The impact of supplier performance measurement systems on supplier performance: a dyadic lifecycle perspective

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Abstract
Purpose:
The purpose of this paper is to empirically investigate the impact of a mature supplier performance measurement system (SPMS) adoption all along its lifecycle phases (i.e. design, implementation, use and review) on the suppliers' performance.
Design/methodology/approach:
The research hypotheses have been tested on a final sample of 147 pairs of buyer-supplier responses, collected by means of a dyadic survey involving manufacturing firms and one key supplier of their choice. The research framework has been tested through a structural model using PLS regression.
Findings:
Considering the joint effect of all the four SPMS phases on supplier performance, the findings show that the system use and review play a prominent effect: the former have a positive impact on supplier quality, delivery and sustainability performance; the latter positively affects supplier delivery, innovation and sustainability. A mature design displays a positive effect on supplier sustainability performance, while a mature implementation results to negatively affect supplier innovation performance. Finally, cost performance is not impacted by any of the four phases.
Originality/value:
This study contributes to the open debate regarding the relationship between SPMSs and actual supplier performance improvement. In particular, the lifecycle perspective is introduced to clearly distinguish among each phase of adoption and assess their relative impact on supplier performance. Besides, the dyadic nature of the study allows to investigate different subcomponents of supplier performance jointly considering the buyer company and supplier company perspective, thus achieving a more insightful and robust information.

Keywords: Performance measurement, Survey, Buyer-supplier relationships

Full reference
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1. Introduction

Suppliers today are increasingly responsible for buyer companies' value creation. For this reason, the careful assessment and monitoring of performance upstream in the supply chain is critical. Hence, supplier performance measurement systems (SPMSs) are critical tools that managers exploit to control and orchestrate suppliers.

The academic literature on SPMSs is quite extensive, though it is mostly focused on the SPMS design. Indeed, most contributions answer the "what to measure" question, focusing on metrics selection and composition into measurement frameworks (Simpson et al. 2002; Kannan and Tan, 2002). Moreover, the impact of SPMSs on supplier performance has been poorly investigated. While a few contributions have addressed performance outcomes of SPMS design features (Carr and Pearson, 1999; Mahama, 2006; Cousins et al., 2008) and implementation related aspects (Prahinski and Benton, 2004; Prahinski and Fan, 2007), the use and review of SPMSs have been neglected so far.

In this paper, a lifecycle perspective is applied to SPMSs (Bititci et al., 2006; Gutierrez et al., 2015), introducing the concept of maturity of the following four phases of the SPMS lifecycle: design, implementation, use and review. In light of Resource Orchestration Theory (ROT - Sirmon et al., 2011), we expect the SPMS adoption throughout its lifecycle to have a positive impact on suppliers' performance (i.e., quality, delivery, innovation, sustainability and cost). ROT has been advanced in conjunction with the Resource Based View (RBV) of the firm (Hitt et al., 2011) and states that firms can achieve a sustainable competitive advantage by orchestrating critical resources at their disposal through stages of structuring, bundling and leveraging. ROT appears to fit well the buyer-supplier relationship management context, by considering suppliers as key resources that the buyer company needs to properly orchestrate. The SPMS is a key tool by which this orchestration is guaranteed, ultimately leading to superior supplier performance. Hypotheses are coherently developed assuming a positive relationship between a mature SPMS adoption and suppliers' performance (i.e., quality, delivery, innovation, sustainability and cost). To test such hypotheses, this research applies a dyadic perspective by triangulating responses regarding supplier performance from both the buyer company and a key supplier.

The remainder of the paper is organized as follows. In the next sections, ROT is presented and literature on PMS lifecycle is reviewed to develop measures for the SPMS lifecycle maturity. Then we report the research framework and the hypotheses to be tested, and explain the method adopted. In the remaining sections, findings of both the measurement and the structural model are reported and then discussed. Conclusions end the paper.

2. SPMS and resource orchestration

A PMS is defined as a set of metrics used to quantify the efficiency and effectiveness of actions (Neely et al., 1995). Similarly, an SPMS is defined as a set of metrics used to quantify the efficiency and effectiveness of suppliers' actions (Hald and Ellegaard, 2011; Maestrini et al., 2017). As the main goal of a PMS is to support the implementation of strategy at various levels (Kaplan and Norton, 1996), the goal of an SPMS is to support the purchasing strategy and align buyer-supplier relationships towards consistent goals (Kannan and Tan, 2002).

The RBV has long claimed that a sustainable competitive advantage is derived from owning bundles of valuable, rare, inimitable and non-substitutable resources (Hitt et al., 2011; Wowak et al., 2013). Based on this nuance, Hansen et al. (2004, p. 1280) argue that "what a firm does with its resources is at least as important as which resources it possesses". Further elaborating on this concept, Sirmon et al. (2011) advance the argument that while owning the right resources is essential, competitive advantage comes from the ability of a firm to "orchestrate" its resources. Indeed, only with a proper resources orchestration, a company manages to execute its strategy. The idea of resource orchestration grounds on the on the seminal works of Sirmon et al. (2007) and Helfat et al. (2007).

ROT complements RBV in that it explains *how* resources are transformed into capabilities. According to Sirmon et al. (2007, p. 273) resource orchestration entails "the comprehensive process of *structuring* the firm's resource portfolio, *bundling* the resources to build capabilities, and *leveraging* those capabilities with the purpose of creating and maintaining value for customers." An in-depth discussion of these three stages is outside the scope of this study. What matters to us is extending the

application of ROT to the context of buyer-supplier relationships and specifically to the role of the SPMS for resource orchestration.

As a matter of fact, we know that resources can be both internal and external to the firm. In particular, purchasing and supply management can yield competitive advantage per se (as an internal capability that is unique to the firm) and allowing the firm to access suppliers' resources and capabilities (Barney, 2012). ROT seems particularly suitable to interpret buyer-supplier relationships: structuring the supply base refers to the buyer company's effort of maintaining a current and aligned portfolio of suppliers. Bundling supplier resources requires allocating specific relational investments with each supplier to access and develop their resources and capabilities. Finally, the buyer company can leverage these resources and capabilities by selecting and activating the right set of suppliers for the achievement of its goals.

