# A Review of Supply Chain Performance Measurements with Special Reference to the Supply Chain Partnership (SCP)

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**Abstract**— This concept paper has been developed with the overall purpose of evaluating the contextually existing Supply Chain Performance Measurements in Literature and its influence on supply chain partnerships. Therefore, an initial review has been undertaken by the researcher to review supply chain performance followed by the contextual supply chain performance methods and models that exits that could be effectively applied and deployed. Thereafter, based on both past research findings as well case study reviews, how the performance and effectiveness of supply chain partnerships can be undertaken to measure, paper attempts to devlop a simple combined view of how supply chain partnerships can be effectively measured by giving special reference to the concept of supplier-buyer behavior. Also this paper focuses on future research areas that could be undertaken in the light of this concept of performance measurements of Supply Chian Partnership's (SCP's).

**Index Terms**— Performance Measurements, Supply Chain Performance, Supplier Chain Partnership, Supplier Buyer Behaviour

## 1 Introduction

THE increased focus and interest in supply chain management (SCM) is mainly attributed to globalization of the markets, escalating competition and to the increasing prominence given to customers (Gunasekaran, Patel, and Tirtiroglu, 2001; Webster, 2002). In this current setting, building and maintaining a sustainable competitive edge is through improved inter and intra-firm relationships. Thus the effective management of the supply chain is crucial (Ellinger, 2000). A supply chain consist of all activities and processes connected with the flow, storage and transformation of material from the raw material stage right up to the consumer (end user) (Handfield and Nichols, 1999). The benefits of SCM have been stated as reduction of costs, increase of market share and sales, and improved customer relationships (Fergueson, 2000). However, there is some evidence to suggest this may be hyperbole rather than organizational reality. For example, Deloitte Consulting reported that 79% of Supply Chain (SC) leaders have revenue growth that is significantly above average compared to 8% of SC followers and 69% have an Earnings before interest and tax (EBIT) significantly above average compared to 9% for SC followers. In view of these modest levels of uptake and effectiveness, one would expect interest in developing measurement systems and metrics for evaluating supply chain performance to be burgeoning. Moreover, it has been argued that measuring supply chain performance can facilitate a greater understanding of the supply chain, positively influence actors' behavior, and improve its overall performance (Chen and Paulraj, 2004). As per Neely, Gregory, and Platts (1995) performance measurement is defined as the process of quantifying the effectiveness and efficiency of action. Effectiveness is the extent to which a customer's requirements are met and efficiency measures how economically a firm's resources are utilized when providing a pre-specified level of customer satisfaction. Performance measurement systems can be described as the overall set of metrics used to quantify both the efficiency and effectiveness of action.

Over the years, there has been a generalized tendency to increase management vision and control, with companies seeking to control inter-firm processes and relationships. Several authors have therefore suggested that traditional intra-organizational performance measurement systems (PMSs) need to be broadened, with the development of external supply chain PMSs (SCPMSs), crossing company boundaries (Gunasekaran, Patel and McGaughey, 2004; Gunasekaran and Kobu, 2007). This is easier said than done. Supply chains are becoming more and more fuzzy: rather than being mutually exclusive chains, they appear as interconnected and overlapping networks, where companies are immersed and linked through diverse types of relationships (Lambert and Pohlen, 2001), hence need to focus on the relevant SCPM's and choice of them are essential when extending the measurement process beyond company boundaries, yet often complex

## 2 Background of the Study

If qualitative assessments such as '''very good', ``good'', ``fair level'', ``adequate level'', and ``poor'' are used for the analysis of a system's performance, then these indicators are imprecise and can't be made use of in a meaningful way. Due to this reason usually qualitative assessments are less preferred than, quantitative assessment methods. A numerical performance assessment method may be utilized by an organization due to the availability of data, or because it has been practiced so for a long time. However it should be noted that, the selected numerical performance measure sometimes may not have the ability to satisfactorily define and assess the system's perfor-

mance. In such a situation the quantitative measurement will also be as vague as the qualitative measures and will not be useful in any meaningful way. The complexity of developing suitable performance measures is heightened by the fact that it consists of defining of the scope which is far more difficult that the issues of context. As an example it has to be decided whether the measurement system should be limited to a single organization or several organizations, or to a certain echelon. Another example is the decision of whether the performance measure is applied to a single product line or to many related/unrelated product lines. Theoretically, a supply chain is an integrated process where raw materials are converted into finished items, and then delivered to consumers through different channels (via direct distribution, or through retail, or both). A typical supply chain is depicted in Figure 1.

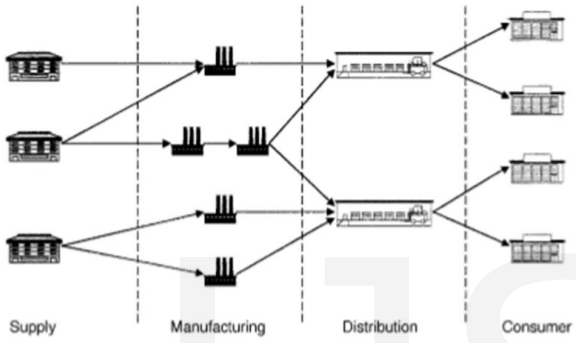



Figure 1: A Typical Supply Chain

The supply chain depicted in Figure 1 contains four echelons (supply, manufacturing, distribution, and consumers), where each level (or echelon) of the chain may comprise of numerous facilities. Thus, the complexity of the supply chain arises from the number of echelons in the chain and the number of facilities in each echelon. Given the inherent complexity of the typical supply chain, selecting appropriate measures to analyse the supply chain performance is particularly critical, since the system of interest is generally large and complex.

