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## Supply Chain Performance Measurement Systems: A Systematic Review and Research Agenda

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## Supply Chain Performance Measurement Systems: A Systematic Review and Research Agenda

### Abstract

Supply chain performance measurement systems (SCPMSs) are experiencing a new life in business practice thanks to new technologies that allow the collecting, integrating and sharing of information among multiple supply chain partners. However, studies that truly investigate performance measurement beyond a single firm's boundaries are still limited. With the purpose of revamping SCPMSs as a relevant research topic, we conduct a systematic review of the literature. To this end, we firstly provide a clear and up-to-date definition of SCPMSs, which sets the boundary of the study. Secondly, we perform a systematic review of academic articles published in peer-reviewed international journals, mostly in the domains of supply chain management and performance measurement. A final sample of 92 articles published from 1998 to 2015 constitutes the knowledge base of the study. The results show the publication pattern over time and provide evidence about the journals, the methodology adopted and the content elements (the SCPMS frameworks presented and the scope and phase of the measurement process). We synthesize the research state of the art and present a detailed research agenda for future scientific contributions. In particular, we envisage a theory-testing approach concerning the relatively more mature component of SCPMSs (i.e. supplier PMSs) from a life cycle perspective as well as an exploratory/theory-building approach concerning the other under-investigated components (i.e. customer PMSs, multi-tier SCPMSs and many-to-many SCPMSs).

**Keywords:** performance measurement, supply chain management, systematic literature review

**Article Classification:** literature review

## 1. Introduction

To fulfil their objectives, organizations must keep their supply chain (SC) under control and manage processes that often extend beyond their boundaries (van Hoek, 1998; Brewer & Speh, 2000). Since the organizational performance increasingly depends on external SC partners (Chen & Paulraj, 2004; Li et al, 2005), extending the management's view and control across the SC is more a need than an option for most firms. Mentzer et al (2001) define supply chain management (SCM) as the “systematic, strategic coordination of the traditional business functions and the tactics across these business functions within a supply chain, for the purpose of improving the long-term performance of the individual companies and the supply chain as a whole”. SCM seeks improved performance through the effective use of resources and capabilities via the development of internal and external linkages, thus creating a seamlessly coordinated supply chain (Ketchen & Giunipero, 2004; Ketchen & Hult, 2007). To achieve this objective, it is of the utmost importance to measure the performance of a large spectrum of tasks (e.g. logistics, inventory management and warehousing, demand forecasting, and supplier and customer relationship management) and to manage such performance through a set of practices at the firm and the SC level. To this end, supply chain performance measurement systems (SCPMSs) enable the adoption of performance metrics that span different firms and processes. Hence, SCPMSs represent a way to improve the SC governance by ensuring more value-adding, conscious and timely decisions (Gunasekaran et al, 2004). While traditional (internal) PMSs normally target processes and data related to one single firm, SCPMSs should entail inter-firm performance measures and therefore pose great challenges in terms of the need to integrate and share data from multiple firms, the need to coordinate inter-firm processes and infrastructures and the relationship management of the external SC partners throughout the measurement process. For these reasons, scholars note that SCPMSs deserve specific attention (Gunasekaran & Kobu, 2007; Gopal & Thakkar, 2012).

Nowadays SCPMSs appear to be an often-discussed but rarely defined topic. Though the interest in SCPMSs has grown over the years, the literature is still fragmented and incomplete for a number

of reasons. Firstly, the SCM scope has evolved in the last two decades from being synonymous with logistics (Cooper & Lambert, 1997) to being a melting pot of primary and supporting activities, ranging from purchasing to operations management, logistics and transportation, distribution and retail, relationship management and information technology (Giunipero et al, 2008). Secondly, different disciplines (such as operations management, information management and accounting) have approached SCPMSs, often adopting different labels, thus impeding the rise of a consistent stream of literature. Thirdly, rarely the full picture but rather bits and pieces of SCPMSs have been explored, such as vendor evaluation systems (e.g. Hald & Ellegaard, 2011; Luzzini et al, 2014), buyer–supplier relationship performance measurement (e.g. Simatupang & Sridharan, 2005; Giannakis, 2007; Ramanathan et al, 2011) or inter-firm process assessment (Chan, 2003; Chan & Qi, 2003). These systems often cover just one portion of the SC (e.g. the supplier’s side, customer’s side and internal SC activities) and address a specific measurement scope (e.g. external SC partners’ capabilities, SC processes and relationships). Still, the scientific literature fails to provide a comprehensive overview of the topic.

Therefore, the present study aims to conduct a systematic review of the literature about SCPMSs, to assess the maturity of the discipline and to set the stage for further research. To this end, we preliminarily scout the extant literature that might even partially be relevant to the study of SCPMSs. In particular, we look for previous literature reviews regarding to some extent the practice of measuring performance along the SC (see Section 2). Then, in Section 3 we consider the most relevant streams of literature connected to SCPMSs (i.e. PMSs and SCM). As a result, we provide a definition of SCPMSs and a corresponding classification, building the necessary background for a systematic review of the literature. Section 4 illustrates the methodology followed to conduct such a review. In Section 5 we report the most relevant results from the analysis of the coded articles. In Section 6 we discuss the current advancement of the SCPMS literature and highlight the relevant gaps to provide an agenda for future research. The conclusions end the paper.

We deem our study to be relevant to researchers in the areas of SCM and PMSs, as it sets clear

boundaries for the topic and defines “what is now and what is next”. In particular, we rely on three main objectives for this study: (i) providing a clear definition of SCPMSs based on their components; (ii) providing a complete review of the scientific literature, including the general characteristics and the content of the studies published so far; (iii) critically discussing the current literature and identifying the relevant challenges for the discipline; and (iv) setting the direction of future research. For this purpose, we conduct a systematic review of the literature, which results in the selection of 92 articles from peer-reviewed journals, published from 1998 to 2015. A classification and an interpretation of all the articles are proposed in the light of the conceptual dimensions arising from the research domains addressed.

## 2. Previous literature reviews on SCPMSs

As a preliminary step to position our study in the literature and highlight its contribution to scholars’ understanding of SCPMSs, we examine previous literature reviews that at least partially deal with SCPMSs. Table 1 presents such studies, providing the authors’ names and year of publication, the number of articles analysed in the literature review and the number of journals considered, the time range of the articles, the criteria adopted for articles’ selection and a brief description of their content.

*Table 1 – Previous literature reviews on SCPMSs*

Authors (year)	Articles (journals)	Time range	Article selection	Content description
Gunasekaran and Kobu (2006)	Unknown (unknown)	1995–2004	Unknown	Articles are classified by: (i) the balanced scorecard perspective; (ii) the components of the measure; (iii) the SC link; (iv) the decision level; (v) the nature of the measures; (vi) the measurement base; and (vii) traditional vs modern measures.
Akyuz and Erkan (2010)	24 (16)	1999–2009	Unknown	Articles are classified according to their methodology and content: (i) general trends and issues in SC; (ii) the dynamic modelling approach; (iii) SC performance management issues; (iv) the process maturity–SC performance relation; (v) metrics’ prioritization and dependence; and (vi) human and organizational elements of SC performance management.
Cuthbertson and Piotrowicz (2011)	45 (unknown)	1998–2009	Keyword based	Articles are classified according to their methodology and content: (i) context (supply chain and organizational factors); (ii) metrics and performance dimensions; and (iii) the measurement process.
Gopal and	28	2000–	Keyword	Articles are classified according to three phases of the PMS life cycle: (1)

Thakkar (2012)	(13)	2011	based	design; (2) implementation; and (3) monitoring and continuous improvement.
Sheperd and Günter (2006)	42 (unknown)	1997– 2005	Keyword based	A taxonomy of metrics used for both SCPMSs and operational PMSs is provided. Metrics are classified according to: (i) the SC macro-processes that they refer to; (ii) the performance dimensions; and (iii) their qualitative or quantitative nature.
Chan et al (2006)	Unknown (unknown)	Un- known	Unknown	The study reviews the literature about PMSs and assesses the increasing importance of SCM. A brief literature review on SCPMSs is presented. A list of key issues for SCPMSs is provided.

