RELATIONAL ANTECEDENTS OF INFORMATION VISIBILITY IN VALUE NETWORKS

Completed Research Paper

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Abstract

Value networks are inter-organizational structures with the purpose of realizing competitive and strategic gains. Effective management of these networks relies on the ability to sense where value lies within the network, and this can be achieved through information visibility. We therefore examine the performance potential of information visibility and the essential enablers of visibility in value networks. Based on the relational perspective of the firm, a research model was developed to investigate the association between relational antecedents, information visibility and strategic performance. Data collected from 168 firms indicated that both demand-side and supply-side visibility play a significant role in strategic performance, and factors such as relational assets, knowledge routines, complementary resources and effective governance mechanisms positively influence information sharing behaviors. Our findings indicate that cooperative partnerships among network members enhance performance through increased information visibility in the network.

Keywords: Value network, Relational View, Information Visibility
Introduction

Integrating fragmented supply chains is viewed as means of overcoming the challenges of increasing uncertainty in predicting consumer demands, larger product and service offerings, rapid technological advances and fiercely competitive markets in today’s fast moving business environments (Lee 2000). Accordingly, organizations consolidate and integrate their supply chains and move towards network-based structures for sourcing raw materials and technical know-how, and, for the distribution and sale of finished goods. Complex product offerings, volatile market conditions and demand uncertainty create the need for such network structures (Jones et al. 1997) that are referred to as value networks. Supplier value networks\(^1\) are inter-organizational structures that enable the flow of physical goods, information, financial resources and knowledge between multiple linked organizations for the design and development of products and services to satisfy end-user requirements (Rai and Bush 2007). Such value networks represent a collection of upstream suppliers, downstream channels to market, and ancillary providers that support a common business model within an industry (Christensen 1997).

An important premise in effective management of these value networks is the ability to sense where value lies within the network and better coordinate activities in order to appropriate the value. Information sharing can help organizations in anticipating opportunities within the network (Bovet and Frentzel, 1999; Samaddar et al. 2006) and react to such opportunities in a timely manner. For example, sharing information about the actual sales data at retail outlets allows manufacturers to understand demand variations and thereby optimize their production capacities (Lee et al. 1997). Buffers are common across value networks to deal with the uncertainties in demand and supply. An effective value network can allow firms to substitute information for these buffers and thereby increase agility in the network which can lead to reduction of inventory cost, as well as stock-out costs, or costs of marking down products.

Realizing the importance of information sharing in such value networks, organizations have introduced information technology (IT) solutions to support buyer-supplier relationships (Malhotra et al. 2005; Straub et al. 2004) that range from transactional exchanges to collaborative partnerships (Dwyer et al. 1987). While technological advancements allow organizations to set up the necessary IT linkages that allow them to share information, it does not necessarily translate into collaborative partnerships among transacting parties that can be achieved through the sharing of strategic information. Strategic information sharing involves risks where a firm might expose its business details and as a consequence limits its bargaining authority in a relationship or facilitate opportunistic behavior by its partners. Hence, firms have to carefully weigh the risks and benefits of information sharing and assess the contexts where information sharing is value enhancing. There exists a gap in understanding regarding why and how strategic information exchange occurs among transacting parties (Klein and Rai 2009). Therefore, there is a need to understand factors and conditions that facilitate and impede the sharing of strategic information among buyer-supplier relationships and the resulting performance implications of such information exchange. Further challenges arise when the information exchange is not just with a single transacting partner (a buyer or a supplier), but rather within a network of transacting parties as in a value network. This research aims to address these gaps by examining the factors that facilitate information visibility within value networks.

Relational processes and routines have been identified as pre-requisites for joint generation of relational rent among organizations. They are classified as joint investments in relational assets, the existence of complementary resources and capabilities among organizations, knowledge sharing routines and effective governance mechanisms (Dyer and Singh 1998). It has been shown that these processes and routines can lead to better inter-organizational relationships and higher performance in inter-organizational relationships (such as strategic alliances and partnerships, supply chain relationships, etc.). We propose that relational processes and routines will also contribute towards creating information visibility in a value network. From an organization’s perspective, however, establishing these processes and routines in one specific relationship (for instance, with one supplier) is simpler than having multiple relationships based on relational governance. Therefore, this research investigates the antecedents to information visibility within value networks.

\(^1\) In this paper, the term value network refers to vertically and horizontally integrated network of firms for the purpose of procuring raw materials and services that are transformed into end-products.
visibility for a focal firm in a value network by considering its relationship both with upstream suppliers and downstream buyers and examines the relationship between information visibility and performance.

The remaining sections of the paper are organized as follows: in the next section we provide the theoretical background for this study. We first conceptualize information visibility and identify its various dimensions, and then provide an overview of various relational factors that facilitate information visibility. This is followed by a detailed description of the research model and hypotheses statement. We then describe the research design and present the data analysis and results. The paper concludes with a discussion on the implications of the findings.

**Theoretical Background**

**Conceptualizing Information Visibility**

Information systems researchers have focused on analyzing the use of information technology to integrate members in a supply network. Such research is guided by the reasoning that the ability to easily, efficiently and economically access information outside a focal firm’s boundaries can generate efficiencies for members of an exchange relationship (Klein et al. 2007). The nature of IT used in exchange relationships, and how information sharing can help in achieving supply chain process integration for performance gains (Rai et al. 2006; Subramani 2004); how capabilities of IS applications deployed in inter-firm relationships can help in performance gains (Saraf et al. 2007); how the use of standardized IT applications can help firms in overcoming knowledge exchange barriers in inter-firm relationships (Malhotra et al. 2007); and how these information systems must be governed (Chatterjee and Ravichandran 2012) have been analyzed.

