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Exploring Internal and External Supply Chain Linkages: Evidence from the Field

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Abstract

In their pursuit of improved operational performance, organizations in supply chains have sought to develop external information-based linkages with their customers and vendors. Has this course of action been at the expense of developing similar internal information-based linkages? This research explores the specific roles of internal and external information-based linkages in achieving improved operational performance. Based on a single case study that comprises a supply chain containing twenty-four internal and fourteen external linkages this research develops a series of propositions. We find that the individual internal linkages may be useful for

extending externally derived visibility, and for addressing to some extent, “structural holes” in the supply chain. Additionally, to extend visibility across the entire supply chain, organizations need to recognize the combining role of internal and external information-based linkages. Finally we offer some thoughts for future research in this area.

1 Introduction

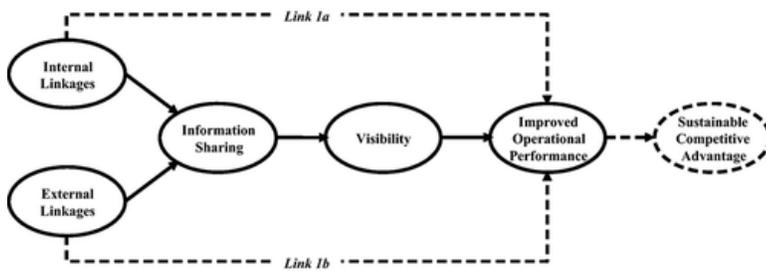
It has been argued that effective Supply Chain Management (SCM) is a source of potentially sustainable competitive advantage for organizations (**Christopher, 1992; Bowersox and Closs, 1996; Lambert et al., 1999; Mentzer et al., 2001**). SCM seeks improved performance through effective use of resources and capabilities via the development of internal and external linkages in order to create a seamlessly coordinated supply chain, thus elevating inter-firm competition to inter-supply chain competition (**Christopher, 1992, 1996; Anderson and Katz, 1998; Birou et al., 1998; Lummus et al., 1998; Ketchen and Guinipero, 2004; Ketchen and Hult, 2007**).

As part of their continued efforts to become more coordinated (**Christopher, 1992; Closs et al., 1998; Lummus and Vokurka, 1999; Lambert and Cooper, 2000; Lee and Whang, 2000; Mentzer et al., 2001; Moberg et al., 2002; Holweg and Pil, 2008**), and thus improve their performance, many firms have over the last decade focused their efforts to develop external, i.e., *inter-organizational* linkages with customers and suppliers (**Mabert and Venkataraman, 1998; Shore and Venkatachalam, 2003; Fiala, 2005; Barratt and Oke, 2007**). A number of authors have suggested that these closer information-based linkages are critical to effective supply chain management (**Spekman et al., 1998; Moberg et al., 2002; Whipple et al., 2002; Barratt and Oke, 2007**).

Rungtusanatham et al. (2003) introduced the concept of linkages in the supply chain, which they define as the “*explicit and/or implicit connections that a firm creates with critical entities of its supply chain in order to manage the flow and/or quality of inputs from suppliers into the firm and of outputs from the firm to customers.*” Such linkages, if managed effectively, could lead to an effective supply chain and have been shown to benefit the operational performance of firms involved in the linkages (e.g., **Kalwani and Narayandas, 1995; Forza, 1996; Narasimhan and Jayaram, 1998; Salvador et al., 2001; Boyer et al., 2005**), and may offer the potential for a sustainable competitive advantage (**Rungtusanatham et al., 2003; Barratt and Oke, 2007**).

Information-based linkages, if managed effectively, can give rise to visibility of customers’ and suppliers’ operational activities (**Aviv, 2001, 2002; Barratt and Oliveira, 2001; Fawcett and Magnan, 2002; Croson and Donohue, 2003; Van der Zee and Van der Vorst, 2005**). A number of researchers have suggested that such visibility can lead to improvements in operational performance (**Armistead and Mapes, 1993; Berry et al., 1994; Gavirneni et al., 1999; Lee and Whang, 2000; Kent and Mentzer, 2003; Mentzer et al., 2004; Patterson et al., 2004; Barratt and Oke, 2007**). For the purpose of this research, we define operational performance in those terms as utilized by the participating firms and informants. As such, improvements in operational performance are considered in terms of increased sales; improvements in customer service; reduction in the levels of on-hand inventory; together with improvements in forecast accuracy and numbers of quality-related issues.