Even though the previous literature reviews represent the necessary starting point for our study, we can identify a series of limitations: (i) they include papers dealing with operational PMSs and not specifically the SC context; (ii) most works focus on the PMS design phase, with particular emphasis on the identification and description of metrics; (iii) they include a limited set of articles, and the selection criteria are sometimes unclear; and (iv) the methodology followed to develop the review is not illustrated. This work aims to overcome the previous limitations. The scope of the study is clearly identified by first introducing a definition of an SCPMS and identifying its components. We include any contribution dealing with the SCPMS life cycle (including design, implementation, use and review). We adopt a cross-disciplinary approach and examine journals belonging to different scientific domains to be as complete and comprehensive as possible. We explain in detail the literature review methodology, including the steps of source identification, selection, evaluation and data analysis, to maximize the reliability of the study and allow its replication. As a result, we are able to include – to the best of our knowledge – all the articles dealing with SCPMSs published since 1998, which constitute the knowledge base for this study.

### 3. Towards a definition of an SCPMS

Clearly stating the boundaries of the topic is essential when performing a systematic literature review. Over the years the SCPMS label has been used as an umbrella term spanning a heterogeneous literature encompassing diverse scopes of the measurement process: from intra-firm SC activities (e.g. Beamon, 1999) to external actors' performance (e.g. Kannan & Tan, 2002;

Simpson et al, 2002) or inter-firm processes and relationships (e.g. Liu et al, 2012). As a result, a unifying definition of an SCPMS is still missing. In this section we ground our study on relevant definitions in the PMS and SCM literature to provide a clear definition and set the boundaries of our study.

According to seminal performance measurement studies, a PMS is a “set of metrics used to quantify the efficiency and effectiveness of actions” (Neely et al., 1995), aimed at supporting the implementation of strategies at various levels (Kaplan & Norton, 1996). A metric is a piece of information with three distinctive features: (1) it is a verifiable performance measure, stated in either quantitative or qualitative terms, that assesses what is happening; (2) it is assessed through a reference or target value; and (3) it is associated with consequences of being on, below or above target (Melnyk et al, 2004, 2014).

The performance measurement literature usually assumes that a PMS is a system adopted within a single firm’s boundaries. It can span different processes and functions, it can involve different organizational units and it can use different types of metrics, yet normally it serves the purpose of monitoring and reporting tasks that are in the firm’s management interest. Instead, when considering processes and relationships involving multiple SC actors, we inevitably fall outside the sphere of influence of a single firm. In this context results can be achieved only through the coordinated effort of multiple entities. As a consequence, performance measurement becomes more challenging, since it must serve the purpose of several firms (i.e. the focal firm, the suppliers and the customers) as well as the SC overall. This requires the collection of data from many sources (which are not always reliable), the creation of a common performance measurement platform, the sharing of information with supply chain partners and collaboration with them on the strategy implementation. Therefore, we argue that an SCPMS – if compared with a traditional PMS – has a broader scope.

The SCPMS goal is to support the deployment of the SC strategy and the fulfilment of the SCM objectives. An effective SCM could be achieved by properly drawing from a wide spectrum of

practices, ranging from internal operations (i.e. activities performed within the boundaries of the company) to external operations related to inter-firm processes and relationships involving SC partners (Chen & Paulraj, 2004; Mentzer et al, 2001). Grounding on the basic PMS definition and acknowledging such a broader scope, we define an SCPMS as “a set of metrics used to quantify the efficiency and effectiveness of supply chain processes and relationships, spanning multiple organizational functions and multiple firms and enabling SC orchestration”.

This definition is the result of our consideration of both the PMS literature presented above and the SCPMS literature that will be presented in the article. We anticipate that such a definition will help to clarify the scope of the analysis for the literature review.

Given the level of complexity that an SCPMS might reach, it is worth splitting it into its different components, considering that a single firm might be willing to monitor only one portion of its supply chain (not necessarily the entire set of processes involving all the SC tiers). Indeed, while collecting the articles related to SCPMSs, we realized that the previous studies usually consider one component of the SCPMS at a time according to the internal or external scope of the SCPMS metrics. In particular, the *internal SCPMS* focuses on the monitoring and control of the processes that take place within the firm’s boundaries (the source–make–deliver sequence according to the SCOR model). This component is also referred to as the operational PMS and is widely addressed by the operations management (e.g. Neely et al, 1995; Bourne et al, 2003) and accounting literature (e.g. Franco Santos et al, 2012; Melnyk et al, 2014). Instead, the *external SCPMS* is intended to monitor and control the inter-firm processes and relationships and can be further decomposed into a *supplier PMS* as a “set of metrics measuring the efficiency and effectiveness of suppliers’ actions and the goodness of the relationship with them” (Hald & Ellegaard, 2011; Luzzini et al, 2014) and a *customer PMS* as a “set of metrics measuring the efficiency and effectiveness of customers’ actions and the goodness of the relationship with them”. Furthermore, an interesting insight gained from the literature review that is worth considering is that the vast majority of external SCPMS studies focus on the immediate supplier or customer rather than encompassing multiple SC tiers (e.g. a supplier’s



suppliers or a customer's customers). Though the concept of SC theoretically embeds an extensive perspective, the actual visibility beyond the first tier is very challenging because of, for example, technological barriers or relational inertia (Barratt & Oke, 2007; Barratt & Barratt, 2011). Nevertheless, synthetic information on critical performance from various SC tiers (avoiding information overload) could improve the alignment of the extended SC, thus achieving both single-firm and overall SC objectives (Maestrini & Luzzini, 2015). Therefore, multi-tier SCPMSs represent an evolution of first-tier supplier and customer PMSs, extending the measurement process to additional downstream or upstream actors (Chan & Qi, 2003).

Finally, some studies (e.g. Stefanović & Stefanović, 2011) and recent empirical evidence (Raj and Sharma, 2015; 2014; Cecere, 2014) suggest another type of SCPMS that does not fall into the aforementioned categories. In some industries (such as automotive, pharma and retail), we observe the diffusion of SCPMSs that are promoted by a focal company or an industry association as a shared tool to solve specific SC challenges. In these cases the SCPMS is usually developed as a web- or cloud-based solution by a third-party IT service provider for the benefit of all supply chain actors. The system enables a flexible *many-to-many* type of interaction, whereby it can be decided which type of information is shared and by whom. Thus, we define a *many-to-many* SCPMS as “a set of metrics used to quantify both the efficiency and the effectiveness of inter-firm processes shared by multiple buyers and multiple suppliers”. This situation represents an interesting avenue for further research, as it seems that the joint initiative at the industry level helps to overcome the lack of standard and typical technological barriers in buyer–supplier relationships.

Figure 1 highlights the various SCPMS components described so far. It also helps to summarize the scope of the literature review, which will be explained in depth in the methodology section. All in all, since an SCPMS appears as a multidimensional concept uncovering multiple elementary components, we consider diverse literature: in addition to the literature explicitly referring to SCPMSs, coherently with the previous explanation, we include other relevant streams of research (e.g. supplier performance evaluation, relationship performance evaluation and customer

relationship management) to provide a comprehensive assessment of the extant literature on any SCPMS component.

