates asking them to give us a short pitch in which they describe their way to innovate" (1)
Performance evaluation	"We assess the innovation potential when we select the supplier, but then we find some tangible ways to measure this potential considering what they do for the project" (2)	No variation	
Elct			
Selection	"We are usually cost-focused when selecting suppliers . . . here, we used seven different metrics" (2)	"Sales [the main project stakeholder] must approve the final selection" (2)	"In addition to the written proposal, we wanted to see a beta version of the software [the innovation]" (2)
Performance evaluation	"We have some standard and consolidated KPIs . . . but in this case, we introduced several measures of internal satisfaction" (2)	No variation	"When we collaborate, we want our partners to improve . . . Every three months a detailed summary report was shared with the supplier" (1)
Housy			
Selection	"The standard selection grid was integrated with two new areas: design management and leadership" (2)	No variation	"We provided the supplier's full transparency on our decision, through a personalized dashboard and summary report" (1)
Performance evaluation	"Our supplier scorecards are pretty basic . . . a specific project area was added, called severity" (2)	"Purchasing is usually in charge of the final assessment (. . .) when suppliers are involved in projects, we require our [quality] department to participate" (2)	No variation
Whigo			
Selection	"We designed the dimension of engineering and technology to help us to evaluate the suitability of the supplier to be integrated into the project" (1)	No variation	
Performance evaluation	"Supplier capability measures are specific for project collaboration (. . .) they are challenging to be measured, but this is how we understand the supplier's ability to be part of a project and potentially collaborate again in the future" (1)	"Purchasing and quality people made a joint effort to evaluate the supplier; that was unusual" (2)	"There is a report that purchasing shares with the supplier (. . .) there are not many numbers, but several considerations from the project team" (1)
Fod			
Selection	"The score of the technical proposal was given higher importance . . . we also included indicators related to the innovation capability and technology roadmap of the supplier" (2)	No variation	
Performance evaluation	"If the supplier improves their operations, our project execution improves as well . . . we include some continuous improvement indicators in their dashboard" (2)	No variation	"We are usually very transparent with suppliers, but even more in collaborative projects . . . information is updated monthly and supplier can access it on our portal" (1)

(***continued***)

Table 3

Company	Design	Implementation	Use
Con			
Selection	"For an effective involvement, knowing what technology and organization the suppliers use for manufacturing is so important . . . so we created criteria to assess their production system quality" (3)	No variation	"This was one of the rare occasions where we selected after a detailed on-site visit . . . this happens only for strategic, high-risk collaborations" (1)
Performance evaluation	No variation		
ChA			
Selection	"We designed several new indicators and many of them were not efficiency-related, as usual" (1)	"Purchasing has autonomy in the selection of strategic suppliers . . . in this case, production people in the team interacted with purchasing a lot" (2)	"We created a detailed report for the first- and second-best suppliers. This motivated both to improve for the future" (1)
Performance evaluation	"Measuring the actual level of innovativeness of the solution proposed by the supplier was very important, as the robustness of their risk management approaches . . . the scorecard had specific KPIs for each of these aspects" (2)	No variation	
ChB			
Selection	"Different indicators were introduced, especially in the areas of quality and innovation . . . that complicated a lot the data collection process" (1)	No variation	"I was surprised to see how transparent we were with the suppliers . . . we usually don't share so much information, as we are not always sure of how up-to-date it is!" (1)
Performance evaluation	"All the traditional indicators were transformed into a project-level perspective and more were added . . . the measures were challenging" (1)	No variation	"Other than purchasing, project team members could also add comments to specific indicators . . . the supplier could access their evaluation report anytime" (1)

selection and evaluation decisions should be planned (Le Dain *et al.*, 2011).

For SPMS implementation, we have to consider the level of cross-functionality. In the context of innovation projects, cross-functional integration can be interpreted as the magnitude of interaction and communication, the level of information sharing, the degree of coordination and the extent of joint involvement across functions in specific new product development tasks (Petersen *et al.*, 2005; Wagner and Hoegl, 2006). Cross-functional integration is recognized as a prerequisite for successful collaborative innovation, as it can assure a combination of different functional knowledge critical in a supplier involvement context (Rosell *et al.*, 2017). When companies decide to collaborate with their suppliers on innovation activities, they need to ensure that, internally, all the relevant areas are involved during the implementation stage of the SPMS, for both partner selection and performance evaluation. That is:

- First, involve purchasing, which is usually responsible for supplier performance measurement and management in traditional relationships and should provide their knowledge also in the context of collaborative innovation projects (Van Echtelt *et al.*, 2008; Schiele, 2010); and
- Second, be sure all the main project stakeholders have an appropriate role in these decisions as, from an operational perspective, they will be those most impacted by supplier activities (Tsai and Hsu, 2014).