Building on the work of **Barratt and Oke (2007)**, this paper explores both internal and external information-based linkages on the basis that improved performance is realized from the ability to coordinate or align *all such linkages* across a supply chain (see **Fig. 1** below). We extend the definition of **Rungtusanatham et al. (2003)** to include internal linkages, i.e., the explicit and implicit connections between the various functional entities within a firm.



(Source: Adapted from Barratt and Oke, 2007).

Figure 1. The concept of information-base linkages, distinctive visibility and operational performance.

1.1 Research questions

Scholars have not looked at internal linkages specifically (e.g., the interface between logistics and production, or logistics and marketing), or compared internal with external linkages (e.g., the linkages within a manufacturer with its links with its customers or suppliers). A comparison of internal and external linkages is useful in order to understand if the benefits of the external linkages are subsequently utilized by the internal linkages to maximize potential improvements in performance. Conversely, have organizations overlooked the ongoing importance of equally developing internal linkages, i.e., achieving internal integration? If this is the case, how have organizations overcome this external bias in terms of their linkage development and its impact on their performance?

This paper seeks to answer two main research questions, as follows: Firstly, what are the specific roles (beyond information sharing) of internal and external information-based linkages in the supply chain? Secondly, in the presence of external linkages with both customers (downstream) and suppliers (upstream), what relational links exist between the downstream and the upstream external linkages?

1.2 Layout of the paper

The paper is divided into four main sections. First, we review information sharing in the retail supply chain. We then review the literature on internal and external linkages and their impact on operational performance (e.g., **Boyer et al., 2005**). Next, we present our methodology which comprises the use of a single case study with embedded, multiple units of analysis, which explores the specific roles of internal and external (information-based) linkages across multiple tiers of a supply chain. Following this, the embedded units are analyzed and the results are discussed in line with the research questions of the study. Finally, a number of propositions relating to the specific roles of internal and external information-based linkages are developed, any relational links between upstream and downstream external linkages are then considered, followed by our conclusions and implications for further studies.

2 Literature review: information sharing in retail supply chains

The last decade has seen considerable attention to the role of information sharing in retail supply chains (for example **Cachon and Fisher, 1997; Chen, 1999; Gavirneni et al., 1999; Cachon and Fisher, 2000; Sahin and Powell-Robinson, 2002**), and, in particular, its role as a generic cure for many supply chain problems (**Forrester, 1958; Lee et al., 1997; Chen et al., 2000**). It has also been argued that the Internet has made it easier for organizations to share information (**Swaminathan and Tayur, 2003**). Despite this attention, the majority of research has focused on simulation and modeling approaches (**Chen, 1999; Gavirneni et al., 1999; Cachon and Fisher, 2000**); with only a very few empirically derived studies (**Gustin et al., 1995; Cachon and Fisher, 1997; Clark and Hammond, 1997**).

2.1 Information-based linkages: emerging visibility!

Many authors have recognized the critical need to share information (Schermerhorn, 1977; Chen et al., 2000; Lee et al., 2000), to improve operational effectiveness (Spekman et al., 1998; Moberg et al., 2002; Whipple et al., 2002), to reduce the impact of the ‘bullwhip’ effect (Dejonckheere et al., 2004), and to reduce the amounts of required finished goods inventory (Huang and Gangopadhyay, 2004). Other studies have also suggested that information sharing also leads to (1) better coordination of physical movements within the supply chain (Clark and Scarf, 1960; Collier, 1982; Gao and Robinson, 1994; Gustin et al., 1995; Closs et al., 1997), (2) improved decision making (Whang, 1995), and (3) closer to optimal inventory holding policies (Gavirneni et al., 1999).

Barratt and Oke (2007) defined supply chain visibility as “the extent to which actors within a supply chain have access to or share information which they consider as key or useful to their operations and which they consider will be of mutual benefit”. Going beyond just information sharing, it has been suggested by many authors that there is an organizational need for gaining visibility of their customers’ and suppliers’ operational activities, including: point-of sale (POS) data (Aviv, 2001, 2002; Barratt and Oliveira, 2001; Croson and Donohue, 2003); customer levels of inventory (Aviv, 2001, 2002; Barratt and Oliveira, 2001); and process visibility (Fawcett and Magnan, 2002; Van der Zee and Van der Vorst, 2005). A number of authors have also suggested the benefits that arise from visibility, including: (1) improved responsiveness (Armistead and Mapes, 1993; Berry et al., 1994; Patterson et al., 2004); (2) improved planning and replenishment capabilities (Armistead and Mapes, 1993; Mentzer et al., 2004); and (3) improved decision making (Kent and Mentzer, 2003).