Although there are numerous studies on integration and performance, there are very few coherent studies to measure the performance of supply chain operations based on the degree of integration among and between their stakeholders (suppliers, internal customers, and external customers). For example, Lohse and Ranch (2001) explored the performance of supply chain operations using collaborative planning, forecasting and replenishment (CPFR) considering roles that each stake-holder plays. Brewer and Speh (2000, 2001) studied supply chain performance using the balance scorecard. Lawton (2002), on the other hand, studied the linkage between performances in general and supply chain operations. Supply chain partnership/collaboration management and performance measurement have been theorized as crucial means for manufacturers to achieve sustainable competitive advantage and superior performance (Lee, Padnababhan and Whang, 2004). Cao and Zhang (2011) noted that a good relationship with suppliers can give a manufacturer competitive advantage over others in the marketplace. Hence, much attention has been paid in the literature to develop effective performance measurements for SC partnerships, where the importance of partnerships for the performance of the entire supply chain is particularly stressed. The measurements which are selected for performance measurement and continuous development must be those which are actually able to seize the core of organizational performance. A measurement system should enable the users to assign the selected metrics to the place or link where they would be most apt. For performance measurements to be effective and assist in further improvements, the measurement goals must be aligned with the goals of the organization. Additionally the metrics included should incorporate a balance between non-financial and financial measures which need to be related to the operational, tactical and strategic levels of an organization's decision making.

Therefore the purpose of this paper is to review the supply chain performance measures available in literature and propose a framework for the evaluation of a supplier buyer relationship/partnership as part of supply chain performance measures. Further this study explores a performance measurement system for a dynamic supply chain partnership (SCP) in a business context. An initial framework is proposed by reviewing the existing literature, which includes the relationship strategy, and operational measurement criteria for a supply chain partnership has been developed.

## 3 METHODOLOGY

This study has focused mainly on reviewing literature technique of concept paper development while deriving information from past research done in similar contexts and case studies of contextual setups. Therefore, the researcher has derived information as well as insights from these sources for the development of this concept paper. Therefore, the objectives of this concept paper development have been set as below by the researcher

- Review literature of exiting Supply Chain Performance Measurements systems/Models.
- Review literature on how to measure performance/effectiveness of Supply Chain partnerships
- Suggest a combined view of measuring supply Chain Partnership special reference to Supplier Buyer relationship
- Develop future research recommendations

# 4 Literature Review

## 4.1Supply Chain Performance Measurements

Defining Key Terms

Supply chain management: A supply chain of an organization is defined as the overall streamlined process of manufacturing and delivery management starting from the point of identifying customer needs and receiving orders through procurement through manufacturing to the point of final delivery of the good/ service to the customer while maximizing the inbound logistics, outbound logistics, procurement, manufacturing and overall customer service effectively. The effective management of this process while maximizing the utilization of scarce resources, increasing efficiency and effectiveness and minimizing waste is called as the supply chain management (Cooper, Lambert, & Pagh, 1997)

Supply chain partnerships: Suppliers, manufacturers and the customers are the three key pillars the key stakeholders of an extended supply chain. Building and maintenance long-term, profitable and mutually rewarding relationships between these stakeholders that lead to organizational success and customer satisfaction is terms as supply chain partnerships which not only applies to the supply chain but to the extended supply chain of an organization (Ireland and Webb, 2007).

Supply chain performance: The manner in which a supply chain of an organization carries out its tasks of order receiving, procurement, inbound logistics, manufacturing, packaging, quality assurance, and outbound logistics while achieving targeted objectives and maintaining high efficiency and effectiveness levels is termed as supply chain performance (Cooper, Lambert, & Pagh, 1997).

Supply chain performance measurements: Various tools, methods and techniques that impose parameters that could be used to timely measure the overall supply, chain performance using different matrices such as output levels, input levels, rate or production are termed as supply chain performance measurements (Cooper, Lambert, & Pagh, 1997).

Any organization must continuously be vigilant about the competition that it is facing and how the competition is changing. In the current business context the combat zone of doing business is moving away from individual companies to supply chains. Therefore what is important is not only just organization's individual performance but the performance of the entire supply chain. Supply chain performance refers to the performance of the extended supply chain processes needed to fulfill consumer (end-customer) requirements, including on-time delivery, product availability and maintaining the necessary inventory levels and adequate capacity in the supply chain in order to perform in a responsive method. Supply chains include activities related to raw materials, components, subassemblies and finished goods, and distribution of the finished products through various channels to the end customer, thus it spans across organizational boundaries. Further it surpasses traditional functional organization divisions such as manufacturing, procurement, distribution, marketing & sales, and research & development. In order to gain the competitive advantage in this new setup, supply chains need to focus on continuous improvement. Therefore to achieve this, it is necessary to develop performance measures, or "metrics," which support broader supply chain performance improvements rather than narrow company-specific or function-specific (silo) metrics which inhibit supply chain-wide improvements. This paper discusses several supply chain performance methods that have been specifically designed to assess supply chain performance and help to make improvements throughout the supply chain. Further it demonstrates the deficiencies of a number of common metrics.

Beamon (1996) discusses several features that are supposed to be included in an effective PMS. Thus these features can be utilized in the evaluation of these supply chain performance measurement systems. Inclusiveness which is the assessment of all appropriate aspects, universality which enables the comparison of measures under diverse functional settings, measurability which denotes that the data necessary are quantifiable, and consistency which measures the consistency with institutional goals are some of the characteristics discussed. Besides analyzing the measures based on their effectiveness, benchmarking is another important method that is used in performance measure evaluation. Benchmarking can be useful in that it can serve as a means of identifying improvement opportunities. Camp (1989) provides an excellent and comprehensive discussion of benchmarking. In order to study the large number of performance measures available, researchers have categorized them. Neely et al. (1995) present a few of the categories in the literature, including: quality, time, flexibility, and cost.

One of the most difficult areas of the development of performance measurement systems is the performance measurement selection. This involves the methods by which an organization creates its measurement system. There are several important questions that must be addressed here: What to measure? How are multiple individual measures integrated into a measurement system? How often to measure? How and when are measures re-evaluated? Although all of the ideas important to examining measurement systems already in place, the problem is difficult since the ``slate is blank'' and the goal is to create the ``best'' possible measurement system for the supply chain or chains of interest. Neely et al. (1995) note that different measurement frameworks have been developed and others have provided criteria for the measurement system design. However, a generally applicable systematic approach to performance measurement has not been developed. Different types of systems require specific measurement system characteristics, and therein lies the difficulty in creating such a general approach. Thus, previous work has sought to develop various performance measure frameworks for different types of systems that share certain critical characteristics.