Information visibility of the network is determined by the extent to which information is available to member firms (Lamming et al. 2001), and is achieved through information sharing. While information sharing plays an important role in supply chain management (Lee and Whang 2000), there is significant ambiguity regarding what information should be shared, how to share it and when to share it (Kaipia and Hartila 2006). Further challenges arise when the information exchange is not just with a single transacting partner (a buyer or a supplier), but within a network of transacting parties as in a value network. Our research addresses this by adopting a more holistic view towards conceptualizing information visibility in value networks and identifying its dimensions.

We conceptualize information visibility as the access to relevant, timely and accurate information to a firm within the value network. Information systems research has focused on understanding the quality of information that a system can provide (e.g., Lee et al. 2002). Thus, the construct “information accessibility” has been used to capture the notion of the quality of the information system, and is usually considered as an important factor determining the success of information systems (Culnan 1984). However, information accessibility does not tap into the notions of timeliness and relevance. Further, it refers to information quality as perceived by individual users of a system, rather than a more objective assessment of the information. There is significantly less research directed towards assessing the quality and completeness of information shared among network members (Straub et al. 2004).

Sharing of information provides the visibility to optimize supply chain performance (Simatupang et al. 2002), and the availability of high quality information can address the supply chain related needs of the member firms (Wang and Strong 1996). For instance, suppliers can pool information about buyer requirements across time, channels and services to globally optimize plans and process execution (Lewis et al. 2007), while buyers can use such information to streamline processes, develop value-added products and services, and strengthen customer ties (Gulati and Kletter 2005).

In the context of supply chain information sharing, previous research has categorized the information shared as order (or transactional) information, operational, and strategic (and/or competitive) information (Rai and Bush 2007, Seidmann and Sundarajan 1997). While order bookings, order processing status, shipping schedules and shipment status can be referred to as transactional information, cost structures, production schedules, inventory status, demand forecasts, marketing strategies and product design information can be considered as strategic information (Klein and Rai 2009). The total spectrum of transactional and strategic information that can be shared within the supply chain is referred
to as the breadth of the information shared. The information breadth is therefore an objective measure of information visibility in supply networks.

Information that is relevant can facilitate firms to take collaborative actions and create higher value (Wang and Wei 2007). Information relevancy is reflected in whether a piece of information is considered to be a factor that can affect supply chain behaviors and is beneficial from the firms' point of view (Huang et al. 2003). Therefore, information relevancy is an important dimension of information visibility in value networks, particularly because the relevancy of the information is often dependent on who receives and uses the information. For instance, demand forecasts are more relevant when shared with upstream suppliers, but may be less relevant from the perspective of a customer.

Information visibility also refers to the timely availability of information. Timeliness refers to the earliness or lateness of information sharing. When information sharing within the supply chain lacks timeliness, there can be negative consequences such as the occurrence of the bullwhip effect (Lee et al. 1997, Hong-Minh et al. 2000). Accordingly, sharing information in advance has been proposed as a positive factor influencing supply chain performance (Huang et al. 2003). For instance, Bourland et al. (1996) found that timely availability of demand information increases the service level under various conditions, and the interaction between earliness of demand information and other factors have been studied using a simulation model (Zhao et al. 2001). Evidence suggests that there is a relationship between the timeliness of information sharing and supply chain performance. Accordingly, information latency – or the time delay with which information is shared within supply networks is an important dimension of information visibility.

Thus, information visibility can be conceptualized as a multi-dimensional construct made up of three dimensions – information breadth, information relevancy and information latency, where each of these dimensions reflects a certain aspect of the information that is being shared.

**Relational Factors Facilitating Information Visibility**

The relational view of the firm (Dyer and Singh 1998) explains how exchange relationships among transacting firms can be developed into collaborative partnerships. The basic premise of the relational view of the firm is that firms can realize relational rents and competitive advantages through value enhancing relationship-oriented initiatives. In contrast to the resource based view of the firm which focuses on a firm’s individual resources and capabilities, and the industry structure and competitive forces model which focuses on external factors to determine firm strategy and performance (Porter 1980), the relational view of the firm emphasizes the value generating potential of dyads or networks on the basis of their connections. Therefore the relational view is particularly suitable for analyzing supply chain management initiatives for realizing higher performance gains (e.g., Klein and Rai 2009; Goswami et al. 2011).

The relational rent generating mechanisms that have been proposed by Dyer and Singh (1998) are investments into relation-specific assets, setting up of knowledge sharing routines, complementary resources and capabilities and effective governance. Relation-specific asset investments refer to joint investments made by firms in order to realize the goals of the exchange relationship. These investments can act as safeguards that deter firms from defecting, work towards enhancing individual firm’s commitments to the relationship, and have been proposed to facilitate strategic information flows between partners through asset interconnectedness (Klein and Rai 2009).

Alliance partners are considered the best source of new ideas and information that can result in performance enhancement. Therefore, firms often establish joint ventures, strategic alliances, and research and development (R&D) networks in order to get access to new ideas and knowledge. Creation of knowledge sharing routines helps firms to realize the expected knowledge gains from such networks and alliances. Knowledge sharing routines define regular patterns of inter-firm interaction that permit the transfer, recombination and creation of specialized network level knowledge (Dyer and Singh 1998; Grant 1996). For instance, Toyota has established such knowledge sharing routines to achieve a high performing supplier network (Dyer and Nobeoka 2000; Dyer and Hatch 2006).

