

# Performance Measurement Systems for Supply Chain Management: How to Manage Its Maturity

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**Abstract**— Supply chains have gained important focus after 2000's due to not only the opportunities that it can provide but also the complexity involved on its management. Into this context, the implementation of different management practices can help companies to achieve better performance in their supply chains. As part of these practices it can be considered the Performance Measurement Systems (PMSs). The theory for PMSs has been concentrated on only organization perspective. At the same time the theory about PMSs for SCM is focused more on scope of measurement leaving a lack with regards other dimensions that must be considered on the PMS maturity development. Therefore, this paper aims to present the findings from the literature review about PMS for SCM and maturity of PMS. As contribution an theoretical model is proposed to help practitioners and researchers on the maturity management of PMS for SCM.

**Keywords**— Supply chain management, performance measurement systems, maturity

## 1. Introduction

Nowadays, market competition does not involve only two or more companies anymore. Actually, it occurs between supply chains which compete with each other [1-3]. In order to be more competitive, the focus of supply chain management (SCM) should be cooperation and trust [1]. It is important to achieve a level of performance in the entire supply chain that is more than the sum of performance of each company in the supply chain [1].

The possible synergies between the companies, members of same supply chain, require the development of new theories, frameworks, methods, and techniques. Those will help the supply chains managers to overcome the challenge of managing the complexity created by the network of companies [1,2] [4-6].

Performance measurement systems (PMSs) play an important role in managing complex supply chains. The task of creating performance measures for supply chain management is a challenge inherent in the complexity of supply chains. Since the 1990s, some approaches to measure the entire supply chain performance have been proposed [7]. It is worth pointing out that the theory to support the development of business performance measurement system is well developed. Unfortunately, the focus of such theory is a single company. Therefore, it is necessary to review the business performance measurement system theory to make it feasible to be applied to supply chains [3]. The evolution and challenges of supply chain management influence the development of performance measurement systems. A few studies have focused on those factors [8].

The correct alignment between the maturity dimensions of PMSs for single organizations and PMSs for SCM can be a contribution to the practitioners since they will understand how to better manage a PMS in the SCM. This could help managers to be more assertive and effective to achieve a superior supply chain performance. This paper aims to present the findings based on the literature review showing the alignment between maturity of PMS for single organizations and PMS for SCM.

Such findings can also contribute to the PMS theory in the supply chain management field. Therefore, the research question which this study aims to answer is:

***What are the dimensions to be considered for the maturity management of PMS for SCM?***

This research question will guide the literature review which will be the basis for field researches to be done in the future. This paper focus on the first step of the research, presenting a literature review built based on a systematic approach. This literature review was the basis to the theoretical model for the relationship between SCM maturity and PMS maturity that will be presented. The framework will be the basis for the field research to seek empirical findings linked to the research question. This paper is structured as follows. The next section presents the literature review. The following section presents the theoretical framework on the relationship between maturity of supply chain management and performance measurement systems. For last, final remarks and future directions are considered as conclusion of this paper.

## **2. Literature Review Method**

The literature review process followed a systematic approach [36]. Management research is a relatively young field and needs more structure and systematic process to allow a better support with regards the research question which is aimed to answer in a management field research [36]. More replicability and traceability of the arguments and conclusions using a systematic approach has been being required in the SCM researches [35]. The systematic review basically follows three steps [36]:

- Planning
- Conduction
- Reporting and Dissemination

In the step planning a plan of the literature review is developed having as the result a review protocol which will be used for the next step of the research: conduction [35]. With regards to conduction step, activities as research identification, selection of studies, and assessment of the sources, data extraction and data synthesis are developed [35].

This paper will focus on the two first steps, 1 and 2 which aim to build a basis for the field research that will be conducted in the future.