Throughout this process, the role of management is empowered. Managers are responsible for setting the vision, deciding upon resource allocation and acting to stimulate resource mobilization (Crook et al., 2008; Hitt et al., 2011). This includes organizing the resource portfolio, developing capabilities out of resources and acting on them to create value (Sirmon and Hitt, 2003). To this end, SPMSs are key tools managers can rely upon to orchestrate supplier resources. Indeed, the SPMS supports the buyer company in each step of the process. By collecting information and measuring supplier performance, the buyer company is able to structure the supply base according to its needs, investing on those that are in line with the company strategy and divesting from those that are not. The SPMS also helps bundling supplier resources, as it allows identifying suppliers that have the potential to generate a competitive advantage and to develop such potential through appropriate supplier development programs. Finally, through the SPMS, the buyer company can mobilize the desired sets of suppliers in accordance to the company strategy.

All in all, the overarching premise of this study is that the SPMS maturity all along its lifecycle (design, implementation, use and review) can grow the buyer company orchestration capabilities and lead to higher supplier performance. In the next sections we will provide an overview of the SPMS lifecycle stages and their expected link with supplier performance.

3. SPMS lifecycle

The subsequent four paragraphs address the phases of PMS design, implementation, use and review, identifying the features characterizing the maturity for each phase. Such phases are mostly grounded in the PMS literature and serve as the premise to introduce the SPMS lifecycle framework which is at the basis of this study.

3.1 PMS design

Designing the PMS consists of the identification of key objectives to achieve, derived from the company strategy, with their subsequent operationalization into a set of metrics (Neely et al., 1995). A proper metric requires the following three distinctive elements: (1) a performance measure that quantifies what is happening; (2) a performance standard, or target, that discriminates between good and bad performance; (3) consequences related to being on, below or above target (Melnyk et al. 2014).

The alignment of the PMS with the corresponding strategy is a critical element that should be guaranteed in the PMS design phase by including all performance dimensions at stake (Chenhall, 2005; Franco-Santos et al. 2012). Another critical element for a successful PMS design is the involvement of all the relevant stakeholders in the process (Choi et al., 2012; Papalexandris et al. 2004; Sandstrom and Toivanen, 2002).

Considering the SPMS, the design phase entails the operationalization of the goals related to supplier relationship management into a set of metrics, addressing critical suppliers' performance (Luzzini et al., 2014). Most diffused performance dimensions monitored are quality, delivery and cost performance (Kannan and Tan, 2002; Gunasekaran et al. 2004). More advanced systems tend to also include metrics measuring supplier capabilities in terms of innovation effort and sustainability approach (Kannan and Tan, 2002; Simpson et al., 2002). Within the SPMS lifecycle, the design phase is the most debated in scientific literature: contributions span from metrics selection procedures (Igarashi et al., 2013; Masella and Rangone, 2000; Huang and Keskar, 2007) and innovative measurement framework presentation (Humphreys et al., 2007; Carter et al., 2010; Muralidharan et al., 2002) to the outcomes of SPMS design (Mahama, 2006; Cousins et al., 2008)

In accordance with internal PMS literature, the following three main elements can be used when evaluating the maturity of the SPMS design: (1) the metric set completeness, which addresses the presence of all the critical supplier performance dimensions (Kannan and Tan, 2002; Simpson et al., 2002); (2) the involvement of all the relevant stakeholders in the design process (e.g., organizational functions other than the one owning the SPMS and/or the suppliers themselves - Luzzini et al., 2014); and (3) the presence of a robust alignment with the purchasing/supply chain (SC) and eventually the business strategy (Gutierrez et al. 2015).

3.2 PMS Implementation

The implementation phase of the PMS consists of establishing procedures and systems to collect, analyse and disseminate data, enabling regular measurements (Bourne et al., 2000; Lohman et al. 2004; Garengo et al., 2007). It is characterized by the activities of data collection and collation, metrics computation and reporting processes (Bourne, 2005; Bourne et al., 2003). To efficiently and effectively manage the PMS implementation, an appropriate information and communication technology (ICT) infrastructure is needed, allowing automation and data reliability (Garengo et al., 2007; Nudurupati et al., 2011; Bititci et al., 2006). A poor supporting ICT may negatively affect the PMS reliability and generates mistrust in metrics reported, thus preventing a successful implementation of the tool (Cavalluzzo and Ittner, 2004).

Considering SPMSs, the activities involved are the same (data collection, metrics calculation, and system reporting) but are further complicated by the need to collect data from external sources and to manage inter-company reporting. The maturity of the SPMS implementation is defined by the reliability of data collection and metrics' computation; the presence of a mature ICT allowing for automation in data analysis and metrics calculation; and structured, formal and frequent reporting (Bourne et al., 2000; Bourne et al., 2003; Luzzini et al., 2014; Leeuw and van der Berg, 2011).

3.3 PMS use

The PMS use concerns the way the measuring part manages the relationship with the measured part through the PMS. It entails activities such as communication and feedback management, discussion of

reported performance, launch of improvement plans, contract and incentives/disincentives management when present (Gutierrez et al. 2015; Hall, 2008; Grafton et al., 2010).

In the present research, as in most operations and accounting literature, the reference model to frame the PMS use is Henri (2006), who identifies, grounding on the previous work of Simons (1995), the following two main paradigms of PMS use: diagnostic and interactive. The former entails a traditional mechanistic control, carried out in a top down fashion by the measuring party (i.e., the buyer company) towards the measured party (i.e., the supplier); it is based on formal reporting and constant control of target achievement. The latter enables the use of PMS to stimulate mutual dialogue and open discussion on reported performance, with the goal of continuous improvement by enhancing collaboration among the parties involved. According to Henri (2006), these two approaches could co-exist, leading to dynamic tension, which arises from the combined use of the PMS in a diagnostic and interactive fashion. In this way, the two methods of use can be seen as complementary forces, jointly shaping the performance management process. Empirical evidence from past studies on PMS use shows how this dynamic tension actually displays the most positive impact on performance (Widener, 2007; Mundy et al., 2010; Koufteros et al., 2014).