Complementary resources and capabilities have been proposed as important determinants of relational rents (Dyer and Singh 1998). Complementary resources refer to the resources that are owned by each firm in a relationship, which when combined and used together can result in improved overall performance.
because of their synergistic effects. In the context of value networks for instance, the capabilities of IT applications and systems used for the management of supply chain activities can be viewed as complementary resources when firms realize synergies through the use of these systems. For example, when IT systems and processes are compatible, firms can share operational and transactional information with each other without having to rely on costly or time-consuming transformations. Transactional dependencies among supply chain members create a need for generating these complementarities (Klein and Rai 2009), and the existence of such complementarities allow organizations to share and meaningfully process the shared information (Malhotra et al. 2005).

Finally effective governance mechanisms are reflected by factors such as trusting beliefs, willingness to solve problems and relational issues together. These mechanisms are based on self-enforcement rather than third party enforcement, and they reduce concerns about opportunistic behavior, misappropriation of information, and therefore facilitate information sharing.

**Research Model and Hypotheses**

Information integration has been described as an important factor in successful supply chain management (Lee et al. 2000). This research posits the relationship between information visibility and performance in value networks based on the relational view of the firm. By proposing information visibility as a requisite for rent generation in supply chain relationships, we examine the various relational factors (Dyer and Singh 1998) that determine information visibility from a focal firm’s perspective.

![Figure 1. Research Model](image-url)

**Information Visibility and Strategic Performance**

Information visibility enables firms to realize performance gains through anticipating opportunities within the network and acting on them (Samaddar et al. 2006). Previous research has discussed the relationship between information sharing and performance (for example, Cachon and Fisher 2000; Sahin and Robinson 2002; Lee et al. 1997). For instance, higher levels of information sharing, and also the sharing of more collaborative information differentiates Toyota’s supply network from that of other automobile manufacturers. Similarly, it was found that the mutual exchange of strategic information with its suppliers allowed Walmart to realize significant performance gains and create value (Yoffie and Mack 2005). Therefore, performance gains are accrued in supply chain relationships through information sharing (Klein et al. 2007).
From a focal firm’s perspective, performance gains have been characterized as operational efficiency gain, revenue growth and better management of relationships with its customers (Rai et al. 2006). Having access to the relevant information in a timely manner will allow network members to improve forecasts, synchronize production and delivery, coordinate inventory-related decisions and develop a shared understanding of performance bottlenecks (Lee and Whang 2000; Simchi-Levi et al. 2003). These improvements can be referred to as gains in supply chain operational performance.

Information visibility not only allows firms to realize operational performance gains, but also improve their strategic performance. For instance, when real time demand information is shared within a value network (demand-side information visibility), members can carry out collaborative forecasting through precise demand estimation and better alignment of supply with demand. This will help firms in improving customer service and in establishing stronger bonds with their customers by reducing stock-outs through timely replenishments. Having timely access to supply fluctuation in the sourcing of raw material (supply-side information visibility) can allow firms to plan for contingencies more efficiently. By having more information regarding customer preferences, the network as a whole will be in a better position to not only generate increased revenue from existing products, but also launch new products, and realize performance gains in both existing and new markets (Rai et al. 2006).

In short, information visibility allows firms to not only improve their operational performance, but also to realize significant improvements in their strategic performance and gain competitive advantages. Further, such performance gains are unlikely to be confined to an individual firm, but can translate into gains for other members of the value network, and can be viewed as relational rent generated due to information visibility. Network members will be able to synchronize their production and delivery cycles based on a better alignment between demand and supply. Figure 1 depicts the research model. We hypothesize:

**H1a:** Demand-side information visibility is positively related to strategic performance of the focal firm.

**H1b:** Supply-side information visibility is positively related to strategic performance of the focal firm.

### Relation-specific Assets and Information Visibility

Investment into relation-specific assets increases the stake that each member has towards the relationship and therefore their commitment towards the relationship, and creates a mutual reliance relationship among partners (Williamson 1983). The specialization of assets is considered a requisite for either direct or indirect relational rent generation (Amit and Schoemaker 1993).

Partner opportunism is a serious concern in inter-organizational relationships, and the apprehension of opportunistic behavior often prevents firms from sharing information that is considered valuable. Concerns regarding opportunistic behavior are particularly critical when strategic information is also shared among the member firms. This is because strategic information such as plans, resources, marketing strategies, etc. are highly proprietary (Klein and Rai 2009), and therefore concerns regarding losing proprietary capabilities and competitive advantages due to loss of information power can be aggravated. Investments into relation-specific assets can mitigate such concerns by acting as deterrents towards partner opportunistic behaviors.

By making relation-specific investments, firms increase their commitment towards the relationship. Increased commitment raises the stakes that organizations face to make the relationship successful and can act as a facilitator for information sharing within the value network. Increased investment in relational assets between the focal firm and its customer will positively influence the demand-side information visibility, while increased investment in relational assets with the supplier will enhance the supply-side information visibility. Accordingly, we hypothesize:

**H2a:** Investment in customer-specific relational assets is positively related to demand-side information visibility for the focal firm.

**H2b:** Investment in supplier-specific relational assets is positively related to supply-side information visibility for the focal firm.