The planning of the literature review considered as a basis the two central themes of the study: supply chain management and performance measurement systems. Into these two main topics the research concentrated to seek sources with the following key-words and their combinations:

- Supply Chain Management
- Performance Measurement Systems
- Supply Chain Management and Performance Measurement System
- Maturity
- Maturity and Performance Measurement System

A period of search was established considering publications since 1990s until 2012. The long period is justified by the few studies available related to these topics. Also, the study aimed to show the evolution of the theories and models over the time. The main sources researched were the following journals:

- International Journal of Physical Distribution & Logistics Management
- International Journal of Production Economics
- The International Journal of Logistics Management
- Journal of Business Logistics
- Journal of Supply Chain Management
- Supply Chain Management – An International Journal
- International Journal of Productivity and Performance Management
- International Journal of Operations & Production Management
- International Journal of Supply Chain Management

The research was not limited to the journals above being them the main sources. Other sources were considered as proceeds of events linked to SCM and operations management, books of relevant authors in the area and other documents from the organizations and institutes linked to SCM and PMS considering the reliability and quality assessment criteria of those sources. Important to emphasize the difficulty faced to find a significant number of publications related to the thematic proposed by this research. Thus, this fact highlights the originality essence of this study and the needs for more clarifications related to maturity of PMS for SCM.

### 3. Literature Review Content

Into this section the results of the extensive literature review done will be presented. The first section presents the findings of maturity of supply chain management. In the following section, the findings about the maturity of PMS are showed.

#### 3.1 Performance Measurement Systems for SCM

New performance measurement systems have been the focus of several researchers since the 1990s after they acknowledged the inadequacy of traditional PMS. The financial performance measurements alone were not enough to track the drivers of performance and to support the establishment of actions to improve organizational performance.

The new perspective was to change the emphasis of performance measurement from a financial perspective to a more holistic perspective considering cause and effect as well as the link with the organizational strategies [19]. Performance measurement is the process of quantification of efficiency and effectiveness of an action. Performance measure can be defined as the metric used to quantify the efficiency and effectiveness of an action. A performance measurement system is defined as the set of metrics used to quantify both the efficiency and effectiveness of actions [19]. Performance measurement systems should have a dynamic characteristic regarding the changes that occur over time in the environment in which they are present [20, 21]. Hence, the understanding of evolution of a PMS is very important because it should change according to the environment evolution aiming to achieve greater suitability in terms of environment requirements.

With regard to PMSs for supply chain management, the focus is only the scope of measurement. This is one of the dimensions to be considered in the evolution of PMS, but it is not enough to achieve higher levels of maturity. Other dimensions should be considered for this purpose as well.

Several PMSs for supply chain management have been proposed in the literature in the last years. The PMSs and their authors are:

- **Andersson, Aronsson and Storhagen [22]:** Focus on processes, customer satisfaction, and financial measures.
- **Van Hoek [23]:** Measures related to logistics costs, customer delivery, flexibility, and level of commitment at the chain.
- **Beamon [24]:** Focus on basic processes, flexibility, customer satisfaction, and financial measures.
- **Pires and Aravechia [25]:** Focus on customer satisfaction for basic process, flexibility, and financial measures.
- **Holmberg [26]:** Proposal of a holistic PMS for supply chain management. Focus on PMS structure.
- **Brewer and Speh [27]:** Based on Balanced Scorecard with performance measures linked to the customer's value, level of services, collaboration, costs, processes, and partnership in the chain.
- **Gunasekaran, Patel and Tirtiroglu [28]:** Focus on process, financial, level of service to the customers, flexibility, initiative, and partnership in the chain measures.
- **Geary and Zonnenberg [29]:** Financial, flexibility, and delivery measures.
- **Chan et al. [4]:** PMS structure implemented in processes and sub-processes in the chain according to major areas of the supply chain.
- **Bhagwat and Sharma [30]:** Focus on processes, financial, level of service, flexibility, and level of partnership measures based on Balanced Scorecard.
- **Supply Chain Council [31]:** Based on four processes of Supply Chain Operations Reference (SCOR) Model (planning, source, production, delivery). Follows the attributes of responsiveness, agility, reliability, costs, and resources.