In the literature on supplier performance measurement, a focus on SPMS use is still lacking; yet, it is critical to depict the buyer company approach in measuring and managing the supplier performance. In this paper, SPMS use is framed by transposing the interactive versus diagnostic framework to SPMS and buyer-supplier relationship management. Doing so, the diagnostic and interactive use of SPMS can be identified. The former allows for monitoring the supplier coherently with performance measures and targets set by the buyer company; the SPMS in this case is mainly exploited to align supplier behaviour to the buyer purchasing strategy. The latter entails an active supplier involvement in the measurement process, emphasizing the bi-directional nature of the relationship; the SPMS facilitates dialogue and open debate on mutual performance, aiming at continuous improvement through win-win performance improvement plans. On the one hand, a diagnostic SPMS use is cost and time efficient, but it could result in stiffening the relationship between the buyer and the supplier. On the other hand, an interactive SPMS stimulates a positive climate fostering collaboration, but is more difficult to apply and more demanding in terms of time and resources. Following Henri (2006), the coexistence of these two

approaches leads to a dynamic tension between the diagnostic and interactive use of the SPMS. Coherent with internal PMS literature, buyer companies are expected to gain the most from this dynamic tension since suppliers are supported and stimulated in a positive manner while constantly controlled and directed towards target achievement. Within this paper, combined high levels of interactive and diagnostic features (dynamic tension) are linked with a mature use of the SPMS.

3.4 PMS review

The PMS review is the last phase of the PMS lifecycle and involves the PMS revision by updating targets and introducing new performance measures, in order to assure alignment with the strategy over time (Kennerley and Neely, 2003; Bourne et al. 2000; Braz et al., 2011). Although it is often neglected by companies and poorly discussed in scientific literature, timely reviewing of the PMS is of crucial importance. If changes in the strategy are not reflected in the PMS, the alignment is lost and the PMS orchestrating role is not coherent with the strategic goals.

Considering SPMSs, the review is even more critical because purchasing strategy and goals are much more volatile and dynamic than business strategy (Hesping and Schiele, 2015). Thus, constant attention to SPMS review is critical. Therefore, the maturity of the SPMS review phase is identified by the degree of the introduction of new metrics and the frequency of target updates (Braz et al., 2011; Bourne et al. 2000).

4. Research framework and hypotheses development

Sirmon et al. (2007, 2011) claimed that resource orchestration requires the following: structuring the resource portfolio (i.e., acquiring, accumulating, and divesting resources), building resources (i.e., establishing current capabilities and developing new ones) and leveraging resources (mobilizing and coordinating capabilities). PMSs facilitate this type of orchestration (Melnyk et al., 2004; Koufteros et al., 2004).

Since suppliers represent critical resources for the buyer company, purchasing/SC managers need to properly orchestrate them. Coherent with ROT, the main argument advanced in this paper is that a

mature SPMS adoption, along its whole lifecycle, guarantees a successful suppliers orchestration. Indeed, an SPMS enables supplier portfolio management, the development of supplier capabilities and, ultimately, the coordination of suppliers, aligning their actions with the buyer company's needs. Thus, our theoretical framework reports a direct positive relationship between a mature SPMS lifecycle and suppliers' performance in terms of quality, delivery, innovation, sustainability and cost (see Fig. 1).

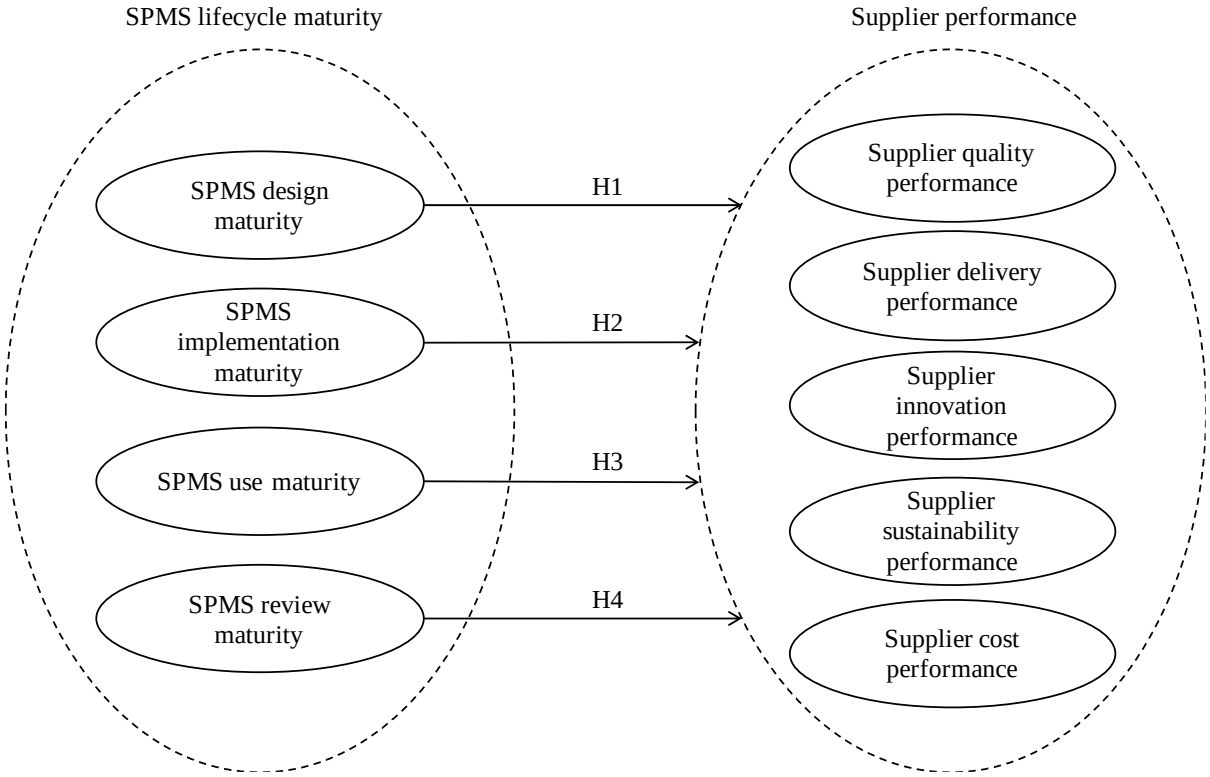

Figure 1: Research framework

The following paragraphs discuss the relationship between each SPMS lifecycle phase and supplier performance, reporting the hypotheses of the model.

4.1 The relationship between SPMS design maturity and supplier performance

Within SPMS literature, several survey-based works highlight a positive relationship between the adoption of different performance metrics and performance. Mahama (2006) found a positive relationship between the adoption of both financial and non-financial metrics and supplier performance in terms of quality, savings, on time delivery and improved decision making. Cousins et al. (2008)

found a positive relationship between the inclusion of both "operational" metrics (delivery to schedule, lead time, and conformance to specifications) and "communication" metrics (communication effectiveness, information quality, and regularity of feedback) and buyer business performance, mediated by socialization mechanism. Other case-based studies examined the design process, highlighting the importance of aligning the SPMS with pre-defined relationship goals and to involve all relevant stakeholders, starting from other organizational functions within the buyer company (Luzzini et al. 2014; Hald and Ellegaard, 2011).