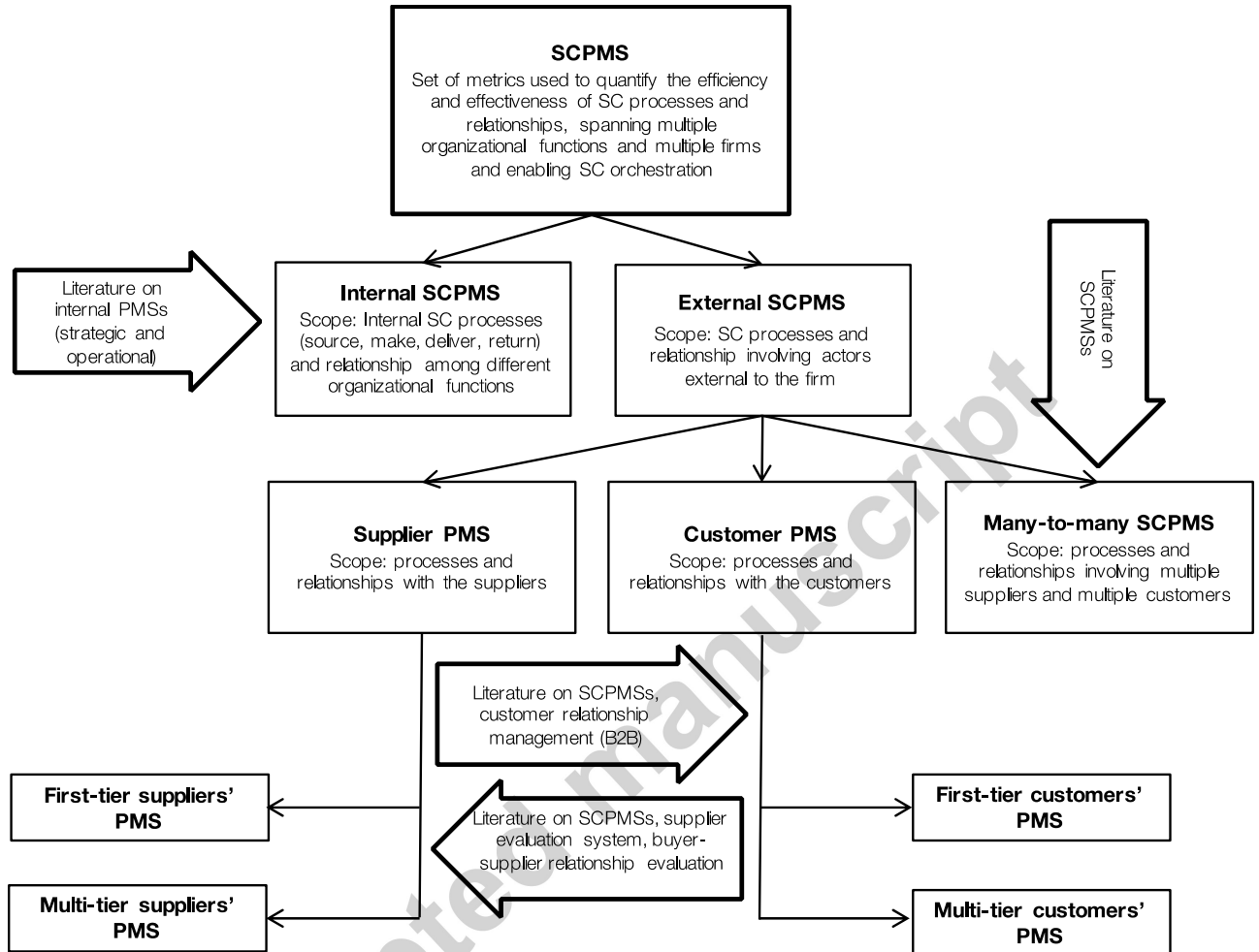


Figure 1: SCPMS definition and components

#### 4. Methodology

The methodology adopted to conduct the systematic literature review consisted of the following steps: (1) source identification; (2) source selection; (3) source evaluation; and (4) data analysis. We took this framework from some relevant references regarding literature review research (Hart, 1998; Bryman, 2012), which have been adopted in previous works and other similar studies in the operations management literature (Giunipero et al, 2008; Spina et al, 2013).

#### *4.1 Source identification*

We first performed a keyword-based search of the Scopus and ISI Web of Knowledge databases to collect articles published in selected peer-reviewed journals, employing keywords like “supply chain”, “performance measurement”, “metrics”, “inter-firm”, “network”, “supplier performance measurement”, “vendor rating” and “vendor evaluation system”. By choosing a large set of keywords, we tried to overcome the limitations of a keyword-based search in cases like this, in which worldwide and cross-disciplinary acknowledged definitions are lacking. Three researchers took care of the overall process, from keyword definition to article collection. Having agreed on the keywords, the three researchers performed the search independently by inserting keywords into the search field of Scopus and ISI Web of Knowledge. Afterwards, one researcher checked Google Scholar to maximize the number of available sources.

Due to the high number of keywords, the involvement of three researchers and the exploitation of three search engines, we increased the likelihood of capturing all the relevant contributions.

#### *4.2 Source selection*

The first fundamental step in the source selection phase consisted of setting the boundaries of the analysis. In line with the explanation provided in Section 3, we addressed papers dealing with at least one component of a SCPMS. We mostly focused on external SCPMSs, as our main goal was to tackle the challenges of inter-organizational performance measurement. It has to be said that several frameworks provided in literature (e.g. the SCOR model), actually include both metrics for internal SC operations (e.g. internal logistics, warehousing, production) and metrics crossing the boundaries of the firm within the source and delivery processes. Therefore, we also included some studies specifically referring to internal SCPMSs, in case they explicitly address supply chain processes or define useful frameworks that have been applied even beyond one single firm (e.g. Beamon 1999). As a result, we excluded articles belonging to the following categories, which were considered to be beyond the scope of our study:

- Articles dealing with internal PMSs, both strategic PMSs aimed at operationalizing the business strategy (e.g. Kaplan & Norton, 1996; Chenhall, 2005) and operational PMSs tackling specific functions of the organization (e.g. Bourne et al, 2000, 2003; Neely et al, 2000; Bititci et al, 2006). This literature stream lies at the intersection of operations management, accounting and strategic management. It precedes the SCPMS literature and is broad enough to deserve a separate literature review (see Franco-Santos et al, 2012; Melnyk et al, 2014). Still, we included articles explicitly reporting SCPMS frameworks, which eventually include the “internal SCPMS” (see Figure 1) as a dimension of a wider framework (e.g. the SCOR-based model or the supply chain balanced scorecard – SCBSC), thus highlighting the integration between external and internal SC activities. Furthermore, we included articles reporting the resource–output–flexibility framework, first introduced by Beamon (1999) and then also reported by Angerhofer and Angelides (2006) and Cai et al (2009). This framework focuses on the internal SC, thus configuring an internal SCPMS (see Table 5). However, it entails internal performance measures that are at the interface with the external SC and explicitly adopts the “SCPMS” label.
- Articles regarding the generic information sharing along the supply chain but not specifically dealing with the sharing of performance metrics (e.g. Zhou & Benton, 2007; Cai et al, 2009).
- Articles dealing with open book accounting (OBA) (e.g. Caglio & Ditillo, 2008; Free, 2008). These studies investigate the sharing of management accounting information (typically the cost structure) with the aim of improving decision making, but they do not tackle the process of external SC performance measurement and management.
- Articles dealing with SC sustainability assessment but not specifically considering the adoption of metrics and performance measurement frameworks in the evaluation process. Most contributions so far focus on auditing procedures and certification adoption procedures (Hamprrecht et al, 2005; Foerstl et al, 2010; Shaltegger & Burritt, 2014). Instead, articles dealing with sustainability SCPMSs (thus reporting metrics to quantify the sustainability

dimension of SC activities) were included.

- Articles developing algorithms or formulas for supplier selection (e.g. Huang & Keskar, 2007; Van der Rhee et al, 2009; Igarashi et al, 2013), as we are interested in the issue of measuring and managing performance with already-established SC partners. Some previous contributions instead investigate supplier qualification activities within the sourcing stage.

As a result, the literature review contains works published from 1998 to 2015. Van Hoek (1998) is probably the first author explicitly to raise the issue of measuring performance along the supply chain, and Beamon (1999) proposes one of the first SCPMS frameworks. Previous articles only focus on costing models for inter-firm activities (e.g. Cavinato, 1992; Ellram & Feitzinger, 1997). We included all peer-reviewed academic journals in English but excluded papers published in conference proceedings, resulting in a final sample of 92 peer-reviewed articles.

#### *4.3 Source evaluation*

The source evaluation consists of the classification of the papers selected according to critical dimensions of analysis. The classification dimensions should be defined either inductively or deductively, possibly with a clear connection with the existing theory (Spina et al, 2013). Thus, the first draft of the codebook for article classification was developed by including relevant dimensions used in previous studies on SCPMSs or related topics (deductive approach): in particular, we took into account the SCPMS taxonomies developed by Cuthbertson and Piotrowicz (2011) and Gopal and Thakkar (2012) as well as relevant literature reviews of SCM (Giunipero et al, 2008) and performance measurement (Bourne et al, 2003; Nudurupati et al, 2011; Bititci et al, 2012; Franco-Santos et al, 2012). The codebook was then revised and refined according to the inputs derived from the analysis of the collected papers (inductive approach). The final version of the codebook is described in the following table:

Table 2: Codebook for article evaluation

Topic	Items	Reference
Sources' recorded information	<ul style="list-style-type: none"> <li>• Authors' names</li> <li>• Year of publication</li> <li>• Title</li> <li>• Journal of publication</li> <li>• Journal domain</li> <li>• Journal relevance (Impact Factor, Scimago Journal Rank)</li> </ul>	Association of business School (2015)
Methodology and approach	<ul style="list-style-type: none"> <li>• Main research methodology adopted</li> <li>• Position in the research cycle (i.e. explorative, theory building, theory testing)</li> </ul>	Voss et al (2002)
SCPMS life cycle	<ul style="list-style-type: none"> <li>• SCPMS design: answering the questions of what to measure and how to select the limited set of metrics. Information on the unit of analysis of the measurement process, the performance dimensions to tackle, the specific metrics to adopt, the overall SCPMS framework and the way in which it is built is considered</li> <li>• SCPMS implementation: the procedures to follow to put the SCPMS in place</li> <li>• SCPMS use: actions stimulated by the measurement process</li> <li>• SCPMS review: the process of reviewing performance measures and targets</li> </ul>	Neely et al (1995); Bourne et al (2003, 2004); Henri (2006); Braz et al (2011)
SCPMS adoption consequences	<ul style="list-style-type: none"> <li>• The impact of SCPMSs on operational performance</li> <li>• The impact of (external) SCPMSs on relationship capabilities (e.g. collaboration, trust, commitment, etc.)</li> <li>• Barriers and criticalities of the adoption</li> </ul>	Micheli and Manzoni (2010); Franco-Santos et al (2012); Melnyk et al (2014)