If information sharing is so critical and the benefits so wide-ranging, then this issue is not about information sharing but rather about the quality, timeliness and usefulness of the information in creating visibility that leads to meaningful operational benefits (Bailey and Pearson, 1983; Gustin et al., 1995; Mohr and Sohi, 1995; Closs et al., 1997; Whipple et al., 2002).

2.1.1 Internal linkages and operational performance

Generally, the purpose of creating internal linkages has been to enhance information sharing (Carrood and Carrood, 1982; Link and Zmud, 1986; Kahn and Mentzer, 1998). While many authors have made the general case for improved operational performance from internal linkages between various functions within the firm (Table 1), there has been little research that examines specifically the impact of internal information sharing on organizational performance (Stank et al., 1999a,b; Ellinger et al., 2000; Mollenkopf et al., 2000).

Table 1. Impact of internal linkages on general organizational performance.

Organizational functions	References
Purchasing and manufacturing	Watts et al. (1990), Narasimhan and Das (1999), Pagell and Krause (2002)
Logistics and other internal functions	O’Neil and Iveson (1991), Stock et al. (1998)
Marketing and logistics	Schary and Becker (1973), Kahn and Mentzer (1996), Lynagh and Poist (1984a,b), Voorhees et al. (1988), Murphy and Poist (1992, 1994, 1996)
Manufacturing and marketing	Rho et al. (1994), Shapiro (1977)
Purchasing, logistics and operations	Fawcett and Fawcett (1995), Pagell (2004)
Marketing and R&D	Wind (1981), Souder and Moenaert (1992)
Marketing, manufacturing and R&D	Kahn (1996)

Source: Adapted from Ashenbaum (2005).

2.1.2 External linkages and operational performance

There have been two separate approaches to considering the impact of information sharing via external linkages on supply chain performance. Firstly, **Table 2** presents a breakdown of the literature that has adopted a coordination perspective of the impact of information sharing on supply chain performance (**Sahin and Powell-Robinson, 2002**).

Table 2. Impact of information sharing on supply chain performance.

Approach/perspective	References
Coordination of the flow of information	Forrester (1958, 1961), Stalk et al. (1992), Mason-Jones and Towill (1997, 1998)
Coordination of physical movements	Clark and Scarf (1960), Collier (1982), Gao and Robinson (1994), Silver et al. (1998)
Coordination of decision making	Whang (1995), Lee and Whang (1999), Chen et al. (2001)
Price coordination	Jeuland and Shugan (1983), Moorthy (1987), Lee and Rosenblatt (1986)
Optimal inventory policies	Gavirneni et al. (1999)
Information delays	Chen (1999)

Secondly, there has been a relatively small amount of empirical research that links the sharing of information to supply chain performance: (1) continuous replenishment for reducing cost of goods (**Cachon and Fisher, 1997**); (2) customer perceptions of logistics service provider's performance (**Stank et al., 1996a,b; Strader et al., 1999**); (3) information sharing as an antecedent to JIT purchasing (**Handfield, 1993**); (4) new product performance (**Gupta et al., 1986; Souder and Moenaert, 1992; Perks, 2000**); and (5) supplier performance (**Stank et al., 1996b**).

3 Methods

3.1 Background

The motivation for the study was to explore the specific roles and performance implications of internal and external information-based linkages across the supply chain. Data was collected between January 2004 and February 2005, with each visit taking from one day to one week, and multiple visits were made to three of the six firms involved. In all six firms, follow-up telephone conversations were held to complete the interviews. To enhance the triangulation of the data collected in the interviews, the same questions were asked of multiple informants. To further support the informants' responses additional firm-specific documentation was collected and observations were made within all the six firms.