This study advances previous ones by addressing a more complete construct of design maturity, including (1) the presence of several performance dimensions within the measurement framework and (2) the maturity of framework design procedures. First, a mature design should guarantee the robustness and completeness of the measurement framework. Second, in line with ROT, a multi-dimensional SPMS should stimulate the supplier to focus on all the critical performance, leading to a wider positive effect. Thus, the first hypothesis concerns the existence of a positive relationship between the SPMS design maturity and supplier performance, with sub-hypotheses for each performance dimension.

H1 The SPMS design maturity positively affects the supplier's performance.

H1a The SPMS design maturity positively affects the supplier's quality performance.

H1b The SPMS design maturity positively affects the supplier's delivery performance.

H1c The SPMS design maturity positively affects the supplier's innovation performance.

H1d The SPMS design maturity positively affects the supplier's sustainability performance.

H1e The SPMS design maturity positively affects the supplier's cost performance.

4.2 The relationship between SPMS implementation maturity and supplier performance

Starting from the early 2000s, some authors within internal PMS literature began to argue that many PMS adoption projects actually fail, not because the system is poorly designed, but rather because it is poorly implemented (Bourne et al. 2000; Bourne et al., 2002). Implementation failures could be due to three main reasons. The first reason is weak data processing along primary data collection, data analysis

and metrics calculation; a reliable ICT infrastructure could limit or avoid this problem, along with a clear definition of roles and responsibilities. The second reason is inappropriate content and frequency of reporting, which should be set coherently with the business context, the relationship between the measuring and the measured parties and the supporting ICT. Third, the lack of top management commitment, which may eventually lead to failures in launching the system (Bourne, 2005).

A few contributions in the literature addressed SPMS implementation aspects. Prahinky and Benton (2004) found that, in the presence of a supplier commitment, a structured and formal reporting can improve supplier performance. Prahinski and Fan (2007) focused on reporting frequency, finding that while a high frequency of operational metrics (quality, delivery) reporting positively affects communication quality perception, no significant relationship was found dealing with financial metrics and more strategic oriented performance.

Reliable data processing from data collection to metrics calculation contributes to a rigorous performance measurement process, which is a critical precondition to establish trust in the system (Hald and Ellegaard, 2011; Purdy and Safayeni, 2000). According to ROT, frequent and structured reporting should empower the orchestration process, stimulating suppliers' attention towards the progression of performance tracking. Both factors concur with the SPMS implementation maturity. Thus, the second hypothesis can be formulated as follows:

H2 The SPMS implementation maturity positively affects the supplier's performance.

H2a The SPMS implementation maturity positively affects the supplier's quality performance.

H2b The SPMS implementation maturity positively affects the supplier's delivery performance.

H2c The SPMS implementation maturity positively affects the supplier's innovation performance.

H2d The SPMS implementation maturity positively affects the supplier's sustainability performance.

H2e The SPMS implementation maturity positively affects the supplier's cost performance.

4.3 The relationship between SPMS use maturity and supplier performance

The diagnostic versus interactive framework (Henri, 2006) has become the reference paradigm for SPMS use. Although related constructs have been operationalized in slightly different ways over the years, most empirical evidence suggests that the best impact on performance is achieved when the diagnostic and the interactive component coexist, leading to dynamic tension between the two approaches (Henri, 2006; Widener, 2007; Mundy, 2010; Koufteros et al., 2014).

Though some studies approach the way buyer companies use SPMS (Hald and Ellegaard, 2011; Luzzini et al., 2014), the use maturity is a novel construct introduced in this research, corresponding to the diagnostic-interactive dynamic tension. Coherently with ROT, SPMS use directly shapes the supplier orchestration process. More operational and short-term performance dimensions (like delivery, quality, and cost) should be positively impacted by a diagnostic use of the system, since they are frequently tracked and easier to measure and quantify. Other more strategic aspects, related to supplier capabilities in terms of innovation and sustainability, may benefit from a more interactive SPMS use, allowing the use of the tool for supplier development. Thus, the third hypothesis is formulated as follows:

H3 SPMS use maturity positively affects the supplier's performance.

H3a SPMS use maturity positively affects the supplier's quality performance.

H3b SPMS use maturity positively affects the supplier's delivery performance.

H3c SPMS use maturity positively affects the supplier's innovation performance.

H3d SPMS use maturity positively affects the supplier's sustainability performance.

H3e SPMS use maturity positively affects the supplier's cost performance.

4.4 The relationship between SPMS review maturity and supplier performance

The PMS review has been neglected so far, even dealing with internal PMS. Nevertheless, it plays a critical role within performance management: first it prevents "strategy ossification" (Micheli and Manzoni, 2010), i.e., a rigid and obsolete PMS misaligned with strategic goals. Second, it allows for

continuous improvement, since both performance measures and targets are challenged over time (Braz et al., 2011; Gutierrez et al., 2015).

SPMS literature is still lacking contributions on the review phase, though buyer-supplier relationship goals are likely to change over time for a variety of reasons, including changes in buyer company purchasing strategy, relationship disruptions, major market changes or technological innovation. Thus, coherently adjusting the SPMS in a timely manner is important. In accordance with ROT, the orchestration needs of the buyer company may change over time within a specific supplier relationship. Reviewing the SPMS is instrumental in keeping it effective and aligned with relationship goals. Thus, the fourth hypothesis is reported as follows.

H4 SPMS review maturity positively affects the supplier's performance.

H4a SPMS review maturity positively affects the supplier's quality performance.

H4b SPMS review maturity positively affects the supplier's delivery performance.

H4c SPMS review maturity positively affects the supplier's innovation performance.

H4d SPMS review maturity positively affects the supplier's sustainability performance.

H4e SPMS review maturity positively affects the supplier's cost performance.