This principle is well reflected in all our cases: the SPMS implementation stage always includes the involvement of more than one functional area in both selection and performance evaluation activities. They are usually purchasing and the department(s) leading the project team.

For SPMS use, we have the level of information sharing. Transparency, visibility and trust are the basis for every collaboration, particularly in the supply chain (Prahinski and Benton, 2004; Prahinski and Fan, 2007; Revilla and Knoppen, 2015). Performance data is a category of information that, when shared, enables virtuous improvement cycles (Carr and Kaynak, 2007; Dey *et al.*, 2015; Maestrini *et al.*, 2018c). By combining these two aspects, it is not surprising how all companies interviewed found it necessary to adopt effective ways to communicate and share with suppliers' approach and content of SPMS activities, to reach a positive project integration and reduce uncertainty (Yan and Dooley, 2013).

This means:

- During the selection phase, to show the potential partners how they were evaluated, why they were (or not) selected and provide suggestions about how to best integrate with the project (actually or potentially); and
- During project execution, to share clear and objective data about current performance, so they can be the best point of start to discuss possible improvement and/or consolidate the best practice implemented so far to maintain the same standard.

Table 4 Characteristics of purchasing departments (numbers after the brackets refer to the interviewee, in line with Table 2)

Company	Level and type of responsibility of purchasing in innovation projects	Level and characterization of the purchasing absorptive capacity
Aer	High – "We are part of the project team . . . several people on my staff have technical skills, so they can understand the design of the new product . . . we are in charge of several activities, including most of the performance measurement decisions" (1)	Medium – "Technical skills allow us to scout and monitor relevant technological developments in the market and we often interact with other departments for this . . . our knowledge and support is not always requested when taking strategic supply network decisions" (1)
Auto	Medium – "Purchasing came up with a list of suitable suppliers to be involved in the project" (2) "We assisted several supplier interface activities, especially to ease communication and coordination" (1)	Medium – "Our buyers are not engineers, but they are trusted in scouting for suppliers and technologies . . . information exchange with key departments [production and marketing] is mostly informal . . . production and quality always asks our opinion about suppliers . . . we provided them with relevant information [such as risk analysis], but we never make the final decision" (1)
Elct	High – "We lead the supplier involvement process . . . I was one of the managers in the project team and decided when and how to integrate the supplier . . . we usually directly manage several strategic activities such as performance monitoring, communicating changes and evaluate supplier's decisions on project execution" (2)	High – "We have a strategic role and other departments recognize this . . . we know the supply market and we constantly look for new trends in line with our company strategy . . . production and engineering listen to us and we learn from them . . . we never decide alone" (1) "It happened in the past that we came up with ideas to innovate the product and how suppliers can help" (2)
Housy	High – "Purchasing support is fundamental during the initial phases of the project . . . several strategic suppliers do not like to discuss with project managers directly" (2) "Our projects are complex, the presence of suppliers complicated them even more . . . my people are part of the project team and they have the responsibility to manage every supplier relationship aspect . . . This is very different from day-to-day, where we do not always participate in supplier decisions" (1)	Medium – "Our products are subjected to technological evolution and suppliers are critical in this process . . . manufacturing often scout the supply markets" (2) "We support and talk a lot with quality, manufacturing and engineering . . . our supplier decisions are mostly based on technical aspects, so they drive most of them, but they always consult with us . . . we were able to propose several improvements at an operational level and they appreciate it" (1)
Whigo	High – "The opportunity to involve a supplier is initiated by purchasing . . . they know what is best for the project, everyone trusts their decisions" (1) "We have the possibility to allocate a fair amount of people to the project team . . . they sometimes create a project procurement unit and all the strategic and operational activities are managed there and this includes performance measurement" (2)	High – "My office manages only what is strategic . . . we have people specifically dedicated to supplier market analysis and supplier profiling . . . we often innovate performance measurement tools . . . we are good in identifying promising suppliers before our competitors . . . the relationship with other departments is good, they respect us and we rarely have conflicts" (2)
Fod	Low – "We are not always involved . . . we really provide operational support . . . data collection, analysis templates, official communications, summary reports, platforms updates are examples of activities we do" (2)	Low – "We are still a staff office . . . we support several activities, but we don't make supply chain decisions . . . we have a good knowledge of the supply market, especially for strategic materials and we try to engage with other departments when we discover something . . . we are rarely consulted in key supplier choices" (1)
Con	Low – "I was involved in projects twice and both times there was a collaboration with a supplier . . . there was a fair amount of purchasing expertise, but our role was mainly to act as a facilitator on some supply decisions and communication and coordination with the partner supplier" (2)	Low – "They [purchasing] mostly deal with selecting, evaluating and ordering parts from suppliers . . . for selection, they always need our approval" (3) "The interaction with quality and engineering exists, but it happens ad-hoc . . . they rarely ask for advice when making strategic supply network decisions, as we lack technical knowledge" (1)
ChA	High – "Buyer are engineers, so having them in the team helps to identify supply constraints when defining the product requirements" (2) "We often innovate with the suppliers . . . we have several people who have gained expertise on supplier involvement and they are systematically allocated to strategic projects . . . They have full responsibility on supplier selection, interface management and relationship performance evaluation" (1)	High – "Our innovation comes through the suppliers of strategic raw materials . . . we constantly look for innovative suppliers and we are up-to-date on innovative and sustainable materials (1) "I often review with purchasing product requirements, to see if improvements or simplifications make sense . . . they always give us high-quality information, especially on potential supplier partners" (2)
ChB	Medium – "Integrating suppliers in product innovation is important because the innovation mostly refer to what they produce and we need to anticipate supply constraints" (2) "Our projects are characterized by technological complexities and risks . . . having purchasing onboard is useful because they can bridge the interface with suppliers and focus on monitoring performance" (1)	Medium – "Purchasing falls under quality, so it is clear that their decisions should be production-focused . . . They are not technical people, but they really learn from our department . . . they often participate in product meetings and they constantly scout for supply market trends" (2) "Purchasing does not have high authority on commodity strategies, but they always discuss with production the decisions to be made . . . We are in charge of the performance measurement system architecture" (1)