As previously mentioned, a supply chain performance measurement system that consists of a single performance measure is generally inadequate since it is not inclusive, ignores the

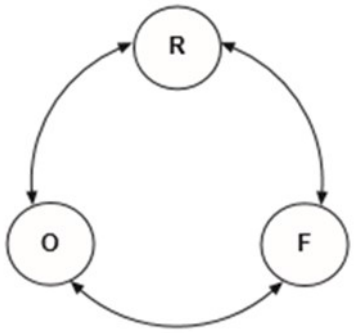
interactions among important supply chain characteristics, and ignores critical aspects of organizational strategic goals. Strategic goals of an organization involve key features that include the measurement of resources, output and flexibility. Resource measurement may generally include cost and output measures may generally include number of units and these two types of measurements have been widely used in supply chain models. Although there are many advantages that exist by a having a flexible supply chain, flexibility has been applied only in a limited scope in supply chains. The utilization of resources, the expected or planned output and level of flexibility have been identified as vital components to supply chain success. Thus, a supply chain performance measurement system must focus on three different categories of performance measures which can be stated as: measures for resource usage (R), measures for output achieved (O), and measures of flexibility (F) (Beamon, 1999). These three categories of SC performance measures will strive to achieve different goals, as depicted in Table 1. A particular SC performance measurement system must have the ability to measure each of the above mentioned three types (R, O and F), as all three types are essential to ensure the overall success of the supply chain. All the above mentioned types of measures have important features and the measure of each of these will have an effect on the others. Figure 2 illustrates the interrelationship that exists among the three categories of measurements.

Table 1: Goals of Performance Measurements

| Performance measure type | Goal | Purpose |
|---|---|---|
| Resources | High level of efficiency | Efficient resource management is critical to profitability |
| Output | High level of customer service | Without acceptable output, customers will turn to other supply chains |
| Flexibility | Ability to respond to a changing environment | In an uncertain environment, supply chains must be able to respond to change |

Source: Benita M. Beamon, (1999) "Measuring supply chain performance", International Journal of Operations & Production Management, Vol. 19 Issue: 3, pp.275-292

Figure 2: Interrelationship among 3 types of Performance Measures




Source: Benita M. Beamon, (1999) "Measuring supply chain performance", International Journal of Operations & Production Management, Vol. 19 Issue: 3, pp.275-292

**Resources**

Measures for resource utilization may include: level of inventory, human resource requirements, machinery/equipment utilization, energy consumption, and cost incurred. The resource requirements are generally measured in terms of the minimum requirements (quantity) or by using a combined efficiency measurement. The utilization of the resources to meet the system's objectives is measured through efficiency. Therefore resource measurement is an important part of the measurement system. Too few resources can negatively affect the output and the flexibility of the system, while the deployment of too many resources artificially increases the system's requirements.

**Output**

Measures of output may include: quantity of final product, customers' responsiveness, and quality of product or service. A number of performance measures related to outcome can be easily denoted numerically, e.g.: number of units manufactured; number of on-time deliveries or orders processed; time requirement for production of a particular good or set of goods. On the other hand, there are numerous performance measures related to output which can't be expressed directly using numeric, and these include mainly quality of products/services and customer satisfaction. A minimum level of output is often specified, although the relationship between the costs required to achieve different output levels is not generally considered, such as; what is the added value or cost if the product is delivered early? Likewise, what are the costs if the product is delivered late? Additionally, output measures are based on short, finite time horizons, and address issues such as how many were produced today? Not on how many can be produced tomorrow? Thus, resources affect the output of a supply chain, and the output of the supply chain system (quality, quantity) is important in determining the flexibility of the system. Strategic goals are usually formed in a manner to address meeting the customer expectations and requirements.

Therefore the output performance measures too must not only be aligned to the organization's strategic goals, but they need to match up to the customers' goals and values too. As an example, Corbett (1992) identifies a furniture manufacturer that discovered that their customers actually valued delivery reliability more than fast delivery. For the customer, short lead times were secondary to having the product delivered on time. Although lead times may be extremely important to the manufacturer, on time delivery was more important to the customer. In this case, both of these output performance measures should be utilized.

**Flexibility**

Flexibility can be used to measure the ability of a particular system to accommodate fluctuations of volume as well as schedules from different parties of the supply chain such as manufacturers, suppliers and customers. It is important to note that flexibility is seldom utilized for supply chain analysis. Indeed, flexibility is vital to the success of the supply chain, since the supply chain exists in an uncertain environment. Slack (1991) states two types of flexibility which are response flexibility and range flexibility. "Range flexibility is defined as to what extent the operation can be changed. Response flexibility is defined as the ease (in terms of cost, time, or both) with which the operation can be changed". Although there will be a limit to the range and response flexibility of a supply chain, the chain can be designed to adapt adequately to the uncertain environment. For example, a reduction in system resources may negatively affect the supply chain's flexibility. A supply chain may be currently utilizing its resources efficiently, and producing the desired output, but will the supply chain be able to adjust to changes in, for example: product demand, manufacturing unreliability, the introduction of new products, or supplier shortages? Thus, flexibility is an important consideration in supply chain performance.