5. Methodology

Given that we rely on research hypotheses that are formulated based on extant literature and that require to be tested on a large sample, we chose to distribute a survey that would allow measuring the SPMS maturity and the supplier performance as a series of latent variables. In particular, data were collected through a dyadic survey process addressing buyer-supplier dyads, in order to solve perception biases (e.g., Aminoff and Tanskanen, 2013; Oosterhuis et al., 2013; Ambrose et al., 2010; Barnes et al., 2006; Kim et al., 1999). The dyadic approach represents an important methodological contribution in respect to previous survey-based single-respondent studies within the SPMS literature (Carr and Pearson, 1999; Mahama, 2006; Heide et al., 2007; Prahinski and Fan, 2007; Cousins et al., 2008). The

first paragraph explains the procedures followed to design the survey, select the sample and collect the data. The second paragraph reports relevant information regarding the constructs' measures.

5.1 Survey development, sampling, data collection

Two specular versions of the questionnaire (one for buyers and one for suppliers) were prepared, both in English and in Italian. The English versions of the two questionnaires were first developed from literature-driven constructs. Then, they were subjected to a pilot test in order to assure clarity, conciseness and effectiveness in addressing the concepts behind the questions. Both questionnaires were submitted to four English scholars, experts in the field of performance measurement and management, and questions were adjusted based on their advice. The questionnaires were then translated into Italian through the TRAPD (translation, review, adjudication, pre-testing, and documentation) procedure in order to assure the content's validity (Harkness et al., 2004). The Italian versions were then submitted to three Italian scholars and to four practitioners (two couples of respondents from two buyer-supplier dyads) for pretesting. At each step, the wording was adjusted based on the feedback received. Finally, a personalized link to access and fill in the online survey was created to be sent to each company involved.

Buyer companies were addressed first, starting from a population of Italian manufacturing companies with at least 100 employees (smaller companies rarely have a structured SPMS in place). The choice to focus only on the manufacturing sector (ISIC codes from 10 to 33), was primarily aimed at increasing the homogeneity of the empirical sample. Moreover, manufacturing companies are expected to rely on more mature SPMSs, given the historical relevance of suppliers in this sector. No specific requirement was set in advance in respect to suppliers: they were selected by the buyer company's respondent among the most important active suppliers in terms of spending.

Previous criteria were followed to perform the sampling starting from the AIDA-Bureau Van Dick database (aida.bvdinfo.com) of Italian companies. Buyer companies satisfying the previous requirements were first contacted by phone in order to understand their willingness to take part in the research and were then given instructions on how to fill in the questionnaire. An email with a personalized link to the online survey was sent to those agreeing to participate. The telephone contact

and the email text followed a default script developed at the beginning. When filling in the questionnaire, the buyer company respondent had to refer to the selected supplier and provide its contact details. Then, the indicated supplier was contacted following the same procedure used for buyer companies: they were first contacted by phone and then sent an email with the link to the online survey (supplier version). After a defined time of non-response, reminder emails were sent.

Buyer companies' employees tasked with completing the questionnaire were mostly executives in the purchasing or SC functions, knowledgeable about the SPMS in place and about the relationship with the selected suppliers. Supplier respondents ranged from sales to customer service positions. From the total number of buyer companies contacted, 458 agreed to participate in the research, and 238 of them began filling in the questionnaire. The threshold for considering a questionnaire to be acceptable was established as 75% of questions answered. According to this criterion, 204 buyer questionnaires were ultimately usable, leading to a response rate of 44.5%. Regarding suppliers, 156 questionnaires were considered complete (according to the threshold), achieving a response rate of 65.6% with respect to all the contacts provided by the buyer companies. Finally, matching together buyer-supplier questionnaires, 147 dyads were ultimately usable, meaning that both questionnaires satisfied the completion threshold requisite. Some descriptive information on the usable sample are provided in Table 1 (buyer companies) and Table 2 (supplier companies).

Table 1: Buyer company sample descriptives

Descriptive	**Freq.**	**%**	**Descriptive**	**Freq.**	**%**
Revenues (million €)			***Employees***		
0-5	0	0	Small (1–49)	0	0
5-50	43	29,25	Small-Medium (50–99)	0	0
50-100	30	20,41	Medium (100-249)	62	42,18
100-1000	67	45,58	Medium large (250-499)	32	21,77
≥1000	7	4,76	Large (500-999)	31	21,09
			Very large (≥1000)	22	14,97
Industry Sector			***Respondent organizational function***		
Machinery and equipment	62	42.18	Purchasing	114	77.55
Metallurgy and steel goods	17	16.33	Supply chain and logistics	20	13.61
Chemical and pharmaceutical	15	11.56	Operations	9	6.12
Textile	11	10.20	Other	4	2.72

Vehicles	10	7.48			
Food and beverages	8	6.80			
Other manufacturing	24	5.44			
Total	**147**	**100**		**147**	**100**

Table 2: Supplier company sample descriptives

Descriptive	**Freq.**	**%**	**Descriptive**	**Freq.**	**%**
Revenues (million €)			***Employees***		
0-5	28	19.31	Small (1–49)	65	45,14
5-50	67	46.21	Small-Medium (50–99)	22	15,28
50-100	17	11.72	Medium (100-249)	24	16,67
100-1000	25	17.24	Medium large (250-499)	15	10,42
>1000	8	5.52	Large (500-999)	5	3,47
Missing	2	-	Very large (>1000)	13	9,03
			Missing	3	-
Industry Sector			***Respondent organizational function***		
Metallurgy and steel goods	40	27.2	Sales and Marketing	87	59
Machinery and equipment	27	18.4	Operations	18	12
Distributors	19	12.9	Customer Service	7	5
Chemical, iron and steel	14	9.5	Quality	7	5
Wood and paper	12	8.2	Accounting	5	3
Other services	18	12.2	Other	23	16
Other manufacturing	17	11.6			
Total	**147**	**100**		**147**	**100**

After the collection process, the data were cleaned and checked for response bias (Armstrong and Overton, 1977). Non-response bias was tested by ruling out the differences in terms of size and industry distributions between respondents and non-respondents. Similarly, early response bias was also tested. Both tests showed no significant differences between groups.

5.2 Measures

Constructs were operationalized on the basis of both existing measures within the SPMS literature and measures adapted from other literature streams, in particular internal PMS contributions.

Respondents were asked to answer each question on a Likert scale ranging from 1 ("strongly disagree") to 5 ("strongly agree").