Table 5 Distinctive characteristics of the SPMS lifecycle in collaborative innovation projects

SPMS phase	Design	Implementation	Use
Qualification	Same lifecycle of traditional relationships		
Selection	Type of measures • Selection parameters based on measures beyond cost and quality •Integration of quantitative and qualitative aspects	Level of cross-functionality • High integration between purchasing and key functional areas in the project team	Level of information sharing • Transparency during the selection process • Sharing of selection motivation
Performance evaluation	Type of measures • Design of a comprehensive set of indicators to be measured •Integration of quantitative and qualitative aspects		Level of information sharing • Joint definition of relationship objectives • Real-time sharing of the performance trends

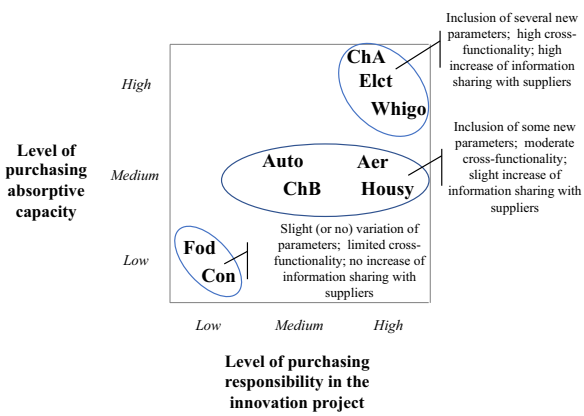
6.2 The impact of purchasing on supplier performance measurement system characteristics

In line with the case evidence discussed in Section 5.3, the successful implementation of the previous three distinctive characteristics of SPMS seems to be connected to the role of the purchasing in the collaborative innovation project (Wynstra *et al.*, 2003) and the level of absorptive capacity (Revilla *et al.*, 2013).

We can better highlight this relationship by positioning the cases according to these two factors (Figure 2).

As shown in Figure 2, these SPMS lifecycle choices (i.e. type of measures included, level of cross-functional integration and level information sharing with suppliers) are likely to be radically modified, compared to traditional relationships, in organizations where the purchasing department is assigned a more substantial role in the project and characterized by higher absorptive capacity. When characterized by high absorptive capacity, purchasing can gain a stronger status and recognition within the organization; this acts as a prerequisite for being considered a strategic department (Kauppi *et al.*, 2013; Saenz *et al.*, 2014). With this strategic role, purchasing is more intensively involved in innovation projects, where their project responsibilities usually include supplier performance measurement and management activities. In this situation, the project can count on professionals who use their competence and expertise to customize an SPMS to select the best innovation partner and evaluate their performance effectively (Schiele, 2010).