Table 2: Suply Chain Performance Metrics Framework

| Supply chain activity/ process | Strategic | Tactical | Operational |
|---|---|---|---|
| Plan | Level of customer perceived value of product, Variances against budget, Order lead time, Information processing cost, Net profit Vs productivity ratio, Total cycle time, Total cash flow time, Product development cycle time | Customer query time, Product development cycle time, Accuracy of forecasting techniques, Planning process cycle time, Order entry methods, Human resource productivity | Order entry methods, Human resource productivity |
| Source | | Supplier delivery performance, supplier leadtime against industry norm, supplier pricing against market, Efficiency of purchase order cycle time, Efficiency of cash flow method, Supplier booking in procedures | Efficiency of purchase order cycle time, Supplier pricing against market |
| Make/ Assemble | Range of products and services | Percentage of defects, Cost per operation hour, Capacity utilization, Utilization of economic order quantity | Percentage of Defects, Cost per operation hour, Human resource productivity index |
| Deliver | Flexibility of service system to meet customer needs, Effectiveness of enterprise distribution planning schedule | Flexibility of service system to meet customer needs, Effectiveness of enterprise distribution planning schedule, Effectiveness of delivery invoice methods, Percentage of finished goods in transit, Delivery reliability performance | Quality of delivered goods, On time delivery of goods, Effectiveness of delivery invoice methods, Number of faultless delivery notes invoiced, Percentage of urgent deliveries, Information richness in carrying out delivery, Delivery reliability performance |

Source: Gunasekaran, A., Patel, C. and McGaughey, R.E. (2004), "A framework for supply chain performance measurement", International Journal of Production Economics, Vol. 87 No. 3, pp. 333-347

Alongside the metrics and measures are discussed in the context of the following supply chain activities/ processes: (1) plan, (2) source, (3) make/assemble, and (4) delivery (Stewart, 1995; Gunasekaran et .al., 2001). Following is the supply chain performance metrics framework presented by Gunasekeran et al., 2004.

### 4.2 Supply Chain Optimal Metrics

There is extensive literature on SCM that deals with performance management metrics. For effective performance evaluation, measurement goals must represent organizational goals and the metrics selected should reflect a balance between financial and non-financial measures that can be related to strategic, tactical and operational levels of decision making and control (Gunasekaran et al., 2004). Likewise, it is important to reduce many of the established performance metrics to a relatively low number that are more effective for performance evaluation. All the metrics are selected based on existing research (Shepherd and Gunter, 2006; Gunasekaran et al., 2001). Shepherd and Gunter (2006) provided a catalogue of performance measures (in terms of cost, time, quality, flexibility and innovativeness) using the five SCOR processes. Gunasekaran et al. (2004) used the same processes and developed supply chain measures at strategic, tactical and operational levels of the framework. Appendix A gives a taxonomy of measures of Supply Chain Performance.

### 4.3 Measuring Supply Chain Partnerships

It is a common thought in the operations management literature that competition is no longer between companies, but among SCs, leading to the concept of SC-based competition (Zhang, 2006; Qi, Zhao, and Sheu, 2011). This is a critical concept, often treated superficially by referring to misleading formulas like the "supply chain vs supply chain" game. In most industries (e.g. consumer goods, consumer electronics, pharmaceutical, automotive, etc.), competing SCs appear more like interconnected or overlapping networks than mutually exclusive chains of companies enrolled in a tier vs tier competition. Companies are nodes in fuzzy enterprise networks more than tiers in straight SCs: in this context, strategic SCM practices could be exploited in order to create privileged paths, thus achieving sustainable competitive advantage. The management of Supply Chain partnerships such as buyer-supplier relationships is therefore essential for achieving superior performance.

Starting from the late 1990s (Beamon, 1999), several authors in the academic literature have described about studies about the development of PMS addressing the evaluation of activities outside legal company boundaries. Hald and Ellegaard (2011) identify three converging and overlapping streams of research, according to the scope of the system they address and

the labels used are: SCPMS tackling SC processes and practices (Gunasekaran et al., 2001); supplier evaluation focusing on first tier suppliers (Kannan and Tan, 2002; Luzzini, Caniato, and Spina, 2014) the buyer-supplier relationship assessment, focusing on soft aspects like mutual commitment, integration, trust, etc. (Giannakis, 2007; Ramanathan, Gunasekaran, and Subramanian, 2011). For the sake of clarity, it is worth providing precise definitions of recurrent labels in this paper. Influenced by Neely et al.'s (1995) definition of PMS, this article refers to external SCPMS as a set of metrics used to quantify the efficiency and effectiveness of inter-firm processes and relationships. From the perspective of a business-to-business company, we can eventually distinguish between suppliers PMSs (set of metrics used to quantify the efficiency and effectiveness of suppliers' actions) and customers PMSs (set of metrics used to quantify both the efficiency and effectiveness of responding to customers' needs). Within the broad area of external SCPMS, most studies address the pattern of evaluating the buyer company, adopting supplier PMSs to control and orchestrate its supply base. This implicitly uncovers two main limitations: the lack of insights on customer PMSs put in place by supplier companies to monitor their buyer's performance: apart from a few comprehensive SCPMS tackling also downstream processes and relationships (e.g. Gunasekaran and Kobu, 2007), customers PMS are largely neglected, yet often used by companies' customer service functions; and the paucity of contributions reporting also the point of view of the evaluated company. Therefore in assessing the effectiveness of the measurement process, it seems logical to take into account both the evaluating and evaluated company perspectives. On this behalf, it is interesting to note that the few studies jointly reporting the dyadic perspective actually highlight a strong dichotomy of perceptions between the two parties. Purdy, Astad, and Safayeni (1994) and Purdy and Safayeni (2000) report three main conclusions: the majority of suppliers feel that their effectiveness is not accurately reflected in the evaluation, which seems more at test of how much their companies look like the buyer; the evaluating buyer company did not utilize the information gathered through the audit process properly because in the end, their decisions were based only on price savings; and suppliers believe that the score reported is driven by bargaining power rules and does not result from a formal and objective evaluation process. Hald and Ellegaard (2011), by means of two longitudinal case studies, investigate how performance measurement facts and figures, transferring between the evaluating buyer and the evaluated suppliers, is molded and reformed in the evaluation process. The authors highlight that regularly a severe dialectic arises between the two parties about the supplier PMS used. Another characteristic of the extant scientific literature on external SCPMSs is the primary focus on the design process. Various models have been proposed over the years, like the SC balanced scorecard (Bhagwat and Sharma, 2007); the SCOR framework (Sellitto, Pereira, Borchardt, daSilva, and Viegas, 2015; Gunasekaran et al., 2004); process-based approach (Chan and Qi, 2003); and suppliers' scorecard (Kannan and Tan, 2002). Maestrini et al., (2018) tabled a performance measurement model which captures both supplier and buyer perspectives. Table 4 depicts the relationship regulator and supplier –buyer collaborative perf ormance measurement system.

