Omega 39 (2011) 667–676

Contents lists available at ScienceDirect

Omega

journal homepage: www.elsevier.com/locate/omega

Inter-organizational information systems visibility in buyer–supplier relationships: The case of telecommunication equipment component manufacturing industry

Kyung Kyu Kim [a], Sung Yul Ryoo [b,*], Myung Dug Jung [c]

[a] Graduate School of Information, Yonsei University, Republic of Korea
[b] Rm#708, Matthew Hall, Graduate School of Business, Sogang University, 1 Shinsu-dong, Mapo-gu, Seoul, 121-742, Republic of Korea
[c] Purchasing Cooperation Department, KT, Republic of Korea

ARTICLE INFO

Article history:
Received 24 February 2010
Accepted 31 January 2011
Processed by B. Lev
Available online 19 February 2011

Keywords:
Inter-organizational information systems (IOIS) visibility
Asymmetries in IOIS
Supply chain cooperation
Information visibility

ABSTRACT

The concept and operation of supply chain (SC) visibility remain underexplored questions in supply chain management, as is the question of the facilitating role of inter-organizational information systems (IOIS) in achieving SC visibility. This paper seeks to elaborate on the novel concept of IOIS visibility and to explore the antecedents and consequences of IOIS visibility. Investigating SC cooperation from the perspectives of both partners (buyers and suppliers) is important, especially when channel partners depend on each other and when asymmetries in IOIS visibility can exist.

The data that this study requires were collected from 51 matched pairs of intermediate producers of telecommunication equipment components and their immediate suppliers. The results show that IOIS visibility is an important predictor of supply chain performance from the supplier's perspective. In turn, IOIS visibility is significantly influenced by the supply chain partner's internal IS integration and inter-organizational IT infrastructure compatibility.

1. Introduction

IT-enabled supply chain (SC) cooperation, such as virtual supply chain management and extended enterprise, has recently received increasing attention in the supply chain management (SCM) and information systems (IS) literature [1–6]. Specific issues related to IT-enabled supply chain cooperation include supply chain visibility (e.g., [7]), inter-organizational information sharing (e.g., [2,8]), and external linkages (e.g., [9,10]). While these concepts have become popular buzzwords in SCM, they remain ill-defined and poorly understood [7]. Many researchers have highlighted the need to elucidate the concept and operation of supply chain visibility [10–12]. Furthermore, the facilitating role of inter-organizational information systems (IOIS) in achieving supply chain visibility has received inadequate research attention, while IOIS has been treated as a black-box (e.g., [13]). Supply chain visibility becomes feasible only when participating organizations are inter-connected through IOIS.

An IOIS is defined as a network-based IS that extends beyond traditional enterprise boundaries [14]. With IOIS making information visible to other organizations, the organizational boundary is redefined and extended to the extent that a firm's value chain needs to be redesigned. IOIS has the potential to produce synergistic effects on supply chain performance, although implementing an effective IOIS requires a significant amount of effort from participating firms. Penrose [15] asserts that the extent to which a firm's resources fit with another firm's resources (e.g., IOIS) can reduce imitability and deter mobility. This effect can be further enhanced if the resources are embedded within a complex inter-firm relationship, making the resource even more difficult to replicate [16].

Reflecting on the central role of IOIS in IT-enabled supply chain cooperation, this paper proposes a new concept of IOIS visibility, namely, *the extent to which partner firms' information/knowledge related to supply chain cooperation is visible to the focal firm through inter-organizational information systems.* Organizations in a supply chain need to have access to information from their partner firms that they consider key or useful to their operations and that will provide mutual benefits [7,17,18]. The enhanced visibility of customer and/or supplier operations may help improve the entire supply chain performance and their own internal decision making and operating performance [9,19–22]. Thus, the first objective of this paper is to elaborate on the novel concept of IOIS visibility and to explore the IS-related antecedents and consequences of IOIS visibility.

Furthermore, most existing empirical investigations of supply chain cooperation investigate the phenomenon from the perspective

* Corresponding author. Tel.: +82 2 705 8019; fax: +82 2 2123 8654.
E-mail addresses: kyu.kim@yonsei.ac.kr (K. Kyu Kim), syryoo@sogang.ac.kr (S. Yul Ryoo), pointman@kt.com (M. Dug Jung).

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doi:10.1016/j.omega.2011.01.008

of only one partner (for exceptions, see [23]). Investigating supply chain cooperation from the perspectives of both partners (buyers and suppliers) is important [24], especially when channel partners depend on each other and when asymmetries in IOIS visibility can exist [23]. Channel relationships that are asymmetric in dependence and power are more dysfunctional and less stable than symmetric relationships [25]. When dependence asymmetries occur, IOIS visibility can be distorted according to the firm's status in the channel, that is, according to whether it has relative power or relative dependence. Asymmetric IOIS visibility may increase the possibility of opportunistic behavior by a trading partner [26], leading to uncertainty about the level and division of benefits from increased information sharing.