### Complementary Resources and Information Visibility
Complementary resources are also defined as distinctive resources of alliance partners that when collectively deployed can generate higher returns than the sum of returns generated by their individual deployments (Dyer and Singh 1998). These resources are often difficult to imitate or procure from the market. The extent to which these resources are indispensable for the relationship determines the level of dependence that the focal firm has on its buyer or supplier (Klein and Rai 2009). It has been proposed that complementary resources and capabilities can result in the creation of relational rents (Dyer and Singh 1998). However, the mechanisms through which they work can vary.

Increased dependency among firms can motivate them to share more information with the buyer. Therefore, the greater the complementary resources among member firms, the greater will be the information visibility within the relationship. At the same time, greater levels of information visibility help firms in recognizing valuable partner resources and capabilities which can complement their own; and deploy them appropriately for joint innovation and improvement. In the context of information sharing in supply chain relationships, complementary resources can also be operationalized through complementarities among IT systems and applications used by the firms involved in the relationship. IT is considered an important differentiator in terms of performance among supply chains and networks, and accordingly, firms deploy sophisticated IT tools and infrastructures to manage their supply chain and logistics related processes and activities. Complementarities between the IT of the focal firm and that of its buyers and suppliers can make it easier to share the required information without having to rely on different transformations of the information that is being shared. Therefore, complementarities in IT resources and capabilities facilitate information visibility in supply chains and networks.

Based on the above reasoning, hypotheses 3a and 3b posit that higher levels of complementary resources between the focal firm and its customers and its suppliers results in higher information visibility for the focal firm.

H3a: Complementary resources between the customer and the focal firm are positively related to demand-side information visibility for the focal firm.

H3b: Complementary resources between the supplier and the focal firm are positively related to supply-side information visibility for the focal firm.

**Knowledge Sharing Routines and Information Visibility**

Alliance partners are considered the best sources of new information and knowledge that can result in performance gains. However, learning within an alliance is contingent on the knowledge sharing environment and mechanisms that exist between alliance partners (Kale et al. 2000). Knowledge sharing routines refer to the regular patterns of interaction between networks members that allow the transfer, recombination and creation of specialized network knowledge (Dyer and Singh 1998; Grant 1996). Therefore, knowledge sharing routines can be defined as the extent to which formal and informal mechanisms are established for the exchange of information and knowledge between the focal firm and its supply chain partners (Patnayakuni et al. 2006). Superior knowledge sharing mechanisms between supply network members can out-innovate and out-perform less effective knowledge sharing routines and mechanisms (Von Hippel 1988).

Well-defined knowledge sharing routines help in structuring the coordination and communication between a focal firm and its supply chain partners so that more information and knowledge is revealed and combined (Patnayakuni et al. 2006). By establishing knowledge sharing routines in the network, member firms not only become aware of the need for information exchange for these routines to function properly, but also of the kind of information that needs to be shared within the network. For instance, formal routines and practices focusing on collaborative planning related interaction among supply chain partners resulted in an integration of their information flow (Siemieniuch et al. 1999). Therefore, knowledge sharing routines result in higher levels of information visibility in supply chains and networks. This leads us to hypothesize:

H4a: Knowledge sharing routines established between the customer and the focal firm is positively related to demand-side information visibility for the focal firm.

H4b: Knowledge sharing routines established between the supplier and the focal firm is positively related to supply-side information visibility for the focal firm.
Effective Governance and Information Visibility

Governance measures affect the willingness of network members to engage in value creating initiatives (Dyer and Singh 1998). Inter-firm governance can rely either on third-party enforcements (such as legal contracts) or on self-enforcing mechanisms. The cost and complexity of contracting and monitoring third party governance is usually higher than that of self-enforcing governance mechanisms; self-enforcement is therefore considered an effective approach towards rent generation in inter-firm relationships (Dyer and Singh 1998). Self-enforcing agreements focus on mutual benefits for all involved parties. An expectation of long-term continuity of the relationship acts as a deterrent to selfish opportunistic behavior on behalf of the transacting parties, and forms the basis of self-enforcement in governing the relationship.

Self-enforcing governance mechanisms can be further distinguished into formal and informal governance mechanisms. Formal mechanisms are reflected by joint investments which increase each partner’s stake in the relationship, and therefore act as safeguards against relational contingencies. Informal governance mechanisms are embedded in trust and mutual cooperation (Uzzi 1997). Therefore, informal governance mechanisms emerge through repeated exchanges that are embedded in social relationships (Poppo and Zenger 2002), and reflect the values and agreed-upon processes that are commonly found in such social relationships (Heide and John 1992, Macneil 1980).

Strong trusting beliefs are considered a pre-requisite for fostering a firm’s willingness to share tacit knowledge (Patnayakuni et al. 2006), engage in collaborative initiatives such as sharing strategic information (Klein and Rai 2009), and create relationship-specific routines that are the sources of sustainable value. When partners are confident about each others’ integrity and reliability, competitive impediments to information exchange such as partner rivalries, and protective behaviors due to the fear of losing ownership and superiority are reduced (Simonin 1999). Relationships based on mutual trust will naturally be conducive towards sharing higher order information that allow for synchronization and optimization across the value chain. Therefore, effective governance measures are positively associated with information visibility.

H4a: Self-enforcing governance mechanisms between the customer and the focal firm are positively related to demand-side information visibility of the focal firm.