3.1.1 Rationale

The case study represents a *rare* and *unique* (**Yin, 1989, p. 45**) example of information-based linkages within and across three tiers of a supply chain. According to **Yin (1989, p. 40)**, the single case can "offer a significant contribution to knowledge and theory building." While a single case offers only limited generalizability (**Bartlett et al., 2007; Ngai et al., 2007; Dunne, 2008**), it does allow an in-depth exploration of information-based linkages in their natural setting, i.e., a supply chain. It also provides the opportunity to develop a deep understanding of the nature and complexity of the phenomena and is appropriate when few (if any) previous in-depth studies on information-based linkages have been carried out (**Benbasat et al., 1987**).

3.1.2 Sampling

This research is based on a qualitative design involving a single case study with embedded multiple units of analysis (Yin, 1989, 2003; Denis et al., 2001; Clements et al., 2008). The case was selected for theoretical and not statistical reasons (Eisenhardt, 1989; Eisenhardt and Graebner, 2007). The case is made up of three tiers of a supply chain, comprising a retailer, a manufacturer and four packaging suppliers, and was identified due to the many industry plaudits its firms were receiving for their innovative use of information sharing. The manufacturer and the retailer had jointly developed a collaborative planning process and system specifically for improving their effectiveness and efficiency in managing and replenishing product promotions (Barratt and Oke, 2007). Upon contacting the manufacturing firm (hereinafter referred to as “ManCo”), we learned that despite the industry plaudits they had received, there were parts of their supply chain where information was not being shared. The case thus selected provided examples of polar types, i.e., high levels of information sharing and low levels of information sharing occurring in both internal and external linkages. In our study, the “unit of analysis” occurs at the operational level in the context of two embedded units of analysis: Internal information-based linkages and external information-based linkages. The supply chain for Brand X in Fig. 2 (below) comprises the Retailer (RetailCo), the Manufacturer (ManCo), and four packaging suppliers (GlassCo–glass Jars; LabelCo–plasticized labels; LidCo–plastic lids; and BoardCo–corrugated cardboard). There is also a supplier of a raw material which was excluded from the study, as the raw material is a commodity, purchased on the commodities spot market and therefore any linkage with the spot market is unlikely to benefit from information sharing.

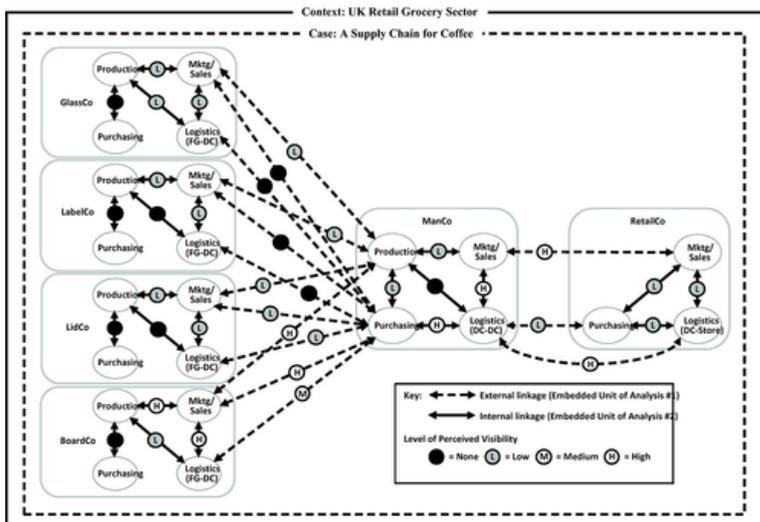


Figure 2. Context, case, and embedded units of analysis (internal and external linkages).

3.2 Units of analysis and informants

The purpose of this study was to explore the performance implications of information-based supply chain linkages. These can be internal linkages, i.e., intra-organizational within the firm, or external, i.e., inter-organizational between firms (see Tables 3 and 4 below). Such linkages could be purely technology based, e.g., an Internet or Electronic Data Interchange (EDI) linkage between a customer and a supplier or a combination of the use of technology combined with significant personal interaction (e.g., involving face-to-face communication) across internal or external linkages.

Table 3. External (embedded units of analysis) information-based linkages.

BoardCo ↔ ManCo	LidCo ↔ ManCo	LabelCo ↔ ManCo	GlassCo ↔ ManCo	ManCo ↔ RetailCo
Mktg-Prod.	Mktg-Prod.	Mktg-Prod.	Mktg-Prod.	Mktg-Mktg.