**TABLE 4:** Illustrative example on supplier–buyer collaborative performance measurement system

| Unit of Analysis | | Supplier (metrics) | Buyer (metrics) |
|---|---|---|---|
| Financial dimension "To achieve financial value from this relationship, what parameters should be optimized?" | Business Relationship | Revenue growth | Extra-savings |
| | Transactional Costs | Total cost of sales | Total cost of ownership |
| | | Distribution costs | |
| Operative processes "To ensure routinely operational excellence, which SC operational activities should be optimized?" | Order cycle | Agreed order fulfillment | |
| | Order | Order fill rate, order lead time | No of urgent orders, order variability |
| | Delivery process | Punctuality index<br>Flexibility index<br>Reactivity index | |
| | Invoicing | Invoicing accuracy, invoicing timeliness | |
| | Payment | | Payment timeliness<br>Documentation accuracy |
| | New product development | Product development time<br>No of new products developed per year | |
| | Traceability and stock control | Inventory level, security stocks level | |
| Planning process "To achieve superior coordination, which planning process must we excel at?" | Demand planning | | Forecast accuracy, forecast variability |
| | Production planning | Actual versus planned production | |
| | Distribution planning | Changes entity, changes frequency | |
| Product/service exchanged | Quality based performance | Quality rate, number of defects | |
| Relationship intangible capabilities "To continuously improve our relationships, which capabilities should we develop?" | Social capital | Mutual trust<br>Goal alignment<br>Number of meetings<br>Perceived value of the relationship | |
| | Information capital | Exploitation of collaborative platforms<br>Digitalization degree<br>Information quality<br>Information timeliness | |

Source: https://doi.org/10.1108/ IJOPM-10-2016-0595

Alongside, by exploring other literature, a framework of performance measurement indicators (PMIs) to assess the effectiveness of multicultural collaboration is presented by Han, Huang and Macbeth, 2017. It was developed within the framework including relationship strategy and operation measurement of the key driving forces identified from the literature. Each of these criteria was considered separately. According to Melnyk et al. (2014) performance measurement research directions on 'what the firm wants to achieve (or communicate by its strategy) and what the firm measures and rewards are not synchronized with each other (i.e. there is a lack of "fit")'. Han et al., 2017 incorporated the performance measurement criteria into relationship strategy and operation measurement criteria (see Table 5).

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**Table 5:** Supply Chain Partnership Performance Measurement indicators

| Categories | Key criteria | Description | Select author(s) |
|---|---|---|---|
| Relationship strategy | Strategy orientation | Gain access to or acquire unique and valuable resources or leverage resources | Eisenhardt and Schoonhoven (1996) |
| | Management style | Structure on distinct methods, control systems, decisions format, communication styles | Covin and Slevin (1988), Datta (1991) Austin and Seitanidi (2012) |
| | Interdependence | Combine mutual forces to reach a common objective | Andaleeb (1996) |
| | Mutual organizational characteristics | Minimize interpersonal and organizational differences | Cao and hang (2011), mahlendorf et al. (2012), Zaheer and Venkatraman (1995) |
| | Common goals | Multiple partners working together to achieve common goals | Pidduck (2006), Zhang aand Goffin (2001) |
| | Complementarity | Impact on effectively aspects of businesses, integrate competencies and activities | Ohma (1989), Spekman and Sawhney (1990) |
| Operation measurement criteria | Commitment | Crucial enough to allocate substantial resources to maintaining | Morgan and Hunt (1994), Kwon and Suh (2004) |
| | Trust | Confident act in own interests when taking action and will not act unpredictably to disadvantage | Anderson and Narus (1990), Cai et al. (2013), Gulati (1995) |
| | Communication behavior | A critically important relational competency, leverage for mutual gains within collaborative | Paulraj et al. (2008) |
| | Information sharing | Effective and methodological in managerial roles and ultimately impact on success of the partnership | Angeles and nath (2001), elofson and Robinson (2007) |
| | Participation decision | Active in the formulation of business strategy; satisfied each partner with the relationship | Mohr and Spekman (1994), Cao et al. (2010) |
| | Quality | Manufacture of products with high quality and performance standards | Leong, Snyder, and ward (1990) |
| | Delivery | Delivery schedules or promises, react quickly to customer orders | |
| | Cost | Production and distribution of the product at low cost | |
| | Production Performance Supplier strength | Improve product quality; reduce customer time; production design and operational efficiencies, size scales, sales, industry relationship | Paulraj et al. (2008) |

Source: HTTPS://DOI: 10.1080/00207543.2017.1377357

At a strategic level, the relationship process lays the foundation for how relationships with suppliers will be developed and managed. Relationship strategy refers to the possibility of achieving comprehensive performance or competitive advantage in value activity if both partners cooperate in aspects of their relationship where they may collaborate based on strategic goals, values and other areas (Lambert and Shmeterman 2012). The relationship strategy between the manufacturer and supplier is consistent with its context in a supply chain. Relationship strategy meets the indicated demand in a supply chain partnership. At the operations measurement criteria level, supplier selection has been cited as one of the reasons for the successful implementation of partnering (Brouthers, Brouthers, and Wilkinson 1995; Hagen 2002). In this field of discourse, supplier selection is an aspect that is relevant to both practitioners and researchers, and the criteria used to choose suppliers are a fundamental part of this process. Choosing the right partner is important, because the failure of many partnering attempts can easily be traced to poor partner selection at the planning stage (Pansiri, 2005). In choosing appropriate partners, research identifies operation measurement criteria such as compatibility, capability, commitment and control as criteria for successful pre-selection of partners (Hagen, 2002). Above all, it can be seen that the critical criteria of the supplier selection enables both manufacturers and suppliers to more effectively capitalize on the potential for development. There is little doubt that supplier selection is critical for successful SCP measurement; however, what is needed for achievement in both high-level (relationship strategy) and detailed level (operation measurement criteria) require more in-depth understanding and exploration of the empirical research. Finally, the literature suggests that SCPs may be a significant moderating factor on performance (Chen, Paulraj, and Lado, 2004).