H4b: Self-enforcing governance mechanisms between the supplier and the focal firm are positively related to supply-side information visibility of the focal firm.

Control Variables

In addition to the theoretical variables considered in our research model, we control for the following factors which are often considered influential in supply chain management, and therefore, likely to affect information visibility and performance in the value network.

Product Lifecycle

The nature of the product plays a significant role in determining how the supply chain is designed and managed (Fisher 1997; Lee 2002). Products have often been characterized by differences in life-cycles, where products with short life cycles become outdated very soon. Managing the value network of such products require capabilities to spot trends, or respond quickly to demand fluctuations (Cachon and Swinney 2010; Caro and Gallien 2010). These products call for market responsive supply chains to meet the requirements of small response times and short product life cycles. We include product lifecycle as a control variable for demand-side and supply-side information visibility.

Product Customization

The extent to which a product is customized depends on several factors such as flexibility or the planning and production process and market factors such as demand volatility, and is determined by competitive priorities (Olhager 2003). Therefore, the downstream customer-facing activities and upstream supplier facing activities will be affected by the extent of product customization. We include product customization as a control variable for demand-side and supply-side information visibility.
Firm Size

Past research suggests that larger firms have advantage in terms of greater available resources to influence the realization of performance gains. Therefore we specify firm size as a control variable for strategic performance (Hitt et al. 2002).

Research Design

Choosing survey research as the research methodology for this study, we developed and validated measures for this study using guidelines from the information systems literature (example, Sethi and King 1991; Straub 1989). Past literature was reviewed to develop measures that tapped into the underlying theoretical constructs, had face validity and had minimal overlap with other constructs. As measures were developed for the first time for this survey, steps were taken to assess content validity. Items were independently evaluated by each researcher, and then subsequently in joint meetings where each construct and its items were reviewed and discussed until there was agreement regarding the content validity of the items. We further had four industry experts (experienced professionals working in the area of supply chain management) and two experienced IS researchers evaluate the instrument at various stages of development, and their feedback was used to refine and finalize the questionnaire (Cronbach 1971). The finalized questionnaire was then pilot tested on eight IS doctoral/masters student who were enrolled in masters level courses on supply chain management and can therefore be expected to have domain level knowledge and expertise on the subject of research. They were asked to comment on the content of the items as well as the provided instructions. Their feedback was used to refine the final instrument by deleting certain items, clarifying instructions, and so on.

Unit of Analysis: A Focal Firm and its Two Dyads

The phenomenon of interest in this study is information visibility in the value network, and its antecedents and consequences. Information visibility goes beyond just the sharing of information between a focal firm and its supplier (or its customer), to that of having both upstream and downstream visibility of the network.

Therefore, in the context of this study, we assess information visibility by focusing on a focal firm and two dyadic relationships that the firm has – one with a supplier, and the other with a customer. In industrial supply chains which are the context of this study, customers refer to industrial channel partners rather than end customers. Respondents of our survey were asked to name one major supplier and one major customer with whom they carried out a significant portion of their business, and then respond to the corresponding questions, keeping in mind their relationship with the named supplier/customer. This research design allowed us to investigate information sharing patterns existing between the focal firm and two transacting partners – an upstream supplier and a downstream customer.

Operationalization of Variables

Constructs in a research model gain meaning from their definition and the theoretical context in which they are embedded. Table 1 provides the definition of each of the constructs in our research model and the items used to measure them. In order to enhance the validity of the measures, we selected items from previous research wherever possible. The theoretical meaning of information visibility and its content domain is conceptualized as multi-dimensional and made up of three different dimensions – information breadth, information relevancy and information latency. Therefore, empirically it modeled as a formative construct made up of three sub-constructs (Kim et al. 2010; Petter et al. 2007). Most of the items were measured using a five-point likert scale.