Starting from the independent variable, the SPMS lifecycle maturity has been split into four constructs, addressing maturity at each phase. (1) The SPMS design maturity includes the following three main features: SPMS framework completeness (Cousins et al., 2008; Mahama, 2006; Kannan and Tan, 2002), involvement of other organizational functions (Luzzini et al., 2014; Leeuw and van der Berg, 2011), and alignment with supply chain and purchasing strategy (Taylor and Taylor, 2013; Chenhall, 2005). (2) The SPMS implementation maturity is a combination of reliable and rigorous data collection and metrics calculation (Bourne et al., 2000; Grudinschi et al., 2014), automation degree and solid ICT infrastructure (Bourne et al., 2000; Bourne et al., 2003; Nudurupati et al., 2011; Bititci et al., 2006), frequent and formal reporting (Bourne, 2005; Leeuw and van der Berg, 2011; Taylor and Taylor, 2013), and procedures for system implementation (Leeuw and van der Berg, 2011). (3) The SPMS use maturity is identified with dynamic tension (Henri, 2006; Koufteros et al. 2014) derived from a combined use of the PMS in a diagnostic and interactive fashion. The review maturity is measured looking at the review effort, which is aimed at constantly improving the clarity, usefulness and quality of the SPMS and at keeping the SPMS aligned with the strategy and the changing external environment (Braz et al., 2011; Gutierrez et al., 2015). All these constructs were measured, addressing the buyer side only, considering the 147 buyer responses belonging to a complete dyad; in other words, the buyer who filled out the questionnaire had a linked supplier who responded as well. This choice was made because some lifecycle phases are rather objective and hardly allow for biases (design and review), while others entail activities that are mainly under the scope of the buyer company and not visible to the supplier (implementation).

Addressing the dependent variable, supplier performance was measured by asking the performance impact of the relationship with the specific buyer company and the SPMS in place. Performance dimensions addressed included supplier quality, delivery, innovation, sustainability and cost, based on existing scales (Cheung et al. 2010; Gonzales-Benito, 2007). These constructs were measured considering the mean between the buyer and the supplier responses for each item, exploiting the dyadic

nature of the questionnaire. Therefore, the 147 dyadic measures were available to measure supplier performance.

6. Findings

The research model was tested using the partial least square approach (Oh et al., 2012) in Smart PLS. The results of the measurement model, based on a confirmatory factor analysis, are reported in the first paragraph. The results of the structural model are reported in the second paragraph.

6.1 Measurement model

The measurement model counts 42 items asked to buyer companies and 12 asked to supplier companies (responses on the SPMS lifecycle were collected only from the buyer side, while responses on supplier performance were collected from both parties). Overall, 13 multi-item constructs were generated. The SPMS design maturity is a second order formative construct that includes completeness of the measurement framework (presence of operational metrics and presence of strategic metrics) and maturity of the measurement process, which are reflective constructs. The SPMS implementation maturity is a second order formative construct that includes data collection reliability and frequency of reporting, which are reflective constructs.

The SPMS use maturity reflects a dynamic tension between a diagnostic and an interactive SPMS use and is operationalized by means of a second order construct given by the product of SPMS diagnostic use and SPMS interactive use. The others (i.e. review maturity and various supplier performance) are first order constructs.

Table 3 shows the result of the confirmatory factor analysis performed with PLS. The constructs' validity was verified, first demonstrating evidence for convergent validity. In accordance with Fornell and Larcker (1981) and Nunnally and Bernstein (1994), we checked first order constructs composite reliability (CR) and the average variance extracted (AVE) to respect the relative thresholds, 0.7 and 0.5, respectively. Discriminant validity was then tested in two ways. The correlation matrix proved that in most cases, the AVE was greater than the square correlation between each pair of latent constructs

(Fornell and Larcker, 1981), as shown in Table 4. The heterotrait-monotrait ratio (HTMT) (Henseler et al., 2014) showed good discriminant validity properties with most values lower than the threshold of 0.85 (Table 5).

Table 3: Measurement properties of the relative constructs

	Construct	Items asked of the respondent	Loading	Mean	Std. Dev.	CR	AVE
SPMS design maturity	Presence of operational metrics	We measure the extent to which the supplier delivers products/services according to buyer specifications	0.850	4.5	0.86	0.84	0.64
		We measure the extent to which this supplier delivers product/service on time	0.721				
		We measure the extent to which this supplier meets acceptable quality levels for the product/services supplied	0.819				
	Presence of strategic metrics	We measure supplier flexibility performance	0.681	3.8	1.1	0.88	0.64
		We measure supplier innovation capabilities	0.808				
		We measure the extent to which the supplier meets environmental sustainability standards	0.842				
		We measure the extent to which the supplier meets social sustainability standards	0.856				
	Maturity of the measurement process	Managers of other key functions actively participate in the design of the SPMS	0.791	3.9	0.78	0.87	0.7
		The SPMS is aligned with the purchasing/SC strategy	0.827				
		SPMS is derived from strategic and tactical company objectives	0.887				
SPMS implementation maturity	Data collection reliability	The data collection process is rigorous and reliable	0.798	3.74	0.82	0.89	0.66
		The data for performance calculation are up-to-date	0.818				
		The data collection process is highly automated	0.838				
		The performance measures calculation is highly automated	0.801				
	Frequency of reporting	We periodically report the SPMS data (either publicly or confidentially) to the supplier	0.885	3.37	1.1	0.9	0.81
		We frequently create formal reports from the SPMS	0.916				
SPMS use maturity	Diagnostic use	We use the SPMS to monitor results	0.851	3.9	0.89	0.92	0.73
		We use the SPMS to track progress towards goals	0.897				
		We use the SPMS to compare outcomes to expectations	0.853				
		We use the SPMS to review key measures	0.818				
	Interactive use	We use the SPMS to encourage discussion in meetings with the supplier	0.750	3.96	0.8	0.94	0.7
		We use the SPMS to enable the organization and the supplier to focus on common issues	0.850				
		We use the SPMS to enable the organization and the supplier to focus on critical success factors	0.825				
		We use the SPMS to enable to launch continuous improvement plans	0.857				
		We use the SPMS to develop a common language between our organization and the supplier	0.865				
		We use the SPMS to tie the organization with the supplier	0.837				
		We use the SPMS to develop a share strategy with the supplier	0.855				