Mktg-Purch.	Mktg-Purch.	Mktg-Purch.	Mktg-Purch.	Log.-Purch.
Log.-Purch.	Log.-Purch.	Log.-Purch.	Log.-Purch.	

Table 4. Internal (embedded units of analysis) information-based linkages.

BoardCo	LidCo	LabelCo	GlassCo	ManCo	RetailCo
Mktg-Log.	Mktg-Log.	Mktg-Log.	Mktg-Log.	Mktg-Log.	Mktg-Log.
Mktg-Prod.	Mktg-Prod.	Mktg-Prod.	Mktg-Prod.	Mktg-Prod.	Mktg.-Purch.
Log.-Prod.	Log.-Prod.	Log.-Prod.	Log.-Prod.	Log.-Prod.	Log.-Purch.
Prod-Purch.	Prod-Purch.	Prod-Purch.	Prod-Purch.	Prod-Purch.	
				Log.-Purch.	

Data was collected on the type, medium for sharing, nature and quality of information shared (i.e., accuracy, timeliness, etc.), the perceived level of visibility derived from the linkage and the impact of such visibility on operational performance. Within each of the external and internal linkages, this was achieved through individual interviews with the managers and employees (from both functions/firms) involved with the linkage. A total of 48 informants were interviewed. Informants within the firms ranged from a supply chain director, to logistics directors, to account managers, to purchasing managers, to supply chain planners to customer service managers. The diversity of informants provided a more complete picture of the environment being studied and helps to ensure construct validity (Jick, 1979; Stuart et al., 2002). Summary information on the six firms is presented in Table 5.

Table 5. Overview of the companies visited.

Firm	Main markets ^a	Annual sales ^a	Employees	Product	# Informants
RetailCo	UK	\$27.2bn	46,000 ^b	Brand X ^c	8
ManCo	UK	\$7.9bn	16,000	Brand X ^c	14
GlassCo	UK	\$538m	3000	Glass jars	6
LabelCo	UK	\$141.6m	2000	Plastic labels	6
LidCo	UK	\$89.6m	1500	Plastic lids	6
BoardCo	UK	\$1.76bn	3000	Corrugated board	8

a Only the UK markets and sales considered here.

b RetailCo also employs approximately 100,000 part-time employees.

c Brand X: disguised as per ManCo request.

3.3 Data sources

To enhance “data triangulation” (Jick, 1979; Eisenhardt, 1989; Eisenhardt and Graebner, 2007) data came primarily from three separate sources from each organization: semi structured interviews with multiple respondents, public and internal firm-specific documentation, and observation. Such data triangulation also leads to stronger substantiation of constructs and propositions (Benbasat et al., 1987; Eisenhardt, 1989; Voss et al., 2002). These data sources are now discussed briefly.

3.3.1 Semi structured interviews

In order to develop a more complete understanding of information-based linkages, an in-depth, semi-structured interview technique was adopted. Questions developed from the extant literature, focused on the general background to the research; information sharing and visibility; current and potential information sharing; the

benefits of information sharing and the level of visibility across the linkages. A brief sample of the interview tool is included in Appendix. For each interview, the questions were asked in the same order, although, on some occasions, the informants, when answering one question, would also answer a subsequent question. When this occurred, the informant was asked to verify their earlier answer. To improve the construct validity, the transcripts of the interviews were returned to the informants for them to review. New interviews were added until no new information was forthcoming, i.e., until a point of data saturation had been reached (**Glaser and Strauss, 1967; Eisenhardt, 1989**).

In the initial interviews with informants that were boundary spanning, e.g., within the logistics department of ManCo, we began by discussing the nature of the relationships, e.g., the composite linkages between ManCo and RetailCo, together with how these relationships manifested themselves and the resulting benefits. This led us to identify and discuss the various department-based external linkages between the firms in the supply chain under consideration, e.g., the linkages between the respective marketing departments as well as the linkages connecting ManCo's logistics department and RetailCo's purchasing and logistics departments. We then shifted our focus from between to within firms. This allowed us to uncover the internal linkages, e.g., marketing with purchasing and marketing with logistics, and purchasing with logistics within RetailCo. By starting with the general nature of the relationships, i.e., the composite linkages, between the organizations, we were able to collect data, e.g., interviews and organizational documents, on how the composite (external) linkages impacted operational performance. Through careful analysis of this data, and supported by the collection of organizational documents (see Section 3.3.2 below), we were able to isolate the individual external linkages and reveal how these impacted operational performance. This process was then repeated for the internal linkages.