Figure 2 Case positioning according to purchasing department characteristics and role in the innovation project



In conclusion, if companies invest in growing a higher purchasing absorptive capacity, they create the conditions for stronger purchasing involvement in collaborative innovation projects with suppliers. This, in turn, makes the opportunity to develop a tailored and more specific approach to SPMS in the context of supplier collaboration.

7. Conclusions

The involvement of external partners in company innovation projects is a common practice of firms to achieve superior innovation performance. Among the possible external partners that can be involved in innovation, suppliers represent an incredibly valuable source. To set up collaborative innovation with suitable suppliers, companies need to design specific approaches to select innovation partners and measure their performance as part of the project. The role of purchasing department is critical for the effective execution of these activities.

To investigate this issue, we studied nine international focal companies in supply chains of different industrial sectors. We identify how they managed performance measurement activities in innovation projects, where collaboration with suppliers occurs on a strategic purchasing item. By analyzing information collected from these cases, we explain the characteristics of SPMS in collaborative innovation projects, how much these characteristics differ from those of SPMS used in traditional buyer-supplier relationships and the role of purchasing in driving these differences. These results have several implications from theory and practice.

7.1 Theoretical implications

Our study represents the first attempt to explore the characteristics of the SPMS in collaborative innovation projects, considering all the phases of this process (i.e. selection and performance evaluation) and all the stages of the lifecycle for each (design, implementation and use). From a theoretical standpoint, in the SCM field, our results first contribute to the supplier involvement (Petersen *et al.*, 2005; Zhao *et al.*, 2014; Najafi-Tavani *et al.*, 2018), where few authors focused on this research problem and not comprehensively (Le Dain *et al.*, 2011; Winter and Lasch, 2016). We also generate knowledge for the supplier performance measurement and management literature, where several authors focused on SPMS technical aspects in traditional relationships (Hald and Ellegaard, 2011;

Maestrini *et al.*, 2018c; Patrucco *et al.*, 2020), but without a focus on collaborative innovation projects. Finally, our study emphasizes the importance of three SPMS elements i.e. the need for a multicriteria approach, high cross-functional integration, information sharing and a strategic purchasing department. These aspects have been largely discussed in the purchasing literature (Schiele, 2010; Koufteros *et al.*, 2012; Luzzini *et al.*, 2014; Maestrini *et al.*, 2018a), but never in such an integrated way and never adopting an OI perspective.

Finally, we also contribute to the innovation management literature, where the problem of how to measure the performance of the innovation network has been discussed (Emden *et al.*, 2006; Yoon and Song, 2014), but not from a comprehensive and technical point of view and rarely with a focus on the buyer-supplier collaboration context.

7.2 Managerial implications

This paper also has relevant practical implications. We provide both project and supply chain managers with several insights regarding how companies should define the characteristics of SPMS in collaborative innovation projects. Our sample includes organizations in different industries and projects with different characteristics, thus increasing the probability that managers could relate their reality to one of the study cases.

Our research framework (Figure 1) can help companies to structure their decision-making process. It presents the SPMS not merely as a measurement tool, but as a pivotal contributor to effective support supplier involvement in innovation projects. It highlights the importance of rethinking two phases (selection and performance evaluation) through different lifecycle stages (design, implementation, use), compared to what is usually done in the context of traditional relationships.

Our overall results (Table 5) focus the attention on the SPMS specific elements that, more than others, need to be revised (i.e. type of measures, level of cross-functionality, level of information sharing). Our within-analysis (Tables 3 and 4) can provide managers with evidence, through quotes, of examples of SPMS lifecycle decisions, the role of the purchasing department in the project and assessment of their absorptive capacity.

Finally, we highlight that SPMS characteristics depend on the role of the purchasing department in the project and the level of absorptive capacity (Figure 2): the stronger these aspects are, the more radical the customization of the SPMS is likely to be. Managers need to be careful to develop the absorptive capacity of purchasing to an appropriate level and carefully assign to these professionals project responsibilities commeasured to this level, if they aim to arrive at an SPMS able to support the collaboration with the supplier and project success effectively.