The information included in the articles' records helps to define the literature boundaries in terms of research domains and time span. Methodological aspects are to be considered to assess the degree of empirical evidence and the maturity of the subject as a scientific research topic. Among the multitude of contents, the choice of highlighting the SCPMS life cycle elements and the outcomes from the system adoption is strongly aligned with the thematic development of the internal performance measurement and management literature. First, to describe PMSs properly (and SCPMSs are no exception), all the aspects within their design, implementation, use and review should be taken into account. Second, the link between the PMS adoption and the actual performance improvement follows a critical and tortuous path (see Micheli & Manzoni, 2010); taking into account all the possible consequences related to the measurement process is of primary importance to avoid criticalities and maximize outcomes.

#### 4.4 Data analysis

The last step of the systematic literature review entails data organization and discussion, aimed at capturing relevant information through a critical analysis process. The ultimate goal is to synthesize a limited set of key messages from the study while highlighting underdeveloped topics, which deserve further attention from the scientific community. We performed our analysis using a Microsoft Excel data set, allowing the identification of quantitative trends and incidence analysis of the codebook items, as well as qualitative considerations of the research outcomes.

### 5. Findings

In this section, we report the main results from the analysis of the article sample. In the first section, we report the articles' distribution in terms of journals and disciplines, cumulatively and over time. In the second section, we review the research methods and approaches adopted (theoretical vs empirical). In the third and fourth sections, we discuss the specific content of the articles in terms of the SCPMS life cycle (i.e. design, implementation, use and review), distinguishing between the vast majority of the articles, which focus on the first phase (i.e. design), and the rest, which partially tackle the remaining phases.

#### 5.1 Source description

The final sample consists of 92 articles from 40 different journals. Table 3 reports the article distribution in each journal, highlighting the journal disciplinary area as defined by the *ABS Journal Guide* (2015) and the related impact factor (IF). When the impact factor was not present, we referred to the Scimago Journal Rank (SJR). Figure 2 reports the reviewed article distribution over time. Different colours within each column identify the sources' disciplinary area, as in Table 3.

The majority of the articles (72 out of 92) belong to the operations management domain, followed by information management (9 out of 92), mainly focusing on the ICT infrastructure supporting the SCPMS. Only 1 article belongs to the accounting literature, which contains plenty of

contributions on internal PMSs (Franco Santos et al, 2012) but seems to neglect the inter-organizational nature of SCPMSs. Interestingly, in the last five years, it seems that the growing attention to corporate social responsibility and sustainability management has been influencing the SCPMS research, which recognizes the importance of sustainable SCPMSs (see Beske-Janssen et al, 2015 for a comprehensive review). Looking at the longitudinal distribution of the articles, a certain degree of interest followed the first seminal articles in the early 2000s. The peak in 2011 might be a consequence of the 2008–2009 economic crisis, which emphasized the vulnerability of supply chains and the need for control. In the upcoming years, we foresee another peak resulting from the opportunities provided by the new technologies applicable to SCPMSs (such the Internet of Things, big data, cloud platforms and SC analytics).

## 5.2 Methodology

Almost half of the articles in the sample (41 out of 92) are theoretical studies (see Table 4): they either provide a conceptual framework for measuring SC performance (e.g. Beamon, 1999; Gunasekaran et al, 2001) or conduct a literature review (e.g. Gunasekaran & Kobu, 2007; Gopal & Thakkar, 2012). Among the empirical works, the most adopted methodologies are case studies (55%) and surveys (37%). While some case-based studies follow the theory-building paradigm (e.g. Holmberg, 2000; Luzzini et al, 2014), most of them are illustrative or refine an existing theory (e.g. Agarwal et al, 2006; Angerhofer & Angelides, 2006), which results in a context-specific test for a given SCPMS framework. On the other hand, surveys are often exploratory, providing insights into what is measured and to what extent (e.g. Kannan & Tan, 2002; Gunasekaran et al, 2004). Instead, 10 survey-based studies display a theory-testing approach (e.g. Carr & Pearson, 1999; Cousins et al, 2008).



Table 3: References by journal

Area	Journal	ABS	IF (SJR)	#	References
<b>Operations Technology and Management</b>	<i>Journal of Operations Management</i>	4*	3.82	2	[15] [71]
	<i>International Journal of Operations and Production Management</i>	4	1.74	7	[6] [25] [40] [41] [61] [62] [79]
	<i>Journal of Supply Chain Management</i>	3	3.86	5	[63] [70] [85] [88] [48]
	<i>Supply Chain Management: An International Journal</i>	3	3.5	6	[16] [34] [46] [49] [59] [90]
	<i>International Journal of Production Economics</i>	3	2.75	5	[30] [32] [39] [42] [46]
	<i>International Journal of Production Research</i>	3	1.48	6	[3] [13] [38] [58] [77] [92]
	<i>Production Planning and Control</i>	3	1.47	6	[9] [10] [27] [44] [47] [64]
	<i>IEEE Transactions on Engineering and Management</i>	3	1.1	1	[72]
	<i>Journal of Purchasing and Supply Management</i>	2	2.33	2	[56] [65]
	<i>Journal of Business Logistics</i>	2	1.83	1	[11]
	<i>International Journal of Physical Distribution and Logistics</i>	2	1.8	4	[5] [45] [83] [89]
	<i>Computers and Industrial Engineering</i>	2	1.78	3	[8] [19] [23]
	<i>Journal of Intelligent Manufacturing</i>	1	1.73	1	[51]
	<i>International Journal of Logistics Management</i>	1	0.95	2	[53] [60]
	<i>Integrated Manufacturing System</i>	1	(0.71)	1	[20]
	<i>Benchmarking: An International Journal</i>	1	(0.6)	8	[22] [43] [73] [74] [80] [82] [84] [87]
	<i>Business Process Management Journal</i>	1	(0.59)	1	[21]
	<i>International Journal of Productivity and Performance Management</i>	1	(0.58)	4	[12] [26] [81] [35]
<i>International Journal of Business Performance Management</i>	1	(0.2)	1	[18]	
<i>International Journal of Supply Chain Management</i>	NA	NA	2	[33] [91]	
<b>Operations Research and Management Science</b>	<i>European Journal of Operational Research</i>	4	2.36	3	[1] [28] [68]
	<i>Operations Research and Management Science</i>	3	0.95	1	[50]
<b>Information Management</b>	<i>Decision Support Systems</i>	3	2.3	2	[4] [14]
	<i>Expert Systems with Applications</i>	3	2.24	1	[66]
	<i>European Journal of Information Systems</i>	3	(2.2)	1	[69]
	<i>Computers in Industry</i>	3	(1.29)	1	[7]
	<i>Industrial Management and Data Systems</i>	2	1.23	1	[37]
	<i>Applied Mathematical Modelling</i>	NA	2.3	1	[78]
	<i>Software Quality Journal</i>	NA	0.85	1	[55]
	<i>Computer Science and Information Systems</i>	NA	0.47	1	[86]
<b>Sustainability<sup>2</sup></b>	<i>Journal of Cleaner Production</i>	NA	3.84	2	[2] [36]
	<i>Resources, Conservation and Recycling</i>	NA	2.56	1	[67]
	<i>Clean Technologies and Environmental Policy</i>	NA	1.9	1	[24]
<b>General Management</b>	<i>MIT Sloan Management Review</i>	3	0.97	1	[31]
	<i>Management Decision</i>	2	1.42	2	[17] [75]
<b>Economics, Econometrics and Statistics</b>	<i>Ecological Economics</i>	3	2.72	2	[29] [54]
<b>Accounting</b>	<i>Management Accounting Research</i>	3	2.13	1	[57]
<b>Sector Study</b>	<i>Transportation Research Part E: Logistics and Transportation Review</i>	3	2.68	1	[52]

