



# An integrative approach in measuring hub-port supply chain performance: Potential contributions of a logistics and transport data exchange platform



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## ABSTRACT

The widespread globalization of production corporations in the late 20th century, as well as the subsequent trade facilitation policies of state authorities, generates an imperative need to extend the scope of supply chain management. Apart from the evaluation and monitoring of networked operations in different parts of the world, the effectiveness of trade policy measures is also included. This paper examines the potential contributions of a logistics and transport data exchange platform in measuring the performance of supply chain stakeholders of a hub port at different stages along the chain. A case study demonstrates how the integrative characteristics of a logistics and transport data exchange platform can be exploited to measure performances of different parties along the supply chain of a firm. More importantly, the authors explain how such a platform can be transformed into a system that evaluates the integrative supply chain activities of firm, the infrastructure, and the institutional stakeholders. A series of new supply chain performance metrics, including specific monitor end-to-end processes, can be captured by the proposed system. The paper concludes that in view of the significant policy implications of a platform-based supply chain performance measurement (SCPM) system, state intervention is critical to foster a high participation rate of the logistics and transport data exchange platform and develop its SCPM functions.

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## 1. Introduction

As a major force reinforced by advances in information and communications technology (ICT), globalization has expanded the breadth and depth of supply chains, and the complexity of the relationship between stakeholders (Mentzer et al., 2001). However, the development of supply chain performance measurement (SCPM) lags behind in providing an effective mechanism to monitor supply chain activities in the global context (Mann, 2012). Enhancing SCPM has become imperative under the accelerated growth of globalization and ICT advancement in the 21st century.

The international element of supply chain management (SCM) has been transformed significantly when U.S. manufacturers started offshore outsourcing (Dicken, 2011). To manage the widespread globalization of the market and production network of corporations in the late 20th century, supply chain models extend their scope to include the evaluation and study of

networked operations located in different parts of the world (Mentzer et al., 2001). Researchers have also discovered that apart from managing business-level activities and factors, the embedded environment of a global value chain (GVC), such as infrastructure and institutional conditions, also affects chain performance (Frederick and Gereffi, 2011).

In addition to the geographical extension fostered by globalization, SCM is transformed by advances in ICT, particularly the burst of e-commerce in 2000s. Porter (2001) incorporated the Internet into the value chain to illustrate the enhanced primary and supporting activities in terms of improved speed, accelerated information exchange, and wide geographical coverage. By applying ICT in a logistics system (i.e. e-logistics), additional interactions are generated between logistics service providers, shippers, consumers, and governments because of the options offered by e-commerce (Capineri and Leinbach, 2004). Thus Internet-based ICT facilitates real-time information sharing by multiple users of the supply chain.

An essential phenomenon that dissects major studies in globalized and e-based SCM is the principle of integration (among supply chain stakeholders), both from the firm dimension or the supply chain flow perspective (Porter, 2001) and the

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environmental dimension of infrastructures and institutions (Gereffi and Fernandez-Stark, 2011). Porter (2001) expected that the Internet would enable the integration of the whole set of the value chain, namely, suppliers, channels, and customers (i.e. stakeholders at firm level). By contrast, Gereffi and Fernandez-Stark (2011) explained the role of local economic and social conditions and institutions in upgrading GVC (e.g. infrastructure and institution). According to Wang and Cheng (2010), a supply chain is a multi-hierarchy structure of stakeholders associated with the tier of business (i.e. firm), gateway (i.e. infrastructure), and institution. Cross-hierarchy supply chain integration refers to the interplay between the parties of firm, the infrastructure, and the institution hierarchies, which could enhance the competitive strength of the supply chain concerned (Wang and Cheng, 2015). Examples of such services include advanced customs clearance or the integrative information platforms of state agencies, ports, and carriers. This cross-hierarchy perspective can also be applied in the analysis of SCPM, which this paper aims to accomplish.

This paper attempts to accomplish two purposes. First, we investigate how ICT, particularly e-logistics platform, can contribute to SCPM in monitoring activities under the integrated environment. Second, we explain the means in which such platform can be transformed into a system that evaluates interrelated supply chain activities of firm, infrastructure, and institutional stakeholders through a series of integrative performance metrics.

This paper is structured as follows. In the next section, we review the development of SCPM. In the succeeding section, we describe the methodology in detail, followed by a case study analysis of the contributions of a logistics and transport data exchange platform in SCPM. Based on such findings, we explain the means in which this platform-based SCPM may be transformed to expand its monitoring functions across firms, infrastructure, and institution stakeholders of a supply chain. In the last section, we discuss the results and limitations of this project, and further research opportunities of related study.