<table>
<thead>
<tr>
<th>Construct</th>
<th>Definition</th>
<th>Operationalization</th>
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<tbody>
<tr>
<td>Information Visibility</td>
<td>Refers to the availability of the wide spectrum of supply chain related information that is relevant, accurate and useful and is also</td>
<td>Information visibility is operationalized as a second order formative construct where Information Breadth, Information Relevancy and Information Latency are the three first</td>
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<tr>
<td>Construct</td>
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<td>Information Breadth</td>
<td>Refers to the whole spectrum of information – transactional, operational and strategic, that is shared among supply chain members. Respondents indicated whether or not they shared the following different supply chain related information (with their buyer or supplier).</td>
<td>Measured as a summated score for different kind of supply chain related information shared (eg., new product information, bill of material, order bookings, demand forecasts, etc.). For each type of information shared, a score of 1 was awarded. The sum of all information items shared represented Information Breadth. Adapted from Wang and Wei (2007).</td>
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<tr>
<td>Information Relevancy</td>
<td>Refers to whether the information shared is relevant, accurate and useful for the firm.</td>
<td>Average summated score of three items measured on a 5-point likert scale. Adapted from Malhotra et al. (2005).</td>
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<tr>
<td>Information Latency</td>
<td>Refers to the timeliness of the information shared.</td>
<td>Single item measure using 5-point likert scale. Adapted from Malhotra et al. (2005).</td>
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<tr>
<td>Relational Assets</td>
<td>Refers to the non-recoverable asset investments that are specific to the relationship.</td>
<td>Measured on a 5-point likert scale using 3 reflective measurement items. Scale adapted from Bercovitz et al. (2006).</td>
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<td>Knowledge Routines</td>
<td>Refers to processes and exchanges that are established for joint execution with the buyer or supplier for the purpose of creation, combination, sharing and reuse of knowledge.</td>
<td>Measured on a 5-point likert scale using 5 formative measurement items. Adapted from Wang and Wei (2007).</td>
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<td>Complementary Resources</td>
<td>Refers to resources (in this case IT or IS resources) that are more valuable when used in the context of the exchange with the buyer or supplier, rather than on their own.</td>
<td>Measured on a 5-point likert scale using 2 reflective measurement items. Adapted from Gosain et al. (2004-5).</td>
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<td>Effective Governance</td>
<td>Refers to the governance mechanisms that are based on inherent cooperative norms between the firm and its buyer or supplier. Such governance mechanisms involve joint problem solving, mutual collaboration, goal setting through mutual consultation, and collaborative improvements.</td>
<td>Measured on a 5-point likert scale using 5 reflective measurement items. Scale adapted from Bercovitz et al. (2006).</td>
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<td>Strategic Performance</td>
<td>Refers to overall strategic performance gains for the focal firm rather than improvements in supply chain performance. Strategic performance is reflected by being able to take strategic actions such as entering new markets, releasing new products and services, etc.</td>
<td>Measured on a 5-point likert scale using 6 reflective measurement items. Scale developed based on Beamon (1999) and Gunasekaran et al. (2004).</td>
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<td>Product Lifecycle</td>
<td>A single item measure is used as an indicator for the length of the focal firm’s product’s life-cycle.</td>
<td>Measured on a 5-point likert scale asking about the length of the product life-cycle.</td>
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<tr>
<td>Product Customization</td>
<td>The extent to which the product and the production process is customizable.</td>
<td>Measured using 3-point categorical scale: Make to stock; Make to order; Engineered to order</td>
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</table>
Firm Size | The size of the firm as measured in terms of total revenues | Measured as an interval scale with values ranging from $500 million to $25 billion

**Data Collection**

The survey was administered through an online questionnaire. We consolidated the participation of executives from large companies (with annual revenues more than 500 million US dollars in the last two consecutive financial years) by sending them targeted emails and then following up through phone calls. The services of a leading market research firm with expertise in conducting academic surveys were used for the data collection. Our respondents comprised top-level executives (such as directors, vice-presidents, chief operating officer, executive vice-president), and had a minimum of two years of work experience in their current positions. Elaborate screening criteria were built into the online questionnaire to ensure that responses were obtained from companies having the desired profiles, and to ensure the validity of the responses. The screening criteria were aligned with the theoretical population that we wanted to study. All response came from publicly listed companies (company names and stock ticker symbols were used to verify this). Our respondents primarily belonged to the manufacturing, retail or wholesale divisions of various industries (such as automotive, electronics and electrical equipment, aviation, industrial machinery, food, chemicals, and pharmaceuticals). Since supply chain and network management incorporates both information flows and physical flows, we asked the respondents to think of a physical product that they transacted with an upstream supplier, or with a downstream customer. Further, respondents had to name a major customer and a major supplier, and also the length of their relationship with this customer/supplier. This helped in anchoring their responses to be more customer- (or supplier-specific). Post data collection, we used various checks to eliminate invalid responses. For example, responses with questionable answering patterns (all “1” or “5” on the likert scales) and responses where the survey was completed in less than 10 minutes were eliminated from the data-set. We received 168 completed responses that could be used for the analysis.

**Data Analysis and Results**

We used structural equation modeling (SEM) since it allows the modeling of multiple interdependent relationships and second order constructs (Anderson and Gerbing 1988). We used partial least square, a component based SEM technique that allows the inclusion of both formative and reflective measures in a model and does not make any distributional assumptions regarding the data (Diamantopolous and Winklhofer 2001). Further, it allows the simultaneous assessment of the measurement model as well as the structural model between latent constructs proposed in the research model.

**Assessment of Measurement Model**

In our model, Demand Side Information Visibility, Supply Side Information Visibility, Knowledge Routines_Customer and Knowledge Routines_Supplier are modeled as formative constructs, the remaining constructs are modeled as reflective, and the control variables – Product Lifecycle, Product Customization and Firm Size are operationalized using a single measurement item. The decision to model a construct as formative or reflective is based on four criteria (Jarvis et al. 2003): direction of causality from construct to indicators, interchangeability of indicators, covariation among indicators, and the nomological net of causal indicators. In formative constructs, indicators form the construct, and are therefore not interchangeable, need not covary and can be drawn from different nomological networks. The reverse holds true for constructs that are measured using reflective indicators. These criteria were used to determine the formative and reflective constructs in our model.

**Table 2. Psychometric Properties of Measurement Model**

<table>
<thead>
<tr>
<th>Construct</th>
<th>Item</th>
<th>Factor Loadings</th>
<th>Composite Reliability</th>
<th>AVE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strategic Performance</td>
<td>StrPer1</td>
<td>0.743</td>
<td>0.900</td>
<td>0.601</td>
</tr>
<tr>
<td></td>
<td>StrPer2</td>
<td>0.821</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>StrPer3</td>
<td>0.761</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>StrPer4</td>
<td>0.812</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
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StrPer5   StrPer6   0.784   0.727
Relational Asset_Customer
C_RelAsset1 C_RelAsset2 C_RelAsset3 0.818 0.891 0.850 0.890 0.729
Comp. Resources_Customer
C_ComRes1  C_ComRes2  C_ComRes3 0.902 0.810 0.864 0.847 0.735
Effective Gov_Customer
C_EffGov1  C_EffGov2  C_EffGov3  C_EffGov4  C_EffGov5 0.797 0.784 0.699 0.753 0.789 0.876 0.586
Relational Asset_Supplier
S_RelAsset1 S_RelAsset2 S_RelAsset3 0.831 0.698 0.864 0.842 0.641
Comp. Resources_Supplier
S_ComRes1  S_ComRes2  S_ComRes3 0.880 0.785 0.820 0.820 0.695
Effective Gov_Supplier
S_EffGov1  S_EffGov2  S_EffGov3  S_EffGov4  S_EffGov5 0.820 0.774 0.798 0.775 0.795 0.894 0.628