3.3.2 Documents

Various documents were requested from all six of the firms taking part in the research. These documents ranged from annual reports to internal documents discussing specific processes, performance measures (inventory reports, service levels reports) and data/information sharing policies (relating to, for example, POS data and promotional plans). While these documents were shared, we have been asked to keep them confidential. The documents collected were used (1) to ensure construct validity and (2) to support the informants' claims of improved operational performance derived from the linkages.

As mentioned above in Section 3.3.1, we began by discussing with informants the nature and outcomes of the broader relationships between firms, both before the linkage began sharing additional information, i.e., only basic order-related information was shared, and currently, i.e., following the enhanced information sharing. We also collected any organizational documentation that was available, again for both before the linkage began the enhanced information sharing and currently. By collecting documentation on operational performance both before and after the enhanced information sharing, we were trying to increase our ability of attributing changes in operational performance to the enhanced information sharing. Following this stage in the research, we then repeated the above process for each individual linkage. While reiterating this process for both the broader relationships and individual linkages, we looked for confirmation from other informants and cross-document checks that would help validate improvements in operational performance being attributable to specific linkages.

3.3.3 Observation data

A site visit was undertaken at all six firms. During the tour, any physical evidence of information-based linkages (both internal and external) was observed. The purpose of these observations was to further verify the information collected from interviews and documentation.

3.4 Data analysis

The analysis began by examining the information-based linkages, broken down by external and internal, across the supply chain for Brand X. As per suggestions from previous qualitative research, the mode of research was to search for evidence from the information-based linkages and identify the patterns that linked the variables under investigation (**Glaser and Strauss, 1967; Eisenhardt, 1989; Yin, 1989; Stuart et al., 2002; Dubé and Paré, 2003**). Interviews with informants were transcribed by the researchers, which enabled the recording of additional notes, memos, ideas and comments. This process was essential so as to allow for reflection upon what the informants had said and, more importantly, the context in which it was said. To improve construct validity, all transcribed interviews were returned to the individual informants for their corroboration (**Yin, 1989**). During the analysis, when any differences were found, they were recorded and reconciled (**Poole and Van de Ven, 1989**). Then we incorporate the responses from each of the informants supported by the evidence from the organization's documentation and observations, broken down by external and internal information-based linkages, and present a set of relationships that lead to a number of propositions concerning the role of internal and external information-based linkages in deriving competitive advantage.

4 Within-case analysis

In this section, we present our within-case analysis of the external and internal information-based linkages. A comprehensive analysis of the external linkages is displayed in **Table 6** and internal linkages in **Table 7**. For each of the linkages, the role and objective of the linkage is discussed, followed by a brief description of the medium by which information sharing is facilitated. The level and extent of the visibility derived from the linkage is discussed together with the operational performance implications of the linkage.

Table 6. Case analysis display: external linkages.

Linkage	Functions	Information shared: downstream→	Information shared upstream←	Role of information-based linkages	
				Perceived level of visibility	Operational performance
ManCo-RetailCo	Mktg-Mktg	Promotional uplift info, advertising activities, filling plans, promotional forecast and plans, new product info	Forecast, future range, live range, rolling forecasts	Distinctive level of visibility	Significantly increased promotional forecast accuracy
	Log-Purch	Suggested orders, order invoices, stock avail/order	Orders	Low level of visibility	Little if any
	Log-Log	Adv notice service failure, ASN: DC-DC	DC service level, DC stock, depot profiles, layer and pallet multiples, performance data, POS, store stocks	Distinctive level of visibility	Reduced inventory levels, quality issues, increased product availability
GlassCo-ManCo	Mktg-Prod	Production plans, quality KPIs	Actual fills, consignment stock levels, filling schedules, net monthly requirement, filling performance	Relatively low level of visibility	Improved responsiveness
	Mktg-Purch	Cost drivers, other business KPIs	Rolling forecasts	Lack of visibility	No visible impact
	Log-Purch	Stock levels	Supplier development info	Lack of visibility	No visible impact
LabelCo-ManCo	Mktg-Prod	Printing volumes, printing yields, stock available	Line changes, net monthly requirement, consignment stock levels, production schedule	Relatively low level of visibility	Reduced inventory levels
	Mktg-Purch	Nothing shared	Quality requirements	Lack of visibility	No visible impact
	Log-Purch	Nothing shared	Delivery requirements, Orders	Lack of visibility	No visible impact
LidCo-ManCo	Mktg-Prod	Lead-time, stock levels	Net monthly requirement, production schedule	Very low visibility	No visible impact
	Mktg-Purch	Nothing shared	Product development plans	Very low visibility	No visible impact