7.3 Limitations and avenues for future research

This study has some limitations, suggesting high-potential directions for future research. From a methodological perspective, to expand the external validity of our study, there is the need to analyze the SPMS characteristics in the context of small/medium companies and/or other sectors, different from those covered in our empirical analysis (such as oil and gas and pharma), to verify whether the same principles and characteristics still apply. In this spirit, to generalize the results, quantitative data through a properly designed survey should be collected in a statistically representative population of firms, to test the findings which emerged from this study. In terms of research development, this study only considers SPMS management connected to product/service innovations and not business model innovation. It also does not consider the control stage of the SPMS lifecycle (i.e. what happens after indicators have been measured). Both these aspects can be regarded as starting points to pursue in future research.

Note

1 All the quotes used are representative of the interviews – or of most of the respondents. In the (rare) cases where there was a range of opinions emerging from the cases, minority opinion quotes have also been included.

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Appendix 1. Interview protocol

General information

- Please briefly describe:
- The characteristics of the supply chain of your company
- The characteristics of the company organizational structure
- The characteristics of the purchasing organizational structure and role for the company

Characteristics of the collaborative innovation projects with suppliers

- How often does your company formally launch innovation projects?
- How often does your company formally involve suppliers in innovation projects? What type of responsibilities are suppliers usually assigned when involved in innovation projects?
- Consider a recent (i.e. last three years) innovation project with a supplier representative of the collaboration strategy your company adopts in these circumstances. Please briefly describe:
- The characteristics of the project (size of the team, economic value, complexity, strategic relevance)
- The role of the supplier in this innovation project (i.e. timing and extent of the involvement) and why their involvement was needed

Characteristics of the supplier performance measurement system during the collaborative innovation project

- Focus the attention on all the supplier performance measurement activities that were performed for this innovation project.
- Did you select the supplier to be involved through an open bidding process, or did you decide to invite only some selected partners? Was a formal qualification necessary, or all the potential candidates were already qualified suppliers?
- Please describe in detail the selection phase and how it was conducted. In particular, focus the attention on what key criteria were used to select suppliers and their relative importance; what people and roles were involved at the different steps (and particularly, in the final decision); what software and tools were used as a support; and what was the level of communication and transparency with the suppliers concerning the final decision.
- Consider how the selection process is usually handled in the context of a traditional relationship (i.e. outside the collaborative innovation project) for a similar goods/service purchased and/or with a similar supplier. What are the main differences compared to the process you just described? What variations were introduced? Why?
- Please describe in detail how the performance of the partner supplier was evaluated during the project execution. In particular, focus the attention on the key metrics used to assess supplier activities; how data to calculate these metrics were collected, used, and analyzed; what people and roles were involved at the different steps (in particular, in making the final assessment on the supplier); what software and tools were used for support; and what was the level of communication and transparency with the supplier regarding the recorded performance.
- Consider how the performance evaluation phase is usually handled in the context of a traditional relationship (so outside the collaborative innovation project) for a similar goods/service purchased and/or with a similar supplier. What are the main differences compared to the activities you just described? What variations were introduced? Why?

Characteristics and role of purchasing

- How would you characterize the role and responsibilities of purchasing when managing traditional relationships with the supplier (i.e. outside the collaborative innovation project)?
- To what extent is purchasing a source of knowledge acquisition and generation for your company? In particular, focus your attention on how people operating in the purchasing department acquire external knowledge on supplier and supply markets; systematically integrate new knowledge and competencies in supply network decisions; and interact with internal stakeholders to share and grow this knowledge.
- How would you characterize the role and responsibilities of purchasing in the collaborative innovation project described? In particular, focus your attention on how much purchasing was involved in project decisions; what type of project responsibility purchasing people were assigned; and what type of authority purchasing had in managing the relationship with the supplier.

Appendix 2

Table A1 Summary of case study findings: the SPMS life-cycle decisions in collaborative innovation projects (selection stage)