Supply chain structure is how companies are arranged to form a supply chain and how all activities are linked (Cooper et al, 1997; Lambert and Cooper 2000). An individual company can participate in a number of supply chains (Cooper et al. 1997; Mentzer, DeWitt et al. 2001). Cooper et al. (1997) suggest that companies need to determine carefully with which partners of supply chains they should be closely integrated. Cooper et al. also point out that level of integration depends on various factors including firm capabilities, the complexity of products, and corporate culture.

As information sharing is the foundation of supply chain integration (Lee 2000), decisions on the level of integration are strongly correlated with decisions on what information should be shared and how it should be shared. Cooper et al. (1997) contend that designing the configuration of the supply chain is not merely determining with whom companies should integrate but also designing how a company's activities are linked to those of their partners and deciding what information should be made accessible by partners. Therefore the rate at which information sharing is carried out can be considered as one of the key method of measuring supply chain partnership performance.

### 4.4 Combined View of Measuring Supply Chain Partnership Special Reference to Supplier- Buyer relationship

Performance measurement in purchasing and supply management has become an important theme during the last decades. Key Performance Indicators (KPIs) have turned out to be useful in systematic efforts to improve the performance of suppliers from a buying company's point of view. However, in parallel to this development the notion of considering the content and functions of buyer and supplier relationships have also advanced in recent years. Setting the focus on supplier relationships and on the interaction with suppliers directs the attention from the suppliers as independently performing their tasks into a focus on how the buyer and supplier can improve their performance jointly. In particular, there may be huge potentials in considering what the buying firm can do in order for the supplier to be able to improve its performance in the relationship (Wang, 2004)

When different supply chain partnerships are considered by giving special reference to supplier-buyer behavior, it could be identified through past research that there are many different types of buyer-supplier situations. Even for the same scenario of buyer-supplier behavior, the nature could change due to the different stages of the supply chain cycle or the instance faced. Therefore, a static model is proposed to adapt to these fluctuations and offers a combined view as a solution (Wang, 2004).

The static model describes the importance of collaborative buyer supplier relationships in the product development process. This is because the most suitable supplier relationship is different for different products. For the same product, the most appropriate buyer supplier relationship varies with the product's life cycle timing. Therefore, two dynamic buyer-supplier relationship models under different business conditions and in different product life-cycle periods are suggested. The models apply to dynamic processes, not to interacting company organizations in general.

## DISCUSSION

This study has put forward the problems and requirements of today's broadened and complex supply chain performance measurement systems as they are much distinctive from the traditional performance measurement systems. The importance of the 'balanced scorecard' approach and significance of the SCOR model as the foundation of the performance management system are highlighted during the study. Multi-dimensional nature of the issue is evident, involving the concepts of 'total quality', 'fit' and 'excellence'. Also supply chain partnerships are a key element under the umbrella of supply chain collaboration, and it is necessary to measure them and literature has highlighted many ways to do so. Considering the literature analyzed on SCP measurements and measuring of supply chain partnerships, the researcher proposes a model to be further evaluated and researched. The model consists of two main parts as in a supply chain partnership measurement, it is important to measure the performance part of it and the relationship part of it. Hence the author defines two areas to be measures namely Operational Performance and Relationship Performance and each having further measurements to measure the same.

Table 6: Suggested model for Measuring Supply Chain Partnerships

| Supply Chain Partnership | |
|---|---|
| Operational Performance | Relationship Performance |
| • Service Level(On-time in full Delivery)<br>• Cost (Inventory, etc.,)<br>• Quality<br>• Flexibility | • Degree of Information Sharing<br>• Goal Alignment<br>• Value generated jointly (Savings, etc.,)<br>• Design Collaboration |

The study revealed that supply chain performance measurement is still a fruitful research area and very distinctive supportive statements have been traced for the need of further research on supply chain performance measurement during the review. The following are the main guidelines identified for future research:

More research need to be conducted on the performance measurement tools for 21st century business models, the need for the development of more precise frameworks and empirical testing of the performance measures and action research . Further research on validation of developed performance measures, determination of KPI's for partnerships and development of models to cover virtual and e-commerce environments can be conducted. Additionally developing measurement and performance systems in the form of new maturity models supported by SCOR, to enable benchmarking could be suggested. There is also the potential for cross-industry studies, development of metrics for measuring the performance and suitability of IT in SCM and the development of performance measurement metrics for responsive SC.

Immaturity of the frameworks and models are evident in this survey and the authors believe that future contributions to the area will come specifically from: framework development efforts, development of partnerships, flexibility, and improved collaboration among partners, agility, information productivity and business excellence metrics. Further elaboration is needed on the fit–performance relationships, including modelling and case-based surveys.

The authors believe that "service level", "business processes", "fit" and "excellence" are still the key for performance measurement systems of future. The survey provided strong support as to the immaturity of these concepts in relation to supply chain management. To put it clearly, 'supply chain business excellence' deserves further attention in any future research.

Future research could focus on primary data such as industrial surveys, case study development and statistical experiments to gain more concurrent and contextual data that would generate more accurate insights. Moreover, this study focused on a more generalized view of the context of the study area by referring to generally available data, information and insights. Therefore, fir future studies, a particular organization could be focused on which could be reviewed critically with actual industrial and statistical information obtained in collaboration with the organization that would generate a more perceptual and contextual view of the subject area

## LIMITATIONS OF STUDY

Time limitation is one of the key restrictions that limit the scope of research and scope of reviews that could be undertaken during the concept paper development of this study. Moreover, limited accessibility to resource and specifically those of industrial statistics and statistical data that could be reviewed to gain better insights into real-world supply chain management, supply chain performance and supply chain partnerships is another limitation of this study

## REFERENCES

[1] Beamon, B.M. (1996), ``Performance measures in supply chain management", Proceedings of the 1996 Conference on Agile and Intelligent Manufacturing Systems, Rensselaer Polytechnic Institute, Troy, New York,NY, 2-3 October.