SPMS review maturity	We periodically review the SPMS in view of the current competitive environment	0.891	3.2	1.01	0.94	0.83
	We periodically review the performance measures to improve the clarity, usefulness and practicality of the SPMS	0.935				
	We periodically review the SPMS to keep it aligned with the purchasing/SC strategy or corporate strategy	0.911				
Supplier quality performance	Our relationship with this supplier (buyer) has improved their (our) product quality	0.908	3.81	0.65	0.94	0.83
	Our relationship with this supplier (buyer) has improved their (our) product reliability and consistency	0.947				
	Our relationship with this supplier (buyer) has lowered return rates on our (their) orders with them (us)	0.873				
Supplier delivery performance	Our relationship with this supplier (buyer) has improved on-time delivery of the orders we (they) place with them (us)	0.908	3.88	0.64	0.93	0.81
	Our relationship with this supplier (buyer) has improved delivery flexibility of the orders we (they) place with them (us)	0.885				
	Our relationship with this supplier (buyer) has improved accuracy of delivery of the orders we (they) place with them (us)	0.908				
Supplier innovation performance	Our relationship with this supplier (buyer) has had a positive effect on his (our) ability to develop successful new products	0.937	3.52	0.7	0.94	0.88
	Our relationship with this supplier (buyer) has had a positive effect on his (our) ability to make improvements to existing products	0.937				
Supplier sustainability performance	Our relationship with this supplier (buyer) has improved its (our) environmental sustainability performance	0.974	2.8	0.81	0.97	0.95
	Our relationship with this supplier (buyer) has improved its (our) social sustainability performance	0.975				
Supplier cost performance	Our relationship with this supplier (buyer) has provided us (them) with competitive prices	0.904	3.64	0.75	0.91	0.84
	Our relationship with this supplier (buyer) has reduced our (their) costs	0.924				

Table 4: Correlation matrix

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Presence of strategic metrics	**.801**												
2. SPMS interactive use	.301	**.835**											
3. Presence of operational metrics	.138	.438	**.798**										
4. SPMS diagnostic use	.175	.687	.467	**.855**									
5. SPMS review maturity	.283	.520	.323	.563	**.912**								
6. Supplier cost performance	.208	.269	.083	.154	.234	**.914**							
7. Data collection reliability	.181	.452	.331	.616	.520	.107	**.814**						
8. Supplier delivery performance	.142	.386	.373	.416	.438	.409	.370	**.900**					
9. Maturity of measurement process	.370	.534	.309	.547	.437	.116	.496	.144	**.836**				
10. Supplier innovation performance	.212	.260	.151	.197	.278	.348	.015	.466	.081	**.937**			
11. Supplier quality performance	.214	.367	.268	.360	.334	.330	.224	.592	.162	.681	**.910**		
12. Frequency of reporting	.106	.456	.267	.451	.443	.019	.401	.277	.341	.134	.287	**.900**	
13. Supplier sustainability performance	.452	.122	.010	.139	.251	.335	.097	.287	.147	.539	.416	.084	**.974**

The square root of the AVE is shown in bold on the diagonal. Correlations are in the lower triangle of the matrix.

Table 5: HTMT results

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Presence of strategic metrics													
2. SPMS interactive use	.346												
3. Presence of operational metrics	.217	.533											
4. SPMS diagnostic use	.211	.761	.594										
5. SPMS review maturity	.334	.570	.402	.634									
6. Supplier cost performance	.261	.313	.132	.179	.274								
7. Data collection reliability	.225	.515	.445	.719	.602	.131							
8. Supplier delivery performance	.172	.418	.466	.469	.484	.480	.424						
9. Maturity of measurement process	.457	.625	.414	.661	.521	.168	.615	.163					
10. Supplier innovation performance	.258	.287	.197	.225	.313	.420	.123	.529	.105				
11. Supplier quality performance	.252	.402	.334	.406	.369	.390	.259	.661	.194	.775			
12. Frequency of reporting	.164	.545	.354	.549	.535	.063	.495	.326	.442	.170	.350		
13. Supplier sustainability performance	.513	.135	.072	.151	.271	.384	.162	.317	.172	.598	.454	.100	

6.2 Structural model

To test the hypotheses of the framework, we ran a path analysis following the suggestions of Peng and Lai (2012) for the use of PLS. The results are shown in Table 6, including standardized path coefficients with two-tailed-t-tests for the hypotheses. H1, H3, and H4 are partially confirmed with different levels of significance for the different supplier's performance, while H2 is not confirmed. Design maturity has a positive impact on sustainability performance (β=0.366). Implementation maturity negatively affects innovation performance (β=-0.258), while not displaying any significant effect on any other performance. Use maturity displays a positive effect on quality (β=0.271), delivery (β=0.225) and innovation (β=0.216) performance. Finally, review maturity positively impacts delivery (β=0.249), innovation (β=0.260) and sustainability (β=0.261) performance.

Table 6: Path analysis

Dependent variables	Supplier quality performance	Supplier delivery performance	Supplier innovation performance	Supplier sustainability performance	Supplier cost performance
Independent variables					
Design maturity	0.071^{NS} (0.673)	-0.031^{NS} (0.452)	0.094^{NS} (0.855)	0.366^{**} (2.870)	0.095^{NS} (0.883)
Implementation maturity	0.009^{NS} (0.097)	0.132^{NS} (1.634)	-0.258^{*} (2.335)	-0.078^{NS} (0.638)	-0.171^{NS} (1.741)
Use maturity	0.271^{*} (2.445)	0.225^{*} (2.150)	0.216^{*} (2.072)	-0.143^{NS} (1.037)	0.200^{NS} (1.830)
Review maturity	0.142^{NS} (1.246)	0.249^{*} (2.500)	0.260^{*} (2.556)	0.261^{*} (2.458)	0.174^{NS} (1.713)
R^2 adjusted	0.175	0.249	0.131	0.152	0.093

***p-value<0.001; **p-value<0.01; *p-value<0.05; nsp-value≥0.05; the values of t statistics are shown in brackets.

7. Discussion

The application of a lifecycle perspective within the research framework provides insights on the relative impact of each phase on diverse supplier performance. Previous survey based studies separately took into account either design (Carr and Pearson, 1999; Cousins et al., 2008; Mahama, 2006; Heide et

al., 2007) or implementation features (Prahinski and Benton, 2004; Prahinski and Fan, 2007). This study jointly includes the design, implementation, use and review of the SPMS. At a high level of analysis, the results suggest that the design, use and review affect supplier performance, thus confirming the need to effectively manage the entire SPMS lifecycle (Bourne et al., 2000; Gutierrez et al. 2015; Lohman et al. 2004; Braz et al. 2011). Nonetheless, going in depth within each single hypothesis, it is possible to gain interesting insights on the impact of each phase and to compare them.