	Design		Implementation			Use	
	Type of measures	*Importance of measures*	*Decision-makers*	*Level of cross-functionality*	*Type of supporting tools*	*Frequency of measurement*	*Level of information sharing*
Aer	Seven selection parameters grouped in two main areas: technical (technical proposal, lead time, past performance, ability to innovate in the future); economical (price for the current project, price for future reorder, price for spare parts and maintenance)	65% technical area, 35% economic area	Data collection, analysis and final decision are managed by purchasing	Results need to be discussed and shared between purchasing, materials planning and control and manufacturing engineering	Excel	Unique report; one-time evaluation after proposals have been received	A detailed report is generated and shared with all the suppliers participating in the selection process; the report includes detailed evaluation for each area and suggestions for improvement, but specific indicators and measures are not shared with the suppliers
Auto	Nine selection parameters grouped in two main areas: economic (price); technical (offers quality, tender adherence, agency competencies, general organization, service concept, experience, innovation capabilities)	55% technical area, 45% economic area	Data collection and analysis is managed by purchasing for the economic area, by marketing for the technical area; the final decision is jointly taken by marketing and purchasing	Results need to be discussed and shared between purchasing and marketing	Excel	Two-step process: a first evaluation is done after an initial pitch and vision of the service, and can be reviewed after the detailed proposal is submitted (if invited)	All the suppliers invited to submit a proposal are notified of the decision with brief motivations referring to the evaluation parameters
Elct	Seven selection parameters: proposed fee; RFQ adherence; nature of requirements offered; software viability; license and maintenance conditions; vendor project abilities; quality of vendor demonstration	40% proposed fee, 60% other indicators (equally distributed)	Data collection and analysis is managed by purchasing, final decisions taken jointly by purchasing and sales	Results need to be discussed and shared between purchasing, sales and IT	Internal platform	Unique report; evaluation can be reviewed after supplier demonstration of beta software functionalities	All the suppliers invited to submit a proposal are notified of the decision with brief motivations referring to the evaluation parameters
Housy	15 selection parameters grouped into five main areas: quality management (support launch activities, manufacturing quality, quality improvement initiatives); manufacturing	All equally relevant	Data collection, analysis and final decision are managed by purchasing and quality	Results need to be discussed and shared between purchasing, quality and production	Excel	Unique report; one-time evaluation after proposals have been received (and site visit organized)	A detailed report for each area is generated and shared with all the suppliers participating in the selection process; the report includes detailed evaluation for each area and indicator and

(***continued***)

Table A1

	Design		Implementation		Use		
	Type of measures	*Importance of measures*	*Decision-makers*	*Level of cross-functionality*	*Type of supporting tools*	*Frequency of measurement*	*Level of information sharing*
	management (lean tools adoption, just-in-time adoption); procurement (total cost, document management process cost); design management (product data management systems quality, understanding of customer products functionalities, innovation capabilities, prototyping capabilities); leadership (project management experience, decision-making skills, training and development plans)						suggestions for improvement
Whigo	16 selection parameters grouped in five areas: engineering and technology (technology and co-design ability; design capability; resources dedicated to R&D; equipment capability); procurement (total cost of ownership; payment terms; lead time; logistic cost; global contract format; transparency and cooperation); manufacturing (level of preventive maintenance); quality (declared PPM; type of quality control; quality certifications); finance (distress score)	Engineering and technology 20%, procurement 45%, manufacturing 5%, quality 25%, finance 5%	Data collection, analysis and final decision are managed by purchasing and quality	Results need to be discussed and shared between purchasing, quality and engineering	Internal platform	Unique report; one-time evaluation after proposals have been received	All the suppliers invited to submit a proposal are notified of the decision with brief motivations referring to the evaluation parameters

(*continued*)

Table A1

	Design		Implementation		Use		
	Type of measures	*Importance of measures*	*Decision-makers*	*Level of cross-functionality*	*Type of supporting tools*	*Frequency of measurement*	*Level of information sharing*
Fod	11 selection parameters grouped in three areas: company credentials (reputation analysis; investments planned; financial soundness); technical proposal (quality of service; innovation level; track records; team skills; SLA proposed; respect of the delivery due date); total cost (transparency of the cost breakdown structure; overall cost)	Company credentials 5%, technical proposal 85%, total cost 10%	Data collection, analysis and final decision are managed by purchasing	Results need to be discussed and shared between purchasing and logistics	Excel	Unique report; one-time evaluation after proposals have been received	All the suppliers invited to submit a proposal are notified of the decision with brief motivations referring to the evaluation parameters
Con	12 selection parameters grouped in five areas: safety and certifications (type of site certifications, safety policy); production system quality (production technology, process efficiency, equipment availability); quality (quality control procedures, process control tools, level of part conformity); efficiency (price, process cost); project management ability (project management tools, delivery time adherence to project schedule)	All equally relevant	Data collection and analysis is managed by purchasing; the final decision is managed by engineering	Results need to be discussed and shared between purchasing, engineering, and the project manager	Internal platform	Two-step process: a preliminary evaluation is made according to the initial proposal; the evaluation is then integrated with an on-site visit	The suppliers for which both steps were carried out are notified of the final decisions with a detailed report, inclusive of the motivations of the evaluation and suggestions for improvement
ChA	Six selection parameters: technical competence for material development; experience with new product development projects; special skills for material development; opportunity for leverage further	Cost 30%; 70% other indicators (equally distributed)	Data collection and analysis is managed by purchasing; the final decision jointly managed with production	Results need to be discussed and shared between purchasing and production	Excel	Unique report; one-time evaluation after proposals have been received	All the suppliers invited to submit a proposal are notified of the decision; the first and the second are provided with detailed motivations referring to the evaluation parameters