For the reflective constructs, the measurement properties were assessed in terms of internal consistency, convergent validity and discriminant validity. Internal consistency was examined using composite reliability, which in PLS relies on the actual loadings to compute the factor scores, and is a better indicator of internal consistency than Cronbach’s alpha (Ranganathan et al. 2004). As shown in Table 2, the composite reliability for the constructs in the model were all above the suggested threshold of 0.7 (Chin 1998a; Straub 1989), thus supporting the reliability of the measures. Convergent validity is assessed through the correlation among items measuring a given construct. Table 2 presents the factor loadings of the measures of our research model. All items have significant path loadings at the 0.001 level. The average variance extracted (AVE) values are all higher than the recommended value of 0.50 (Fornell and Larcker 1981). Therefore, the convergent validity of the reflective measures can be considered acceptable.

For discriminant validity, the covariance between constructs should be less than the AVE for each construct. We compare the correlation between the constructs with the square root of the AVEs (Table 3), and the results indicate that the reflective constructs satisfies this condition. The factor loadings and cross loadings of the measurement items indicated that for each construct, the items measuring the construct loaded highly on to their corresponding construct, rather than on other constructs. Also, items measuring other constructs had much lower loadings on the construct. Therefore, the reflective measurement items in our model satisfy the two criteria for discriminant validity suggested by Chin (1998b).

<table>
<thead>
<tr>
<th>Measure Type</th>
<th>Measure Type</th>
<th>Measure Type</th>
<th>Measure Type</th>
<th>Measure Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
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<td>6</td>
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<tr>
<td>11</td>
<td>12</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CompRes_C</td>
<td>Reflective</td>
<td>.86</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EffGov_C</td>
<td>Reflective</td>
<td>.56</td>
<td>.77</td>
<td></td>
</tr>
<tr>
<td>KnowRoutine_C</td>
<td>Formative</td>
<td>.43</td>
<td>.63</td>
<td>--</td>
</tr>
<tr>
<td>RelAsset_C</td>
<td>Reflective</td>
<td>.51</td>
<td>.54</td>
<td>.53</td>
</tr>
<tr>
<td>InVisibility_C</td>
<td>Formative</td>
<td>.43</td>
<td>.40</td>
<td>.57</td>
</tr>
<tr>
<td>Prod_LifeCycle</td>
<td>Single Item</td>
<td>.18</td>
<td>-.29</td>
<td>-.21</td>
</tr>
<tr>
<td>StrategicPerf</td>
<td>Reflective</td>
<td>.39</td>
<td>.47</td>
<td>.51</td>
</tr>
<tr>
<td>CompRes_S</td>
<td>Reflective</td>
<td>.44</td>
<td>.48</td>
<td>.39</td>
</tr>
<tr>
<td>EffGov_S</td>
<td>Reflective</td>
<td>.36</td>
<td>.53</td>
<td>.40</td>
</tr>
<tr>
<td>KnowRoutine_S</td>
<td>Formative</td>
<td>.42</td>
<td>.49</td>
<td>.41</td>
</tr>
<tr>
<td>RelAsset_S</td>
<td>Reflective</td>
<td>.35</td>
<td>.36</td>
<td>.36</td>
</tr>
<tr>
<td>InVisibility_S</td>
<td>Formative</td>
<td>.43</td>
<td>.44</td>
<td>.40</td>
</tr>
</tbody>
</table>

Note: For the reflective constructs, diagonal elements are the square roots of the AVE.
Formative constructs are not subject to the same criteria. For formative constructs we assessed the indicator weights, since weights provide insights regarding the meaningfulness of the set of formative indicators and their relative importance for the overall construct (Klein and Rai 2009). When a construct is specified using n formative indicators, the ceiling of their average weight is the $\sqrt{1/n}$. This average standardized weight is achieved when the formative indicators explain all of the variance in a construct. In our case, the constructs KnowledgeRoutine_Customer, KnowledgeRoutine_Supplier, and Information Visibility (Demand side and Supply side) are specified using five indicators each, and therefore the theoretical maximum for the average weight of their indicators is 0.45. The observed average weights for the indicators measuring KnowledgeRoutine_Customer and KnowledgeRoutine_Supplier are 0.24 and 0.25 respectively. For Information Visibility, the observed average weights for the indicators are 0.28 and 0.27 respectively. Further, all the formative indicator weights are significant at 0.1 level of significance. The above results suggest acceptable measurement properties for the formative indicators.

We used Harmon’s one-factor test to assess the extent of common method bias in our data (Podsakoff and Organ 1986). All items were entered into a single exploratory factor analysis which produced 11 factors with an eigenvalue greater than 1, explaining 67% of the total variance, with the first factor explaining 29% of the variance. Since a single factor did not account for most of the variance, the results suggest that common method bias is not a significant issue in our data.