While the buyer's perspective in buyer–supplier relationships receives much attention, prior studies have shown discrepancies in the perspectives of buyers and suppliers. For example, Forker et al. [27] report that both parties have different views on the buyer's implementation of the supplier's development activities. Similarly, Kim et al. [23] have found that buyers' perspectives are different from those of suppliers in regard to both the facilitators and barriers of buyer–supplier relationships. For instance, buyers identify switching costs and inter-organizational trust as significant determinants of cooperation, while suppliers identify technological uncertainty and the reciprocity of the relationship as significant determinants. Therefore, studying supply chain cooperation from mutual perspectives is important in understanding how each partner regards the supply chain. Hence, this study attempts to accommodate both partners' perspectives in IOIS visibility and to look into the consequences of IOIS visibility from each participant's perspective.

The research model in the present study is investigated using a sample of 51 matched pairs of buyers and suppliers in the telecommunication industry. Specifically, the sample firms consist of manufacturers of telecommunication equipment parts and components. Intermediate producers (buyers in this sample) purchase low-level parts from their first-tier suppliers and assemble them into stable intermediate components. The final outputs from the intermediate producers are sold to telecommunication service providers who integrate them into a whole system. Effective manufacturing requires mutual adjustments and cooperation between the equipment manufacturers, because modular technologies must be integrated according to a certain agreed-upon protocol. Further, customer needs are constantly evolving in this industry, as is the technology required to meet them. In this type of environment, both SC partners benefit from cooperation because of the considerable interdependence between buyers and suppliers [28,29]. Thus, the pair of intermediate producers and their suppliers provides a good context in which to study IOIS visibility.

In the following sections, we briefly discuss the conceptual background for IOIS visibility and develop our research framework and hypotheses. We then describe the research methodology used in the present study and our key results. We conclude the paper by discussing the implications of our findings for future research and practice.

2. Conceptual background

2.1. Inter-organizational information systems (IOIS) visibility

Previous studies have identified supply chain visibility as an important determinant of supply chain competitiveness for various reasons: (1) the visibility across organizational boundaries improves supply chain efficiency by reducing cycle time and stockouts [21]; (2) seamless information flows between customers and suppliers can balance supply and demand across the network by alleviating the bullwhip effect [30,31]; and (3) supply chain transparency reduces uncertainties in a dyadic relationship and enhances organizational trust, and thereby, enables flexible adaptation to changing circumstances [32,33]. As a cornerstone of supply chain visibility, the SCM literature (e.g., [7,8]) proposes the concept of information visibility, which is *the degree to which the supply chain partners have on-hand information related to demand and supply for planning and control management* [34]. Although information visibility is critical for supply chain visibility, IOIS visibility that facilitates information visibility has not been investigated.

IOIS visibility should be distinguished from information visibility for the following two reasons: First, information sharing can be realized without IOIS, for example, through social contacts and procedural venues [35]. Since information is an *output* from IS, information visibility is feasible with or without IOIS visibility, which allows outsiders access to internal workings of IS. In addition, IOIS requires significant investments from the participating firms in long-term relationships. Investments into computing/telecommunication resources for an inter-organizational relationship often represent relation-specific capital, which has little value for other economic activities outside the relationship [36]. Further, the assets residing in IOIS are of a company-specific nature, which a firm would not reveal to outsiders. For example, corporate databases contain valuable customer and product information. Application programs often contain rules developed by the firm describing how to conduct its various business practices [37]. Making these IS assets visible to outside firms allow such knowledge assets to become public knowledge, thereby removing the firm's competitive edge over others in the industry group. These characteristics of IOIS visibility result in much higher transaction risks than information visibility without IOIS. In order to realize the benefits of IOIS visibility, participating firms require an effective governance structure (e.g., third-party enforcement or self-enforcing safeguards) that minimizes transaction costs, thereby enhancing efficiency [38].

Second, information visibility often works as a mechanism to mitigate problems such as opportunistic behavior that result from information asymmetry [32]. Exchanging information about forecasting, planning, product design, and manufacturing schedules reduces information asymmetry and monitoring costs, thus lowering the incentives of participants to behave opportunistically [39]. However, IOIS visibility may not mitigate, but actually strengthen asymmetric relationships by reflecting the asymmetry in terms of the scope and depth of the partner information that can be seen through IOIS. In the context of supply contract design, the more powerful party usually can assume the leadership position and, as a result, IOIS asymmetry remains a key feature of real supply chain relationships [40]. Therefore, IOIS visibility should be treated separately from information visibility.

2.2. Relational rents from IOIS visibility

The relational view [38] asserts that a firm may choose to seek advantages by creating assets that are specialized in conjunction with the assets of an alliance partner [41,42]. Productivity gains in the value chain are possible when firms are willing to make relation/transaction-specific investments [26]. IOIS as a relation-specific asset provides an electronic channel through which firms can instantly see their partner firm's information, without incurring significant costs for transactions. IOIS visibility has the potential to achieve relational rents by reducing communication errors, lowering total value chain costs, and fostering greater product differentiation.

IOIS visibility also creates opportunities for organizational learning and knowledge exchange. For example, collaborative planning, forecasting, and replenishment (CPFR) systems allow channel partners to learn concurrently about changes in the market situation and