As can be seen in the PMSs proposals, it is important to highlight that the Holmberg [26] and

Chan et al. [4] focus more on the structure of the PMS. The other frameworks emphasize the scope of measurement presenting the performance measures that should be used in a SCM. Another interesting point is the broad perspectives of measurement of frameworks were proposed after 2000s. Those frameworks are more comprehensive.

### 3.2 Maturity of Performance Measurement Systems

Maturity is defined as the stage achieved in a process which it is better developed on its more advanced stage [9]. Maturity frameworks are not new in the management field. Several frameworks for continuous improvement have been proposed in literature [10], such as project management [11], virtual organizations [12], and product development [13].

Regarding the maturity of PMSs, there are basically two maturity models in the literature. The first model was purposed by Wettstein and Kueng [32] and was built using the Capability Maturity Model concept. Such model is based on six dimensions:

- Measurement Scope
- Data Collection
- Data Storage
- Communication of Results
- Use of Performance Measures
- Quality of Measurement Process

These six dimensions evolve through the four levels of maturity: ad-hoc, adolescent, grown-up, and mature. The second model was purposed by Van Aken et al. [33]. It is based on the Improvement System Assessment Tool (ISAT). Such model is more focused on the evaluation of the PMS considering it as an improvement process. It also takes into consideration the results achieved through the PMS. The Wettstein and Kueng [32] model is more suitable for the development of the theoretical model in this research taking into consideration that it considers dimensions which needs to be managed for each level of maturity.

### 4. The Alignment Between Maturity of PMSs for SCM and Maturity of PMS

In this section, the theoretical model of alignment between PMSs for SCM and maturity of PMS will

be presented based on the findings from the literature review. The framework was developed using the following steps:

- Identification of dimensions for PMSs maturity
- Classification and link of PMSs for SCM found on the literature review in the levels of maturity of PMS

For PMS maturity, the dimensions are those proposed by Wettstein and Kueng [32]. These dimensions are: Measurement Scope, Data Collection, Data Storage, Communication of Results, Use of Performance Measures, and Quality of Process Measurement.

There are three levels of maturity – initial, intermediate, and advanced. For this study purpose, the dimensions of maturity of PMS were grouped into three broad levels. It is worth mentioning that the model considers the maturity from the initial level, moving to the intermediate level, and reaching the advanced level. Based on the Wettstein and Kueng [32] model, the PMS maturity characteristics in the three levels of maturity considered in this study are:

- **Initial:** performance measurement with financial focus, manual data collection, data storage is not organized, communication of results is not frequent, lack of definition regarding to use of performance indicators, and quality of the measurement process is not defined.
- **Intermediate:** performance measurement still occurs with financial focus but with the beginning of some other measurement approaches, automated data collection and storage focused on financial data, while other information is manually collected and stored in a dispersed form, communication of results focused on high and middle management, use of indicators, and small concern about the quality of the measurement process.
- **Advanced:** comprehensive performance measurement including stakeholders in the supply chain management, systematic procedure for collecting and storing data and information, broad communication of results, extensive use of performance indicators for planning, controlling, and improving supply chain performance with the implementation of new technologies.

Analysing the PMSs for SCM as demonstrated in section 3.1 is possible to identify that they

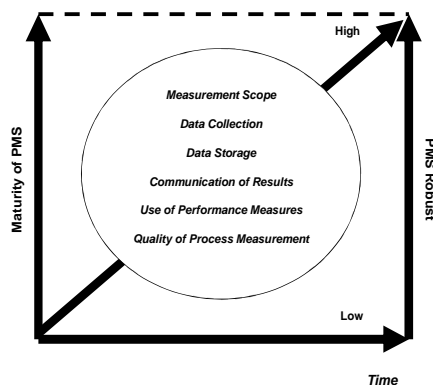
are linked to the level of integration of the supply chain. Some PMSs are focused on basic process and have an internal perspective of the focal-company of the chain. Some proposals have a broader set of measures but remains in an internal perspective. Other ones predict a collaboration and partnership which presumes that those are more fixed to that supply chains with external integration to the customers and suppliers.