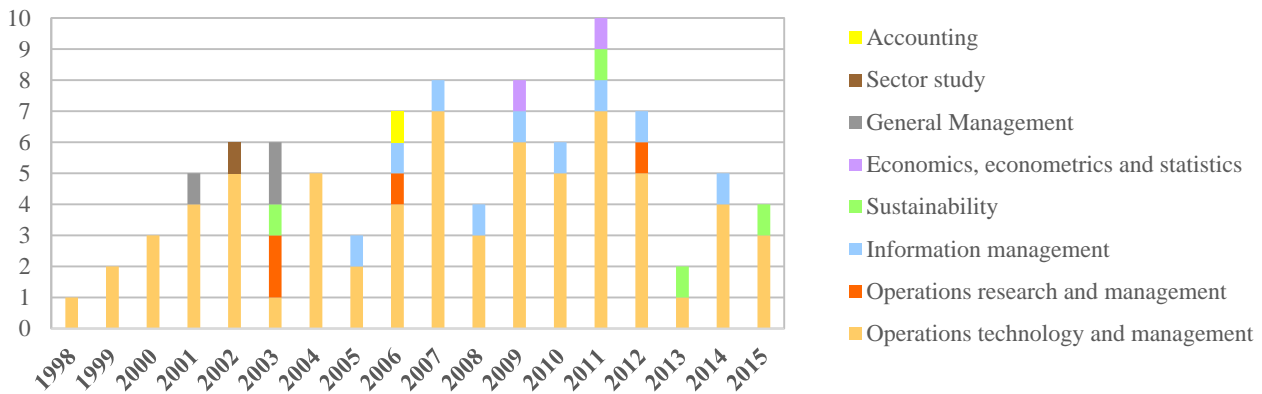


Figure 2: Temporal distribution of the articles

Table 4: Sample articles' methodology distribution

	Conceptual	Literature review	Modelling	Case study (single)	Case study (multiple)	Survey	Action research	Total
<b>Theoretical</b>	[2] [5] [6] [11] [13] [16] [20] [17] [21] [24] [28] [30] [34] [36-38] [43] [46] [49] [50] [53] [54] [60] [62] [64] [68] [72] [80] [84] [86] [88] [92]	[3] [18] [26] [35] [38] [81]	[1] [19] [32]					<b>41</b>
<b>Empirical</b>								<b>51</b>
<i>Exploratory/theory building</i>				[44] [45] [61] [79] [82] [90]	[8] [41] [56] [69] [75] [76] [87]	[9] [22] [39] [48] [65] [67] [74] [85] [89]	[10] [12] [31]	25
<i>Illustrative/refinement</i>				[4] [7] [14] [23] [29] [42] [47] [51] [55] [59] [63] [78] [91]	[27] [73]		[77]	16
<i>Theory testing</i>						[15] [25] [33] [52] [57] [58] [66] [70] [71] [83]		10
<b>Total</b>	32	6	3	19	9	19	4	<b>92</b>

### 5.3 The SCPMS life cycle: Prevalence of the design phase

To discuss the specific content of the SCPMS literature, we adopt a life cycle perspective, as we found that the articles in the sample are clearly distributed according to the different life cycle phases (i.e. design, implementation, use and review; see also Figure 3).

We first acknowledge that most contributions focus on the SCPMS design, thus addressing the process of metric selection and classification into specific performance dimensions. In particular, 62 out of the 92 articles (67% of the final sample) develop or adopt an SCPMS framework. Table 5 summarizes the frameworks recurring most often in the literature, along with an indication of the types of metrics adopted and the SCPMS component tackled. Concerning the metrics, most frameworks entail both financial and non-financial as well as both quantitative and qualitative metrics. In this respect, a consistent stream of literature addresses the process of metric selection, proposing the application of mathematical algorithms and techniques like the analytic hierarchy process (AHP) and derivatives (e.g. fuzzy AHP). Appendix A reports the techniques referred to most often along with a brief description.

Among the studies focusing on the SCPMS design, a broad stream of literature focuses on the supplier PMS component (see Figure 1), referring to the supplier evaluation and assessment (e.g. Kannan & Tan, 2002; Hald & Ellegaard, 2011; Luzzini et al, 2014). Most supplier PMSs propose a balanced approach (Simpson et al, 2002), with metrics covering: (1) quality performance of the product/service exchanged; (2) delivery performance (e.g. punctuality, timeliness and lead time) of the SC processes; (3) supplier capabilities in terms of financial stability, innovative potential and sustainability effort; and (4) relationship characteristics, such as collaboration, commitment and trust. Several contributions specifically tackle this last dimension, investigating how to assess the relationship goodness (e.g. Giannakis, 2007; Kim et al, 2010; Ramanathan et al, 2011).

Another parallel and promising stream of literature investigates the sustainability performance measurement and management along the SC. The proposed systems generally rely on existing frameworks, such as the SC balanced scorecard (SCBSC) (e.g. Bhattacharya et al, 2014) or the process-based SCPMS (e.g. Hassini et al, 2012), but add the sustainability dimension. While most literature on sustainability assessment focuses on ad hoc auditing practices and certification (Beske-Janssen et al, 2015), including the sustainability dimension in a broader SCPMS can allow for systematic and routine SC sustainability management.

Table 5: SCPMS frameworks

Description	Metric type				SCPMS component				References
	Financial	Non-financial	Qualitative	Quantitative	Internal	Supplier PMS	Customer PMS	Multi-tier	
<p><b>Supply chain balanced scorecard (SCBSC)</b></p> <p>The well-known four dimensions of the BSC developed by Kaplan and Norton (1992) (i.e. finance, customer, internal business process, learning and growth) are shaped according to the SCM scope, by considering:</p> <ul style="list-style-type: none"> <li>• SCM goals</li> <li>• End-customer benefit</li> <li>• Financial benefit</li> <li>• SCM improvement</li> </ul> <p>The idea behind the SCBSC is to design an SC strategy coherent with the business strategy, including critical success factors within the four performance dimensions above.</p>	•	•	•	•	•	•			[5] [8] [9] [11–13] [22] [44] [50] [69] [78] [79] [86]
<p><b>SCOR-based</b></p> <p>The supply chain operations reference (SCOR) model developed by the Supply Chain Council (SCC) in 1996 is an important reference for both researchers and practitioners in the area of SCM. An SCOR-based SCPMS provides a balanced set of performance measures: cycle time metrics, cost metrics, service quality metrics and asset metrics. These metrics are then grouped according to the five distinctive management processes, namely plan, source, make, deliver and return. In some cases metrics are also classified according to their strategic, tactical or operational nature. This framework aims to link the internal SC (make) with the external upstream (source), downstream (deliver) and return (reverse) SC.</p>		•	•	•	•	•			[7] [16] [23] [28] [32] [33] [37] [39] [40] [45] [46] [51] [52] [61] [64] [66] [77] [87] [91]
<p><b>Resource output flexibility</b></p> <p>This framework is based on the seminal work of Beamon (1999). Three performance areas are considered:</p> <ul style="list-style-type: none"> <li>• Resources: various dimensions of cost are monitored (e.g. distribution cost, manufacturing cost) with the purpose of fostering efficiency</li> <li>• Output: various dimensions of customer service are reported</li> <li>• Flexibility: it measures the ability to respond to a changing environment</li> </ul> <p>This framework is thought to assess the SCM capabilities of a specific firm and keeps a mainly internal perspective.</p>	•	•	•	•	•				[4] [6] [14]
<p><b>Process-based</b></p> <p>The unit of analysis is the supply chain process: demand management, order fulfilment, manufacturing flow management, procurement, demand forecasting and so on. Quantitative and qualitative performance measures to assess the efficiency and effectiveness of each supply chain process are proposed. These processes entail activities performed by different actors and thus include multiple firms in the evaluation process.</p>		•	•	•	•	•	•		[20] [17] [53] [54] [59] [67]

#### 5.4 The SCPMS life cycle: Following the design phase

The extant literature provides numerous frameworks to which practitioners could refer when designing an SCPMS. However, a proper SCPMS design (i.e. measuring the right things) is not enough to guarantee successful adoption. Studies on the internal PMS show how failures could occur due to poor implementation (Bourne et al, 2000, 2003), inappropriate use (Henri, 2006; Micheli & Manzoni, 2010) or a lack of review (Braz et al, 2011). Considering external SCPMSs, in which the scope of the measurement process crosses company boundaries to involve external SC partners, the previous phases are further complicated.