[2] Beamon, B.M. (1999) "Measuring supply chain performance", International Journal of Operations & Production Management, *19*(3), 275-292

[3] Bhagwat, R. and Sharma, M.K. (2007), "Performance measurement of supply chain management: a balanced scorecard approach", Computers and Industrial Engineering, *53*(1), 43-62.

[4] Brewer, P.C. and Speh, T.W. (2000), "Using balanced scorecard to measure supply chain performance", Journal of Business Logistics, *21*(1), 75-94.

[5] Brouthers, K. D., L. E. Brouthers, and T. J. Wilkinson. 1995. "Strategic Alliance: Choose Your Partner." Long Rang Planning, *28* (3), 18–25.

[6] Camp, R.C. (1989), Benchmarking ± The Search for Industry Best Practices that Lead to Superior Performance, ASQS Quality Press, Milwaukee, WI.

[7] Cao, M., & Zhang, Q. (2011). Supply chain collaboration: Impact on collaborative advantage and firm performance. Journal of operations management, *29*(3), 163-180.

[8] Chan, F.T.S. and Qi, H.J. (2003), "Feasibility of performance measurement system for supply chain: a process-based approach and measures", Integrated Manufacturing Systems, *14* (3), 179-190.

[9] Chen, I. J., & Paulraj, A. (2004). Understanding supply chain management: critical research and a theoretical framework. International Journal of Production Research, *42*(1), 131–163.

[10] Chen, I. J., A. Paulraj, and A. A. Lado. 2004. "Strategic Purchasing, Supply Management, and Firm Performance." Journal of Operations Management *22*, 505–523.

[11] Cooper, M. C., Lambert, D. M., & Pagh, J. D. (1997). Supply Chain Management: More Than a New Name for Logistics. The International Journal of Logistics Management, *8*(1), 1–14.

[12] Corbett, L.M. (1992), ``Delivery windows ± a new view on improving manufacturing flexibility and on-time delivery performance", Production and Inventory Management Journal, *33*,(3), 74-79.

[13] Craig Shepherd, Hannes Günter, (2006),"Measuring supply chain performance: current research and future directions", International Journal of Productivity and Performance Management, *55*(3), 242 – 258

[14] Dodgson, M. (1996), "Learning, Trust, and Inter-Firm Technological Linkages: Some Theoretical Associations" in R. Coombs (edit.), "Technological Collaboration – The dynamics of co-operation in industrial innovation", Edward Elgar, Cheltenham, UK, Brookfield, US.

[15] Doig, S. J. et al. (2001), "Has Outsourcing Gone Too Far?" ,The Mckinsey Quarterly 2001, Number 4.

[16] Dubois, A. & Pedersen, A. (2001), "Why Partner do not Fit into Purchasing Portfolio Models", Paper submitted to the 17th Annual IMP Conference, 9-11 Sept 2001, Oslo, Norway.

[17] Easterby-Smith, M., Thorpe, P. and Lowe, A. (2002), Management Research: An Introduction, London, England, Sage Publications Limited.

[18] Ellinger, A. E. (2000). Improving marketing/logistics cross functional collaboration in the supply chain. Industrial Marketing Management, *29*, 85–96

[19] Fergueson, B. R. (2000). Implementing supply chain management. Production and Inventory Management Journal, March, 64–67.

[20] Gadde, L.-E. & Håkansson, H. (1994): The Changing Role of Purchasing: Reconsidering three strategic issues, European Journal of Purchasing & Supply Chain Management, (1), 27-35.

[21] Gadde, L.-E., & Snehota, I. (2000),"Making the Most of Supplier Relationships", Industrial Marketing Management, *29* (4), 285-386 (July 1000). Elsevier Science Inc.

[22] Giannakis, M. (2007), "Performance measurement of supplier relationships", Supply Chain Management: An International Journal, *12*(6), 400-411.

[23] Gunasekaran, A., Patel, C. and McGaughey, R.E. (2004), "A framework for supply chain performance measurement", International Journal of Production Economics, *87* (3), 333-347.

[24] Gunasekaran, A., Patel, C., &Tirtiroglu, E. (2001). Performance measures and metrics in a supply chain environment. International Journal of Operations & Production Management, 21(1/2), 71–87.

[25] Gunasekaran,A. and Kobu,B.(2007),"Performance measures and metrics in logistics and supply chain management: a review of recent literature (1995-2004) for research and applications", International Journal of Production Research, *45* (12), 2819-2840.

[26] Hagen, R. 2002. "Globalization, University Transformation and Economic Regeneration: A UK Case Study of Public/Private Sector Partnership." International Journal of Public Sector Management *15* (3): 204–218.

[27] Hald, S.K. and Ellegaard, C. (2011), "Supplier evaluation processes: the shaping and reshaping of supplier performance", International Journal of Operations & Production Management, *31*(8), 888-910.

[28] Hamel, G. (1991), "Competition for Competence and Inter-partner Learning within International Strategic Alliances", Strategic Management Journal, 12.

[29] Hammer, M., and Champy, J. (1994), "Reengineering the Corporation: A Manifesto for Business Revolution", Sydney: Allen and Unwin.

[30] Handfield, R. B., & Nichols, E. L. (1999). Introduction to supply chain management. New Jersey: Prentice Hall.

[31] Handfield, R.B. and Melnyk, S.A.(1998), "The Scientific Theory-Building Process: a primer using the case of TQM", Journal of Operations Management – Special Issue on Theory Driven Empirical Research, *16* (4 July)

[32] https://www2.deloitte.com/content/dam/Deloitte/fpc/Documents/services/supply-chain-et-achats/deloitte_supply-chain-trends_en_sept2014.pdf

[33] Kannan, V.R. and Tan, K.C. (2002), "Supplier selection and assessment: their impact on business performance", Journal of Supply Chain Management, *38* (3), 11-21.

[34] Lambert, D. M., and M. A. Shmeterman. 2012. "Supplier Relationship Management as a Macro Business Process." Supply Chain Management: An International Journal, 17 (3): 337–352.

[35] Lambert, D.M. and Pohlen, T.L. (2001), "Supply chain metrics", The International Journal of Logistics Management, *12* (1), 1-19.