(***continued***)

Table A1

	Design		Implementation		Use		
	Type of measures	*Importance of measures*	*Decision-makers*	*Level of cross-functionality*	*Type of supporting tools*	*Frequency of measurement*	*Level of information sharing*
	innovation; output fit to requirements; cost						
ChB	Six selection parameters in two areas: cost (price, internal production cost); quality and innovation (number of alternative derivatives manufactured, quality testing procedures, innovative derivative characteristics, adaptability of the derivative to other products)	Cost 40%, quality and innovation 60%	Data collection and analysis is managed by purchasing; the final decision is managed by production	Results need to be discussed and shared between purchasing and production	Excel	Unique report; one-time evaluation after proposals have been received, which can include a site visit if needed	All the suppliers invited to submit a proposal are notified of the decision with brief motivations referring to the evaluation parameters

Appendix 3

Table A2 Summary of case study findings: the SPMS life-cycle decisions in collaborative innovation projects (performance evaluation phase)

	Design		Implementation			Use	
	Type of measures	*Importance of measures*	*Decision-makers*	*Level of cross-functionality*	*Type of supporting tools*	*Frequency of measurement*	*Level of information sharing*
Aer	Three main indicators: quality rating; delivery schedule adherence; responsiveness to the request of service	All equally relevant	Data collection, analysis and the final decision is managed by materials planning and control	Results need to be discussed and shared between materials planning and control and purchasing	Internal platform	Every project milestone, but data are available weekly	The supplier can access their evaluation on the supplier portal (possibility to add further comments for each indicator)
Auto	Four main indicators: quality; quality/price ratio; flexibility to the user request; service innovation capability; conformity to company regulation	All equally relevant	Data collection, analysis and the final decision is managed by purchasing	Results need to be discussed and shared between purchasing and marketing	Internal platform	Every milestone during campaign design; every six months after the service is released	The supplier can access their evaluation on the supplier portal (possibility to add further comments for each indicator)
Elct	12 indicators in two main areas: internal satisfaction (1–5 scale evaluation of quality of the product; satisfaction level of internal stakeholders; level of actual innovation; strategic consultancy support; innovative approach and method; Availability, responsiveness, and on-time execution; proactivity; flexibility and adaptability) and KPI-based evaluation (quantitative evaluation of satisfaction of point of sales; defectiveness; integration problems with CRM platform; reduction of calls to call center)	All equally relevant	Data collection, analysis and the final decision is managed by purchasing	Results need to be discussed and shared between purchasing and sales	Internal platform	Every three months	A summary report is generated and shared with the supplier; the report includes detailed evaluation for each area and suggestions for improvement, but specific indicators and measures are not shared with the suppliers
Housy	Seven indicators in three main areas: prevention (production efficiency, quality procedure, parts approved), continuous improvement (defects reduction, 8D cycle use), severity (project warning, suppliers claim back)	All equally relevant	Data collection, analysis and the final decision is managed by quality	Results need to be discussed and shared between purchasing and quality	Internal platform	An automatic sharing of performance is made every six months, but data are available monthly	The supplier can access their evaluation on the supplier portal (possibility to add further comments)

(*continued*)