In the implementation phase, the support of a reliable management information system becomes critical due to the need for interaction with external SC partners for data collection (Agarwal et al, 2006; Kocaoğlu et al, 2011) and for performance measure reporting (Bhagwat & Sharma, 2007; Hofmann & Locker, 2009). Indeed, SCMPMSs need to integrate data from different sources (e.g. different firms' information systems), and this might pose several challenges, including reluctance to share sensitive information, standardization of different data codification protocols and data reliability (Gulledge & Chavusholu, 2008).

Next, the way in which the external SCPMS is used strongly affects the relationship management process with external SC partners, and it is likely to affect the enhancement of both relationship capabilities (e.g. trust, commitment and collaboration) and operational performance (Holmberg, 2000; Wickramatillake et al, 2007).

Authors widely discuss the outcomes of implementing and using SCPMSs. The reported benefits include: (1) support for the implementation of the SC strategy (Gunasekaran et al, 2004; Bhagwat & Sharma, 2009); (2) empowerment of decision-making capabilities by focusing on metrics that really matter, avoiding information overloading (Kocaoğlu et al, 2011); (3) a higher level of control over strategy and strategy communication to other organizational functions and external partners (Chae, 2009); and (4) the possibility to implement continuous improvement programmes (van Hoek et al, 2001; Mondragon et al, 2011). However, most studies addressing these aspects lack empirical

validation: the SCPMS outcomes are either discussed theoretically (e.g. Van Hoek, 1998; Beamon, 1999; Brewer & Speh, 2000) or investigated by means of context-specific implementation of a particular SCPMS framework (e.g. Holmberg, 2000; Wickramatillake et al, 2007; Hofmann & Locker, 2009). The same can be said with regard to implementation barriers and criticalities: the most frequently cited (data availability, high investments related to the SCPMS and supply chain complexity; e.g. Bhagwat & Sharma, 2007) are theoretically formulated but not empirically investigated. In Appendix B the relevant empirical papers dealing with the consequences of SC (and more specifically supplier) performance measurement and management are discussed.

Finally, the system review is essential to keep a clear, robust and up-to-date alignment between the SCPMS and the underlying SC strategy. The reactivity to intercept both endogenous factors (e.g. changes in the corporate strategy) and exogenous factors (events occurring to external supply chain partners or the industry as a whole) is critical to guide the SCPMS review. To the best of our knowledge, no existing contributions tackle this issue directly.

Focusing on supplier PMSs, a promising stream of research deals with the performance and behavioural implications of the measurement process in buyer–supplier relationships. Addressing buyer companies, Mahama (2006) and Cousins et al (2008) investigate the key role of the socialization mechanism in mediating the relationship between the supplier PMS and the performance outcomes. Prahinski and Benton (2004) explore how suppliers perceive the supplier PMS adopted by the buyer and how this in turn affects the suppliers' performance. Prahinski and Fan (2007) study how the content and frequency of communication influence suppliers' commitment to changing their behaviour. Purdy and Safayeni (2000) explore suppliers' perceptions of the reliability and appropriateness of the buyers' evaluation process, leading to three important conclusions: (1) most suppliers feel that their effectiveness is not accurately reflected in the evaluation; (2) the data collected are not properly utilized in the measurement process; and (3) the rating achieved is more a question of bargaining power than the result of an objective evaluation. Hald and Ellegaard (2011) finally examine how the performance information exchange between the

evaluating buyer and the evaluated supplier is shaped and reshaped during the evaluation process. Similarly to the internal PMS literature, this stream of research unveils a complex link between the supplier PMS adoption and the actual performance improvement. In particular, two key messages can be highlighted: (i) previous studies suggest a certain misalignment of opinions between the evaluator (buyer company) and the evaluated (supplier company); and (ii) the empirical evidence shows that investing in relationship capabilities like socialization mechanisms and mutual commitment is necessary to achieve the expected outcomes of the measurement process.

## 6. Discussion

The present effort to review the literature on SCPMSs reveals a large and highly heterogeneous literature in terms of labels, sources and contents. Nevertheless, the subject is still of interest for both scholars and practitioners. Melnyk et al (2014) review the future trends of performance measurement and refer to the increasing importance of the supply chain as a major opportunity for the discipline. Similarly, Bititci et al (2012) refer to performance measurement in networks as an important challenge to address. Finally, Franco-Santos et al (2012) encourage further research on the impact of external SCPMSs on inter-firm performance. SCPMSs are indeed a highly debated topic among practitioners. As an example, the Supply Chain Council (one of the most important global non-profit organizations dealing with SCM and the sponsor of the SCOR framework) delivers a report about supply chain metrics annually.

This discussion section is organized as follows. The first paragraph presents the current state of advancement of the scientific literature, along with the relevant themes to take into account and favourable trends for the development of mature SCPMSs. This sets the ground for the research agenda presented in the second paragraph.

### 6.1 *What is now for SCPMSs?*

An important result of our study is the identification of two main dimensions that could be

applied to rationalize the diverse contributions with the aim of defining the current state of advancement of the scientific research on the topic. The first dimension is the SCPMS component, indicating the scope of the measurement process (see Figure 1): internal systems target the source–make–deliver processes performed by a single company, while external systems target supply chain processes that involve suppliers and customers. The latter case could be further complicated when multiple tiers are considered, extending beyond the buyer–supplier dyad and configuring a multi-tier SCPMS. The greatest degree of complexity is reached when considering many-to-many SCPMSs, in which multiple actors on different tiers of the supply chain can participate in the system. The second dimension that we applied in the article content analysis (see Table 2) is the SCPMS life cycle, indicating the stage of the system development that is under scrutiny (i.e. design, implementation, use and review). By combining these two dimensions, we can summarize the state of the art of the SCPMS literature (see Figure 3) and discuss the ways ahead.