The SPMS design, by far the most debated in extant literature, turns out to play a secondary role in respect to other phases, showing a significant positive impact only considering sustainability performance. Thus, H1 is only partially confirmed: in particular, only H1d is supported, while no significant evidence was found for H1a, H1b, H1c, and H1e. What emerges is that a mature SPMS design per se does not improve supplier performance, no matter how much effort and emphasis is put into developing the right framework. As far as sustainability is concerned, buyer companies caring about this aspect generally measure the sustainability approach of suppliers by means of questionnaires and audits. They generally set some requirements that a potential supplier must respect and maintain over time.

Quite unexpected results emerge from the relationship between SPMS implementation maturity and supplier performance: a mature implementation does not have any significant impact on supplier performance, except for supplier innovation performance, where the effect is actually negative. It seems reasonable that the implementation of the system plays a minor effect on performance, if compared to system design, use and review. The negative impact on innovation performance may be explained as a supplier reaction towards a formal and frequent reporting (Prahinski and Fan, 2007), which could be perceived as excessively rigid, not favouring the innovation effort.

As far as SPMS use maturity is concerned, the related hypothesis (H3) is largely confirmed, finding a significant positive effect on supplier quality (H3a), delivery (H3b) and innovation (H3c). Coherent with internal PMS literature, the combined diagnostic and interactive use maximizes the outcomes in terms of performance improvement: the interactive component allows improvement opportunity seeking in different areas; the diagnostic component strengthens the attention towards target

achievement. When the two coexist, there is positive pressure towards target achievement, which is shared by the buyer and the supplier with the goal of continuous improvement.

The SPMS review maturity plays a key role as well. H4 is largely confirmed with a mature review showing a positive impact on supplier delivery (H4b), innovation (H4c) and sustainability (H4d) performance, while no effect is registered on quality and cost performance (H4a and H4e). The primary role of the review phase within SPMS lifecycle extends previous insights from a conceptual paper (Micheli and Manzoni, 2010) and case-based studies (Braz et al., 2011; Gutierrez et al., 2015). Reviewing metrics keeps the attention of the measured part high, avoiding any relaxing effect due to target achievement. The stimulus towards continuous improvement, along with constant attention towards the alignment with underlying goals, makes this phase so important.

The main result of the study is that the SPMS use and review (largely neglected in extant literature) have the largest effect on performance, together positively affecting supplier quality, delivery, innovation and sustainability performance. This seems coherent with ROT, in the sense that the orchestration role of the SPMS is particularly fulfilled within the use and the review phases. The former highlights the approach of the measuring part towards the measured counterpart, thus unravelling the ultimate purpose of the SPMS adoption in terms of the supplier's reaction. The latter enables the SPMS to match the inner dynamism of the orchestration process. The SPMS design and implementation often entail little or no interaction with the supplier, therefore the impact of these phases on supplier's orchestration is less evident.

With respect to previous findings, it is important to note that the maturity of the various phases could be inter-related. For example, a mature SPMS design may be positively related to a mature SPMS use or a mature implementation could positively impact the maturity of the SPMS review. On this behalf, it has to be noted that R_2 adjusted values for supplier performance dimensions (except for cost) are good and increase every time a lifecycle phase is added. Finally, supplier cost performance is not impacted by any of the SPMS lifecycle phases. An SPMS is put in place to manage the ongoing relationship with active suppliers. The suppliers' price proposal and related savings are generally defined in the negotiation phase, in a pre-contractual situation.

8. Conclusions

The present study tests the existence of a positive relationship between SPMS adoption and supplier performance improvement, supporting the relevance of the SPMS in orchestrating supplier resources. Several contributions can be recognized as part of the emergent literature stream regarding the performance impact of the SPMS. Indeed, both sides of the relationship under scrutiny have been investigated. On the buyer side, a lifecycle perspective has been applied to the SPMS, developing constructs for SPMS design, implementation, use and review maturity; on the supplier side, multiple performance dimensions (i.e., quality, delivery, innovation, sustainability, and cost) have been considered separately. Along with a dyadic data collection, this allowed the achievement of more insightful and robust empirical evidence. We study buyer-supplier relationships through the lens of ROT, which provides a suitable theoretical framework to explain the role of a mature SPMS in orchestrating suppliers.

Important managerial implications are provided. Empirical evidence shows that the SPMS use and review have the widest impact on supplier performance. Strictly speaking, this means that measuring the right things is not enough; managers should instead actively use the SPMS (both for controlling and for stimulating collaboration) and timely review the metrics coherently with changing situations. For the buyer company, being able to properly manage multiple dyadic relationships with suppliers is of critical importance. Examining the entire SPMS lifecycle will support purchasing/SC managers in doing so.

The study displays some limitations as well, which open venues to further research on the topic. Regarding data analysis, the R_2 values of the model are in line with other studies, yet relatively low; thus, the importance of the significant linkages achieved must be relativized. The main aim of this study is to introduce a lifecycle perspective of SPMSs, therefore we test the direct link between the different lifecycle stages and supplier performance. The non-significance of some links and the R_2 values suggest that – in the broader context of buyer-supplier relationships – several factors other than a mature SPMS may affect performance. Here we can think about classical integration and/or collaboration practices as well as suppliers' skills and any information technology tool supporting the interaction. In this sense,

the SPMS might represent a necessary but not always sufficient condition to ensure supplier performance and the investigation should expand to include a broader set of factors (including boundary conditions) that can interact with the SPMS in the achievement of better results. Another direction for improving the level of significant can be the study replication and the extension/refinement of our SPMS lifecycle measures. To the best of our knowledge this is the first study adopting a SPMS lifecycle perspective in the context of buyer-supplier relationships, therefore we see room for improving the scales and possibly identifying more significant aspects that can affect the supplier performance.

Since we mostly focused on the introduction of SPSM lifecycle measures and on the SPMS-performance link, we grounded on the buyer's answers for the set of independent variables and on both buyer's and supplier's answers for the dependent variables, in order to ensure data triangulation and reliability. Therefore, the dyadic data are used for validation purposes rather than for the comparison of the different actors' perception. Future studies could instead focus on the perception gap between the buyer and the supplier, and the causes/consequences of such gaps.

Also, the lifecycle perspective on the SPMS could benefit from an empirical investigation over time, to analyse how buyer companies manage supplier involvement all along the sequence of activities, therefore future studies could entail a longitudinal data collection process.

Finally, it could be interesting to look at the antecedents of a mature SPMS all along its lifecycle, thus understanding which resources and skills companies need to develop to properly measure and manage supplier performance.

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