Table A2

	Design		Implementation			Use	
	Type of measures	*Importance of measures*	*Decision-makers*	*Level of cross-functionality*	*Type of supporting tools*	*Frequency of measurement*	*Level of information sharing*
Whigo	Nine indicators in two main areas: supplier performance (project rejected parts; not repairable defects occurrence; field failure; rejected parts improvement in the last six months; not repairable parts improvement in the last six months); supplier capabilities (problem-solving; new product development; process control; continuous improvement)	60% Supplier performance, 40% Supplier capabilities	Data collection, analysis and the final decision is managed jointly by purchasing and quality according to the type of indicator	Results need to be discussed and shared between purchasing and quality	Internal platform	Every six months	A summary report is generated and shared with the supplier; the report includes detailed evaluation for each area and suggestions for improvement, but specific indicators and measures are not shared with the suppliers
Fod	16 indicators in four main areas: Service quality performance (quality management policies; corrective action management; document management quality; service quality); schedule/ delivery (on-time service delivery; schedule/ delivery improvement efforts); technical (technical compliance; process and systems technology; technical project management); cost (payment term flexibility; cost reduction efforts); responsiveness (timeliness; customer focus; effective communication)	All equally relevant	Data collection, analysis and the final decision is managed jointly by purchasing and logistics according to the type of indicator	Results need to be discussed and shared between purchasing, logistics, and production	Internal platform	Every month (coordinated with demand management)	The supplier can access their evaluation on the supplier portal (each indicator value has a standard explanation)
Con	Five indicators: cost of poor quality; project timeline adherence; level of involvement in project decisions; responsiveness in meeting project demand; flexibility in meeting project demand	30% Cost of poor quality, 25% project timeline adherence, 45% other indicators (equally distributed)	Data collection, analysis and the final decision is managed by engineering	Results need to be discussed and shared between purchasing, engineering and project manager	Internal platform	Every two weeks and at every project milestone	The supplier can access their evaluation on the supplier portal (possibility to add further comments)
ChA	14 indicators in four areas: quality (material	All equally relevant	Data collection, analysis and the	Results need to be discussed	Internal platform	Every month and at every	A summary report is generated and shared

(***continued***)

Table A2

	Design		Implementation			Use	
	Type of measures	*Importance of measures*	*Decision-makers*	*Level of cross-functionality*	*Type of supporting tools*	*Frequency of measurement*	*Level of information sharing*
	rework time; material requirements compliance to contract specification); delivery (in full, on time, with no damage); cost (in line with the contract; in line with industry level); customer service (response time; issue resolution); innovation (creative solution; design proposition); risk (risk management system); sustainability (production gas emission; production system certifications)		final decision is managed by purchasing	and shared between purchasing and production		project milestone	with the supplier; the report includes the historical tracking of each indicator, month by month, for the whole duration of the project
ChB	Six indicators: urgent quantity delivered on time; parts per million; quantity defective delaying the development time; on time shipments; cost reduction efforts; derivative specifications adherence with the initial request	All equally relevant	Data collection, analysis and the final decision is managed jointly by purchasing and production according to the type of indicator	Results need to be discussed and shared between purchasing and production	Internal platform	Every month and upon the product manager request	The supplier can access their evaluation on the supplier portal (each indicator value has a standard explanation)

About the authors

Andrea Patrucco is Assistant Professor of Supply Chain Management in the Department of Marketing and Logistics at the Florida International University College of Business. His research interests are in the field of management of buyer-supplier relationships in both private and public sector. He's one of the research leaders of the International Research Study of Public Procurement, and he actively collaborates with government organizations in the United States, such as the National Association of State Procurement Officers and the National Institute of Government Purchasing. His research has been published in several academic journals such as *Journal of Supply Chain Management*, *International Journal of Production Economics*, *International Journal of Production Research*, and *Journal of Purchasing and Supply Management*. He serves as an Associate Editor for the Journal of Purchasing and Supply Management, and he sits in the Editorial Board of *International Journal of Logistics: Research and Applications*. Andrea Patrucco is the corresponding author and can be contacted at: andreastefano.patrucco@gmail.com

Federico Frattini is a Full Professor of Strategic Management and Innovation at the School of Management of Politecnico di Milano (Italy). He is Dean of the MIP Politecnico di Milano Graduate School of Business. His research area is innovation and technology management. On these topics, he has written more than 200 books and papers published in conference proceedings and leading international journals such as *Entrepreneurship Theory & Practice*, *Academy of Management Perspectives*, *California Management Review*, *Journal of Product Innovation Management* and many others. In 2013, he was nominated among the top 50 authors of innovation and technology management worldwide by IAMOT, the International Association for Management of Technology.

Anthony Di Benedetto is a Professor of Marketing and Supply Chain Management and Senior Washburn Research Fellow at the Fox School of Business, Temple University, Philadelphia, PA. He has published in *IEEE Transactions on Engineering Management*, *Journal of Product Innovation Management*, *Management Science*, *Strategic Management Journal*, *Journal of Operations Management* and elsewhere. Professor Di Benedetto was named one of the 50 leading research scholars worldwide in Innovation and Technology Management by International Association for Management of Technology (IAMOT).