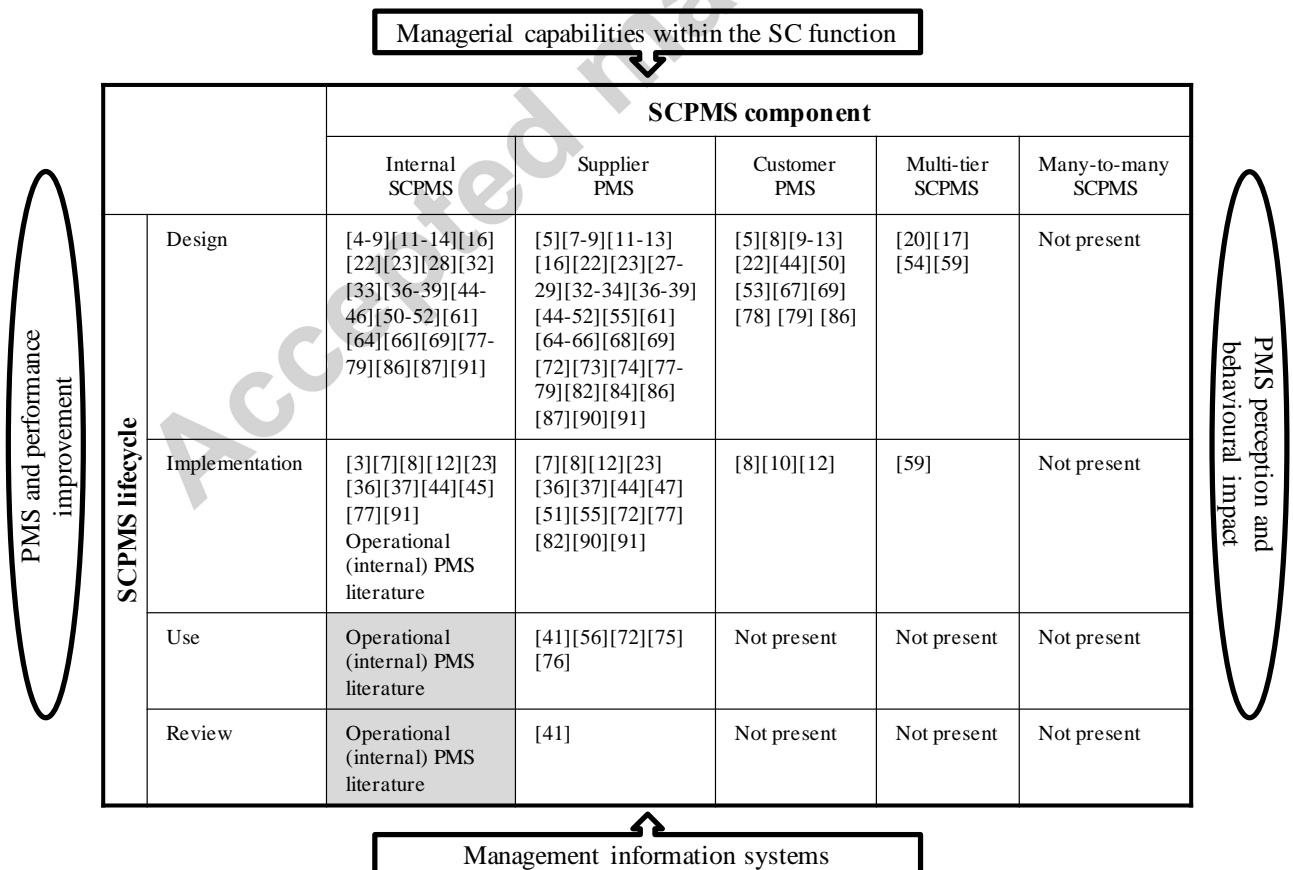


Figure 3: Current state of advancement of the SCPMS literature



Internal SCPMSs (like the resource–output–flexibility framework of Beamon, 1999) stay within the company boundaries. Therefore, the activities involved in the implementation, use and review phases do not differ from those of traditional internal PMSs. Since the 1990s a large body of literature has been developed on the internal PMS life cycle (Neely, 1999), which is beyond the scope of this literature review (see Franco-Santos et al, 2012 for a recent review). To propose a research agenda for the future, we focus our attention on external SCPMSs.

Among the external SCPMS components (see Figure 1), supplier PMSs receive most of the attention: the system design (usually referred to as vendor rating or vendor evaluation) is widely studied; more recent literature is starting to cover the other phases of the life cycle, passing from supplier performance measurement to performance management (Choong, 2013; Gutierrez et al, 2015). However, considering the strategic relevance of supplier PMSs to firms, this area still offers several gaps to be addressed.

Customer PMSs are embedded in the SCBSC framework (see Table 5); therefore, some metrics addressing customers' performance can be found in the extant literature. However, no contribution specifically tackles this component, analysing how the customer service/sales function of the supplier firm uses this kind of information for customer relationship management.

Multi-tier SCPMSs respond to an extended visibility logic, which is embedded in the general SC concept. Though some conceptual process-based external SCPMSs spanning multiple tiers (at least three) of a single SC have been proposed, empirical evidence is still lacking on their applicability, potential diffusion and usefulness.

Finally, a totally unexplored area is many-to-many SCPMSs. They can be considered as new-generation SCPMSs, which have never been empirically investigated by the scientific literature so far but are becoming a reality (Raj and Sharma, 2014; Cecere, 2014). We refer to systems adopted at the industry level, which enable the sharing of standardized metrics regarding supply chain processes or relationships among several players. Usually, in these cases a third-party software company develops and owns the SCPMS and distributes information to all the interested parties.

This is an alternative configuration with respect to the classical paradigm of a supply chain orchestrator monitoring his external partners. Thanks to the role of industry or supply chain associations as well as technological innovations enabling cheaper and more effective integration, many-to-many SCPMSs are likely to develop in the near future.

In addition to the SCPMS components and life cycle phases, we found some recurrent topics in the literature on performance measurement and management that might be relevant to SCPMS research (see the ellipses on the left and right sides of Figure 3):

- *PMS and performance improvement.* The literature on internal PMSs historically unveils a tortuous path between system adoption and actual performance improvement (Neely, 2005; Melnyk et al, 2014). Apart from valuable exceptions (Mahama, 2006; Cousins et al, 2008), little empirical evidence exists about the actual impact of external SCPMSs on SC performance. In exploring this link, it would be important to understand which stages of the SCPMS life cycle have a positive/negative effect on performance as well as the intervening mechanisms displayed by relationship-specific or contextual variable issues.
- *PMS perception and behavioural impact.* Considering external SCPMSs, the literature tends to separate the perspective of the buyer firm (e.g. Mahama, 2006; Cousins et al, 2008) from that of the supplier (e.g. Prahinski & Benton, 2004; Prahinsky & Fan, 2007). As a matter of fact, the different actors involved in an SCPMS could have different perceptions and experience different results (Purdy & Safayeni, 2000; Hald & Ellegaard, 2011). Therefore, expanding the unit of analysis from the single company to the buyer-supplier dyad (or even the network) can provide new insights into possible misfits in perceptions and relative behaviours. This implies the methodological challenge of conducting data collection on different SC tiers (Giunipero et al, 2008).

Finally, we identified two major trends in the current business environment that can favour the development of mature external SCPMSs (top and bottom of Figure 3), thus stimulating further research on the topic:

- *Management information systems.* One of the main reasons why SCPMSs are being revamped these days is the availability of technological solutions that enable more efficient and effective adoption. Basic technologies, such as RFID or the more advanced Internet of Things, allow quick and reliable collection of data; big data and powerful business intelligence analytics enable more robust data analysis and performance calculation; and, finally, performance communication can be easily managed through web-based or cloud-based platforms, which are able to interface with traditional ERP systems. The role of information and communication (ICT) technology is of primary importance to configure and implement any PMSs and external SCPMSs in particular (Nudurupati et al, 2011).
- *Managerial capabilities within the SC function.* Supply chain managers are required to process large amounts of data, to decide how (and to what extent) to share information with third parties and to interact with a growing number of stakeholders, internal and external to the company (Lorentz et al, 2013; Dotson et al, 2015). All these activities suggest new and different skills from “traditional” trading relationships. Along with increasing managerial capabilities within this department, more formalized strategies are being developed, which are likely to be executed by means of PMSs. Therefore, the measurement culture is increasingly diffusing within the supply chain functions of modern organizations, thus stimulating the adoption of mature SCPMSs.

## 6.2 What is next for SCPMSs?

The discussion so far has allowed us to uncover several areas that need further attention. To provide scholars with synthetic and practical recommendations for future research, in Table 6 we

summarize some of the most relevant topics and related research questions that should be addressed. Referring to the different SCPMS components (see Figure 1), we distinguish two main trajectories for research. On the one hand, more theory-testing research is needed, especially on the most consolidated subjects in the literature as well as the most diffused SCPMS components (i.e. supplier PMSs). On the other hand, more theory-building research is needed on the most emergent and under-investigated topics and SCPMS components (multi-tier SCPMS, many-to-many SCPMSs and customer PMSs).

Accepted manuscript

Table 6: Research agenda on SCPMSs

Open issues regarding the SCPMS components	Method	Approach	Units of analysis	Possible research questions
<p><b>Supplier PMSs</b></p> <p>Outcomes and antecedents of mature supplier PMS adoption.</p> <p>The supplier PMSs' maturity depends on:</p> <ul style="list-style-type: none"> <li>• Design phase: a comprehensive set of metrics (Kannan &amp; Tan, 2002); inter- and intra-firm collaboration (Luzzini et al, 2014)</li> <li>• Implementation and review phase: reliability of data collection and performance calculation (Bourne et al, 2003); frequency and formality of the reporting; systematic review of metrics and targets (Braz et al, 2011)</li> <li>• Use phase: diagnostic vs interactive use (Henri, 2006)</li> </ul>	Survey	Theory testing	Buying firm Dyads	<ul style="list-style-type: none"> <li>• What is the impact of supplier PMSs on performance? Possible focus: supplier performance; relationship performance (social capital, trust, commitment, supplier integration); operational performance; business performance</li> <li>• What are the antecedents of the supplier PMS adoption? Possible focus: internal PMS maturity (Chenhall, 2005); strategic purchasing and purchasing status (Hartmann et al, 2012; Luzzini &amp; Ronchi, 2016); environmental uncertainty (Wong et al, 2011); SC governance (Blome et al, 2013)</li> <li>• What are the consequences of a fit/misfit between the supplier and the customer perception about the SCPMS?</li> </ul>
<p><b>Customer PMSs</b></p> <ul style="list-style-type: none"> <li>• Customer SCPMS life cycle: design, implementation, use, review</li> <li>• ICT infrastructure</li> <li>• Impact on the buyer–supplier relationship</li> </ul>	Case study	Theory building	Supplier firm Dyads	<ul style="list-style-type: none"> <li>• How can a customer PMS be adopted? What are the barriers and enablers?</li> <li>• How does the customer PMS influence the buyer–supplier relationship?</li> </ul>
<p><b>Multi-tier SCPMSs</b></p> <ul style="list-style-type: none"> <li>• Extended SCPMS life cycle: design, implementation, use, review</li> <li>• ICT infrastructure</li> <li>• Impact on extended SC relationships</li> </ul>	Case study	Theory building	Buying firm Dyads Supply chain	<ul style="list-style-type: none"> <li>• How can a multi-tier SCPMS be adopted? What are the barriers and enablers?</li> <li>• How is supply chain visibility ensured through the adoption of a multi-tier SCPMS?</li> <li>• What are the benefits and criticalities related to the adoption of a multi-tier SCPMS?</li> </ul>
<p><b>Many-to-many SCPMSs</b></p> <ul style="list-style-type: none"> <li>• ICT system infrastructure</li> <li>• Scope: single supply chain process vs multiple supply chain processes</li> <li>• Roles and attitudes of different supply chain tiers on the platform</li> <li>• Impact on supply network relationships: companies on different tiers; companies within the same tier</li> </ul>	Case study	Theory building	Supply network (many-to-many)	<ul style="list-style-type: none"> <li>• How can many-to-many SCPMSs be adopted? What are the barriers and enablers?</li> <li>• How do different SC actors participating in many-to-many SCPMSs behave?</li> <li>• How do many-to-many SCPMSs enable the collaboration among SC partners?</li> <li>• How do many-to-many SCPMSs change the way in which a firm measures its external SC performance?</li> </ul>