Based on the characteristics for the three levels of maturities presented, a theoretical proposition was developed:

**Proposition:** *The evolution of maturity of PMSs for SCM emerges from an initial level to an advanced level in terms of its scope of measurement, data collection, storage data, communication of results, use of measures, and measurement process quality*

Important to emphasize that the theoretical proposition stated in this paper can be used to guide future field researches and verify if it can be corroborated or not.

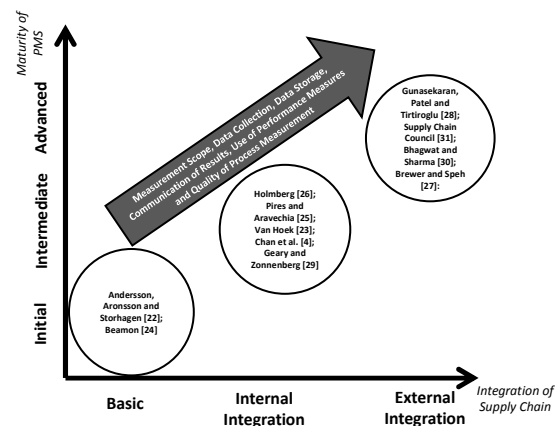
Based on the Figure 1 as the evolution of the dimensions of PMS maturity goes to the advanced level more robust a PMS becomes.



**Figure 1.** Evolution of PMS maturity dimensions

A more robust PMS fits better with a more comprehensive PMS for SCM. As these PMSs presume to be more integrated in the supply chain, PMSs that pursue a better level of these maturity dimensions i.e. comprehensive set of indicators, storage data system, mechanisms to facilitate use and communication and defined quality process review, will be a trigger for a more efficient SCM. This relationship can be viewed on Figure 2, which presents the theoretical model between the maturity

of PMS and PMS for SCM, considering the level of SCM integration.



**Figure 2.** theoretical model between PMS for SCM and its maturity levels

## 5. Conclusions

This paper aimed to present a theoretical model showing the relationship between maturity of PMS and PMSs for SCM. This approach has an important relevance taking into consideration that there is a lack in the literature linked to maturity with regards PMS for SCM purposes. An extensive literature review was presented using a systematic approach which allows a better reliability and quality of the data obtained. A qualitative approach was adopted considering that this study aims to explore the subject proposed and generate a contribution to the literature as basis for future qualitative and quantitative researches.

As the main findings it was possible to identify eleven PMSs for SCM and two maturity models for PMS. It was identified six dimensions which drives the maturity of PMS. Also, it was possible to verify that the PMS for SCM focus only on measurement scope, which is only one dimension to manage the maturity of the PMS. A theoretical model was proposed having as basis Wettstein and Kueng [32] model. Another maturity model for PMS found out in the literature was proposed by Van Aken [33] which considers dynamic dimensions over the stages of maturity, having a static perspective, reason why Wettstein and Kueng [32] was chosen.

Figure 1 presented the theoretical model which shows the link between PMS for SCM and its maturity levels aligning each PMS found on the literature in each level of maturity. This model is

the answer for the research question that orientated this study.

Certainly a field research is required to get more evidences around the dimensions identified as well as to evaluate if the theoretical proposition suggested in this paper can be corroborated or not. However, despite of future field researches, the findings from the literature review brings an important contribution for the theory related to PMS in SCM field, considering the inedited characteristic of the research objective. Besides the contribution to the academy, it also can be a reference guide to help practitioners to seek a better management of the PMSs for SCM.

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