**Hypotheses Testing**

The proposed research model was assessed by examining the significance of paths in the structural model. Figure 2 shows the PLS structural model results. The path model accounts for 28% of the overall variance in the strategic performance of the firm, and the relational antecedents account for 39% of the variance in demand side information visibility, and about 57% of the variance in supply side information visibility, thus providing support for the proposed research model.

The results show that both $H1a$ and $H1b$ are supported. This indicates that both demand side and supply side information visibility significantly influence strategic performance of a firm. In terms of the relational antecedents of information visibility, investment in relational asset did not seem to have any significant effect on information visibility, therefore, $H2a$ and $H2b$ were not supported. However, knowledge sharing routines and complementary resources had a significant influence on information visibility, therefore supporting $H3a$, $H3b$ and $H4a$, $H4b$. Effective governance mechanisms between the supplier and the focal firm has a strong significant effect on information visibility ($H5a$ is supported). However, for the relationship between the customer and the focal firm, there is not significant effect of effective governance mechanism on information visibility ($H5b$ is not supported).
Product life cycle has a significant effect on both demand side and supply side information visibility, indicating that it is a particularly important factor in determining information sharing with both suppliers and customers. Product customization has a significant effect on supply side information visibility, indicating that the customization strategy is a significant determinant of the kind of information that is shared with upstream suppliers, but might not necessarily affect the downstream information sharing practices. Firm size does not have a significant influence on strategic performance. However, even in the presence of the control variables, the research variables in our model remain significant and taken together they have a stronger influence on information visibility than the control variables.

Discussion and Implications

A growing body of research has emphasized the role of integrated supply chain processes as a new model of competitive strategy (e.g., Bovet and Sheffi 1998; Christopher and Juttner 2000; Hsu et al. 2008). Accordingly, there has been a shift towards integrating supply chains to form value networks (Bovet and Frentzel 1999; Dyer and Nobeoka 2000; Harland and Knight 2001). Positing information visibility as a determinant of performance in value networks, we identify antecedents and consequences of visibility. Our research indicates that in value networks, information visibility is a source of rent as operationalized by strategic firm performance. Given the practical difficulties of measuring network visibility, we analyze demand side and supply side visibility for relationships that a firm has with a customer and a supplier. Demand side and supply side visibility together explain about 28 percent of the variation in a firm’s strategic performance. Therefore, our findings support the proposition that when organizations move past transactional exchanges towards collaborative partnerships, they require tighter cooperation (such as through information sharing) for rent generation (Morgan and Hunt 1994). Our results also indicate that while there is a move towards integrating upstream and downstream supply chains into value networks, supply side information visibility has a larger significant effect on strategic performance. This suggests that despite forming value networks, organization may continue attributing more importance to integrating information flows with their upstream suppliers, rather than also on managing the information flows with their downstream customers. This could be because firms having higher baseline expectations regarding information sharing from suppliers than from customers (Klein and Rai 2009).
Relational factors such as knowledge routines and complementary resources are significant determinants of both demand side and supply side information visibility, while effective governance mechanisms are significant determinants of only supply side information visibility. These indicate that pre-established cooperative routines and processes for knowledge sharing, and the ability to complement each other’s resources can act as both motivators and facilitators of information sharing among firms. The execution of such inter-firm routines and processes call for the availability of specialized information, and therefore, motivates firms to share more operational and transactional information with each other. Further, the setting up of such collaborative routines and processes gives rise to trust-based norms of cooperation within the relationship (Heide and John 1992), which encourages each party to share more nuanced information for realizing higher performance goals. Further, while complementary resources are viewed as a source for relational rent, the ability to recognize such complementarities resides on having access to the right information. Therefore inter-linked IT processes and capabilities act as resources that facilitate information sharing, and create the capability to identify and achieve more complementarities.

Surprisingly, effective governance was found to be a significant factor influencing supply side visibility, but not demand side visibility. This provides another indication that the traditional notion of supply chain management prevails among firms. Firms probably expect that in their relationship with a supplier, the onus of establishing self-enforcing mechanisms resides on them, while in their relationship with their customer, the onus of facilitating and establishing self-enforcement falls upon the customer. We did not find a significant effect of relational assets on information visibility, both upstream and downstream. Unlike strategic alliances, supply chain relationships usually start off with primarily transactional objectives that preclude the investment in non-recoverable assets, especially if they are of a physical kind. However, over time these relationships evolve towards being more collaborative and this results in the joint setting up of inter-linked processes and routines which are more important in the context of digitally enabled supply chain relationships. At the same time, further studies are required to explicate under what contexts relational assets might be significant. We provide a better understanding of the performance potential of information visibility in value networks. From a practical perspective, these results can be translated into actionable guidelines for the management of inter-firm relationships for strategic performance gains. From a theoretical perspective, this study explores the linkages between IS, strategy and operations management for value networks.

**Conclusion**

Adopting a holistic view towards information sharing, we theorize and show that strategic performance gains are realized when firms have both demand side and supply side information visibility. The significant influences of the various relational factors indicate that information visibility can be enhanced by managing supplier exchanges in a more collaborative manner, rather than relying on arm’s length management and governance strategies. Our findings have important implications for supply chain managers, who encounter increased complexities in simultaneously managing upstream and downstream relationships with their suppliers and customers.

**Acknowledgement**

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**References**


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