## 7. Conclusions

The present research is grounded on three main questions, implicitly presented in the title: (1) What does SCPMS mean? (2) What is currently known (in the scientific literature) about SCPMSs? (3) What will come next (in the scientific literature) regarding SCPMSs? Throughout the paper we managed to provide answers to the previous questions. First, a clarifying explanation of the broad subject of SCPMSs was provided (see Figure 1) by decomposing them into internal and external dimensions, which were subsequently divided into supplier and customer PMSs (single and multi-tier). Many-to-many SCPMSs were identified as a third possible configuration, with a set of metrics shared by customers and suppliers at the industry level. Second, the results of an extensive systematic scientific literature review were disentangled according to two key dimensions of analysis – the SCPMS component and the SCPMS life cycle element – thus presenting the current state of advancement of the scientific research (see Figure 3). Third, the relevant gaps were identified and a scientific agenda for future research was proposed (see Table 6).

The present study offers fruitful suggestions to overcome some of the inherent limitations of the literature. Specifically, we limited our analysis to the dimensions included in the codebook, thus inevitably leaving aside other elements: for example, we eventually did not provide a taxonomy of metrics (see Sheperd & Günter, 2006). Besides, we only considered academic peer-reviewed journal articles, ignoring a large set of publications, such as practitioners' reports or conference and white papers. Professional magazines and reports (e.g. the reports of the Supply Chain Council) could be considered in future studies to propose a comparison between managers' and scholars' perspectives, thus addressing the considerable amount of practitioner publications on the subject. Finally, for the sake of clarity, we decomposed SCPMSs into internal and external components and then strongly focused on the latter when proposing the research agenda for the future. It must be underlined that the various components of an SCPMS, though addressing diverse units of analysis, should not be considered as independent silos. Satisfying the customer with an appropriate combination of price and offer is a fundamental tenet of strategy for all companies and can be

achieved only through increasing integration with the make and source processes. Therefore, the customer strategy should be aligned with the operational and supply chain strategy; as a consequence, the internal and external SCPMSs should be coherent. Future studies could address this issue, studying the relationship between the diverse components of an SCPMS as well as with the strategic PMSs put in place at the corporate level.

We believe that this study is relevant for both performance measurement and supply chain management scholars, SCPMSs being at the crossroads of the two areas. First, the explanation provided helps to shed light on the topic, as the comprehensive label SCPMS was broken down into its components and relevant definitions were provided, with the aim of having a positive effect on the homogeneity of future studies on the topic thanks to the clarification of the labels adopted. Second, the systematic review of the extant literature helps to provide a cross-domain picture of the SCPMS research, clarifying the as-is situation of academic research on the topic. Thirdly, the research agenda at the end lists clear streams for scholars to follow, outlining two main challenges. On the one hand, empirical testing is needed regarding the antecedents, outcomes and contextual variables related to the adoption of consolidated external SCPMSs, like supplier PMSs. On the other hand, new exploratory, theory-building research could address largely unexplored areas, such as customer PMSs, multi-tier supplier PMSs and many-to-many SCPMSs.

Although this study is primarily oriented towards an academic audience, it may also be interesting and useful for practitioners, who will be able to obtain an understanding of the focus of the extant research and gain access to the most representative frameworks proposed (see Table 3).

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## Appendix A – Methods for metric selection (SCPMS design phase)

Technique	Description	References
Analytic hierarchy process (AHP)	<p>A framework for structuring a decision problem, for representing and quantifying its elements, for relating those elements to the overall goals and for evaluating alternative solutions by pairwise comparison. It has been used several times to help decision makers in KPI selection.</p> <p>We refer to fuzzy AHP when the AHP is performed in a fuzzy environment.</p>	[7] [9] [14] [23] [28] [47] [51] [55] [64] [77]
Questionnaires	<p>A method consisting of a series of questions with the purpose of gathering information from different respondents and making a proper synthesis to guide decision making.</p>	[44] [52] [91]
Analytic network process (ANP)	<p>The ANP is a more general form of the AHP used in multi-criteria decision analysis. The AHP structures a decision problem into a hierarchy with a goal, decision criteria and alternatives; on the other hand, the ANP structures the decision problem as a network of possibilities. Like the AHP, it is developed through a system of pairwise comparisons to measure the weights of the components of the structure and finally to rank the alternatives in the decision.</p> <p>We refer to fuzzy ANP when the ANP is performed in a fuzzy environment.</p>	[1] [10] [29]
Technique for order preference by similarity to ideal solution (TOPSIS)	<p>The TOPSIS method is used for normalization and final ranking. It can be applied to compensate for the imprecise ranking of the AHP.</p>	[36] [51]

## Appendix B – Papers on supplier PMS adoption outcomes

Article	Scope	Method/ approach	Main topic of the study	Main findings
<b>Carr and Pearson (1999)</b>	Supplier PMS: formality and maturity of the system implemented	Survey – theory testing	Antecedents and outcomes of supplier evaluation systems	Having a strategic purchasing function is positively related to the adoption of supplier performance measurement systems. Their use is positively related to the quality of buyer–supplier relationships, which in turns results in major financial performance of the firm.
<b>Prahinsky and Benton (2004)</b>	Supplier PMS: communication strategy	Survey – theory testing The survey is addressed to suppliers	Impact of various communication strategies (indirect influence strategy, formality, feedback) on buyer–supplier relationships and suppliers' performance	The supplier PMS communication process does not ensure improved supplier performance unless the supplier is committed to the buying firm. Buying firms can influence the supplier's commitment through increased efforts of cooperation and commitment.
<b>Mahama (2006)</b>	Supplier PMS: non-financial and financial measures – socialization processes	Survey – theory testing	Impact of supplier PMS and socialization processes on cooperation and relationship performance	Positive association between PMS and relationship performance. Results indicate that socialization processes are indirectly related to performance.
<b>Prahinski and Fan (2007)</b>	Supplier PMS: evaluation content, frequency and communication quality	Survey – theory testing	Suppliers' perception of the buying organization's evaluation content, frequency and communication quality in suppliers' performance	The evaluation content is positively related to the communication quality and to the supplier's commitment to the buying organization. The supplier's commitment was found to mediate the linkage between communication quality and supplier's performance.
<b>Cousins et al (2008)</b>	Supplier PMS: operational measures and communication measures	Survey – theory testing	Examination of the impact of supplier PMS on the enhancement of business performance	Measuring the performance of the suppliers is not enough to improve business performance. The mediating role of the socialization mechanism is tested.
<b>Hald and Ellegaard (2011)</b>	Supplier PMS: the process of shaping and reshaping of supplier performance	Multiple longitudinal case studies – theory building	The paper investigates how performance information travelling between the evaluating buyer and the evaluated suppliers is shaped and reshaped in the evaluation process	The dynamics of representing, reducing, amplifying, dampening and directing shape and reshape supplier evaluation information. Such dynamics are influenced by the involved actors' perception and decision making, as well as the organizational structures, IT systems and available data sources.
<b>Luzzini et al (2014)</b>	Supplier PMS	Multiple case studies – theory building	The paper investigates how various elements of supplier performance measurement systems actually affect company satisfaction	The organizational maturity of the purchasing function is related to supplier PMS implementation. The direct involvement of different functions in the supplier's evaluation process, along with other elements, positively affects the system's effectiveness.

**Highlights**

- Extant literature about SCPMSs is broad and heterogeneous
- We distinguish the different components of internal and external SCPMSs
- We perform a systematic literature review about SCPMSs
- We propose an agenda for future research

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