## 2. Current measurement of supply chain performance

To align with the research purpose, a hierarchical approach-division of the supply chain into firm, infrastructure, and institution level (Wang and Cheng, 2010), is adopted in reviewing related literature on SCPM. As advocated by several researchers (Gunasekaran et al., 2001), the purpose of SCPM is to develop effective performance measures and metrics that are capable of testing and revealing the viability of strategies, which can lead to improvement and realization of goals. Thus, SCPM is expected to generate management improvement. This purpose statement explains the overwhelming concentration of studies in firm-level SCPM (as discussed in the succeeding section) because the business sector considers the conditions of the supply chain environment as given (Holmberg, 2000).

### 2.1. Firm-level SCPM

Given the relevance and significance of SCPM (Gunasekaran et al., 2001), a rich collection of studies related to firm-level performance measurements has been accomplished. The approach of SCPM transforms from single-firm to inter-firm perspective is in line with the network relationship that Gadde and Snehota (2000) argue as the key for superior supply chain performance. We observe four foci of research related to the present study. First, as a management tool to improve a business, SCPM should be consistent with the strategies of a firm (Holmberg, 2000). Second, a balanced approach (i.e. balanced

scorecard or SCOR model) was developed by Kaplan and Norton (1996) not only measuring the financial performance of companies, but also analyzing an organization and its supply chains from four perspectives, namely, learning and growth, business process, customer, and financial performance. In line with such approach, Gunasekaran et al. (2001) developed the multiple-level framework for SCPM metrics, which are classified into strategic, tactical, and operational, such that the results of measurement would be addressed by the appropriate management level. Third, Shepherd and Gunter (2006) developed a multiple-level model and a process-based SCPM that targets five tasks, namely, plan, source, make, deliver, and satisfy customer. This method enables the mapping and analysis of complex supply chain. Fourth, the systems thinking or end-to-end approach argues that a single measurement system should be adopted to cover the entire supply chain (Holmberg, 2000; Cuthbertson and Piotrowicz, 2011). Such approach aligns with the inter-firm collaboration and control strategy of collaborative planning, forecasting and replenishment (CPFR), a supply chain system that has been widely adopted by the industrial and retail sector (Danese, 2007). The last three approaches adopt the integrative principle and consider the close relationship of stakeholders in a globalized and Internet-enabled supply chain. The scope of SCPM studies has been expanded from an intra-firm to inter-firm perspective, but the relationship between firms and the supply chain environment (infrastructure and institution) remains passive or given.

“You cannot manage what you cannot measure (Sink and Tuttle, 1989).” Thus, as an essential tool in monitoring the degree of success of supply chain strategies (Grosvold et al., 2014), SCPM plays an important role in capturing activities under the transformed environment of integrated relationship. Development in the measurement of firm-level performance leads to positive progress in reframing measurement mechanism and metrics from firm to process orientation and, to a certain extent, chain orientation (Schaltegger and Burritt, 2014), but not for cross-hierarchy SCPM.

### 2.2. Infrastructure-level SCPM

Given the concentration of logistics activities in ports and airports, the importance of such facilities in the infrastructure network of supply chains has been increasing (Bichou and Gray, 2004). The conditions of these facilities should be reasonable representations of this sector. Therefore, we focus on research related to the performance measurement of ports or airports. Although not explored as intensively as firm-level SCPM, researchers in this area tend to transform their approaches from discrete firm-based metrics to a process-oriented approach (Bichou, 2006). Bichou (2006) proposed that port performance measurement should be integrated with logistics, including traders affiliated with terminals. However, scant empirical examples are outlined to examine the feasibility of this concept. Other scholars (Langen et al., 2007) discovered that majority of ports commonly measure output and resource utilization performances, whereas the use of integrative performance metrics in the logistics and manufacturing sector are rare among the major ports of ocean trade (e.g. value-added of ports are only captured by Belgian and Dutch ports). Similarly, studies on airport performance measurement have focused on productive efficiency, such as the application of data envelopment analysis (DEA) to reveal the most efficient airports (Barros and Dieke, 2008). A typical illustration is the performance measures adopted by Hong Kong Air Cargo Terminals Limited (HACTL) to monitor services for users. For example, in 2014, the company achieved 100% fulfillment in cargo release (HACTL website) and met the performance standard within 30 minutes after document

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