[36] Lawton, R. (2002), "Balance your balanced scorecard", Quality Progress, *35* (3), 66-71.

[37] Lee, H., Padnababhan, P. and Whang, S. (2004), "Information distortion in a supply chain: the bullwhip effect", Management Science, *43* (4), 546-58

[38] Lohse, M. and Ranch, J. (2001), "Linking CPFR to SCOR",

Supply Chain Management Review, *5* (4), 56-62
[39] Luzzini, D., Caniato, F. and Spina, G. (2014), "Designing vendor evaluation systems: an empirical analysis", Journal of Purchasing and Supply Management, *20* (2), 113-129.
[40] Neely, A., Gregory, M., &Platts, K. (1995). Performance measurement systems design: a literature review and research agenda. International Journal of Operations & Production Management, *15*(4), 80–116.
[41] Pansiri, J. 2005. "The Influence of Managers' Characteristics and Perceptions in Strategic Alliance Practice." Management Decision, *43* (9): 1097–1113.
[42] Purdy, L. and Safayeni, F. (2000), "Strategies for supplier evaluation: a framework for potential advantages and limitations", IEEE Transactions on Engineering Management, *47* (4), 435-443.
[43] Purdy, L.,Astad, U. and Safayeni,F.(1994),"Perceived effectiveness of automotive supplier evaluation process", International Journal of Operations and Production Management, *14*(6), 91-103.
[44] Qi, Y., Zhao, X. and Sheu, C. (2011), "The impact of business strategy and supply chain strategy on business performance: the role of environmental uncertainty", Decision Sciences, 42 (2), 371-389.
[45] Ramanathan, U., Gunasekaran, A. and Subramanian, N. (2011), "Supply chain collaboration performance metrics: a conceptual framework", Benchmarking: An International Journal,*18* (6), 856-872.
[46] Sellitto,M.A., Pereira, G.M.,Borchardt,M.,daSilva,R.I .and Viegas, C.V.(2015), "ASCOR-based model for supply chain performance measurement: application in the footwear industry", International Journal of Production Research, *53*(16), 4917-4926.
[47] Shepherd C., Günter H. (2010) Measuring Supply Chain Performance: Current Research and Future Directions. In: Fransoo J., Waefler T., Wilson J. (eds) Behavioral Operations in Planning and Scheduling. Springer, Berlin, Heidelberg
[48] Slack, N. (1991), The Manufacturing Advantage, Mercury Books, London
[49] Stewart, G., 1995. Supply chain performance benchmarking study reveals keys to supply chain excellence. Logistics Information Management, *8* (2), 38–44.
[50] The Practice of Supply Chain Management: Where Theory and Application Converge. Kluwer, 2004, 61-73
[51] Vieri Maestrini, Veronica Martinez, Andy Neely, Davide Luzzini, Federico Caniato, Paolo Maccarrone, (2018) "The relationship regulator: a buyer-supplier collaborative performance measurement system", International Journal of Operations & Production Management, https://doi.org/10.1108/ IJOPM-10-2016-0595
[52] Webster, M. (2002). Supply system structure, management and performance: a conceptual model. International Journal of Management Reviews, *4*(4), 353–369.
[53] Zhang, D. (2006), "A network economic model for supply chain versus supply chain competition", Omega, Vol. 34 No. 3, pp. 283-295.

**APPENDIX A**

Table 3: A Taxonomy of Measures of Supply Chain Performance

| Stages in Supply Chain | Measure | | Quantitative | Qualitative |
|---|---|---|---|---|
| Plan | Cost | Profit | X | |
| | | Return on Investment | X | |
| | | Total supply chain management costs | X | |
| | | Asset turns | X | |
| | | Value added productivity | X | |
| | | Expansion capability | X | |
| | Quality | Fill rate (target fill rate achievement & average item fill rate) | X | |
| | | Accuracy of forecasting techniques | X | |
| | | Autonomy of planning | | X |
| | | Perceived effectiveness of departmental relations | | X |
| | | Order flexibility | X | |
| | | Perfect order fulfilment | X | |
| | Flexibility | Mix flexibility | X | |
| Source | Cost | Supplier cost-saving initiatives | X | |
| | | Percentage of late or wrong supplier delivery | X | |
| | Quality | Buyer-supplier partnership level | | X |
| | | Supplier rejection rate | X | |
| | | Supplier assistance in solving technical problems | | X |
| | | Extent of mutual planning cooperation leading to improved quality | | X |
| | | Distribution of decision competences between supplier and customer | | X |
| | | Quality of perspective taking in supply networks | | X |
| | | Information accuracy/Timeliness/Availability | | X |
| | Flexibility | Supplier ability to respond to quality problems | | X |
| Make | Cost | Total cost of resources | X | |
| | | Manufacturing cost | X | |
| | | Inventory obsolescence | X | |
| | | Inventory turnover ratio | X | |
| | | Economic order quantity | X | |
| | Quality | Inventory accuracy | X | |
| | | Percentage of wrong products manufactured | X | |
| | Flexibility | Inventory range | X | |
| | | Production flexibility | X | |
| | | Capacity flexibility | X | |
| | | Volume flexibility | X | |
| | | Number of tasks worker can perform | X | |
| Deliver | Cost | Total logistics costs | X | |
| | | Distribution costs | X | |
| | | Transport productivity | X | |
| | | Delivery efficiency | X | |
| | | Percentage accuracy of delivery | X | |
| | Flexibility | Delivery flexibility | X | |
| | | Responsiveness to urgent deliveries | X | |
| | | Transport flexibility | X | |
| Return (customer satisfaction) | Cost | Warranty/returns processing costs | X | |
| | Quality | Customer satisfaction (or dissatisfaction) | X | |
| | | Level of customer perceived value of product | X | |
| | | Customer complaints | X | |
| | | Product quality | X | |
| | Flexibility | Flexibility of service systems to meet particular customer needs | X | |

Source: Craig Shepherd, Hannes Günter, (2006),"Measuring supply chain performance: current research and future directions", International Journal of Productivity and Performance Management, Vol. 55, (3), 242 – 258