	Log-Purch	Nothing shared	Orders	Very low visibility	No visible impact
BoardCo- ManCo	Mktg- Prod	Nothing shared	Forecasts, net monthly requirement, production plan and schedule, annual usages	High level of visibility	Increased flexibility
	Mktg- Purch	Nothing shared	Packaging changes, promotional changes, RetailCo's POS, revised promotional obsoletes and discontinues	High level of visibility	Increased flexibility
	Log-Purch	Case details, pallet configurations, stock levels	Product orders promotional plans	Medium level of visibility	Improved product availability, reduced inventory levels

Table 7. Case analysis display: internal linkages.

Linkage	Functions	Information shared	Role of information-based linkages	
			Perceived level of visibility	Operational performance
RetailCo	Mktg-Log	Forecast, future range, live range, rolling forecasts	Low level of visibility	No direct impact specific to the linkage
	Mktg- Purch	Forecast	Low level of visibility	No visible impact
	Log-Purch	Performance data, POS	Low level of visibility	No direct impact specific to the linkage
ManCo	Mktg-Log	Promotional uplift info, advertising activities, filling plans, promotional forecast and plans, new product info, rolling forecasts	High level of visibility	Improved forecasting accuracy; increased sales volume; less inventory holding and reduced stock-outs
	Mktg- Prod	Rolling forecasts	Low level of visibility	No visible impact
	Log-Prod	No information shared	Lack of visibility	Increased levels of safety stock being held

	Prod-Purch	Net monthly requirement, brand performance	Low level of visibility	No visible impact
	Log-Purch	Promotional forecast and plans, new product info, rolling forecasts	High level of visibility	Improved subsequent performance from BoardCo on promotional-related product availability
GlassCo	Mktg-Log	Promotional plans	Low level of visibility	No visible impact
	Mktg-Prod	Filling line performance	Low level of visibility	No visible impact
	Log-Prod	Supplier development info	Low level of visibility	No visible impact
	Prod-Purch	No information shared	Lack of visibility	No visible impact
LabelCo	Mktg-Log	Forecasts, line changes, net monthly requirement, consignment stock levels, production schedule	Low level of visibility	Some level of reduced inventory
	Mktg-Prod	Forecasts, line changes, net monthly requirement, consignment stock levels, production schedule	Low level of visibility	No visible impact
	Log-Prod	No information shared	Lack of visibility	No visible impact
	Prod-Purch	No information shared	Lack of visibility	No visible impact
LidCo	Mktg-Log	Net monthly requirement	Low level of visibility	No visible impact
	Mktg-Prod	Net monthly requirement	Low level of visibility	No visible impact
	Log-Prod	No information shared	Lack of visibility	No visible impact
	Prod-Purch	No information shared	Lack of visibility	No visible impact

BoardCo	Mktg-Log	Forecasts, net monthly requirement, production plan, production schedule, annual usages	High level of visibility	Lower levels of inventory holding and improved product availability
	Mktg-Prod	Forecasts, net monthly requirement, production plan, production schedule, annual usages	High level of visibility	Lower levels of inventory holding and improved product availability
	Log-Prod	Product orders, promotional plans	Low level of visibility	No visible impact
	Prod-Purch	No information shared	Lack of visibility	No visible impact

4.1 External linkages

4.1.1 *ManCo ↔ RetailCo*

As part of their ongoing efforts to increase sales, both ManCo and RetailCo engaged in numerous promotional activities (approximately 6–10 promotions per product per year), which created some huge uplifts in demand (i.e., between 700 and 1200%), although managing the volatility of such promotionally derived demand proved to be difficult. Some promotional stock was completely sold out early in the promotional period, while other promotions finished with considerable unsold stock. The main role of the linkages between the two organizations was to create shared levels of higher process, sales, inventory and promotional performance-related visibility, with the objective of getting everyone in the two firms “working off of the same page,” so that the underlying and promotionally derived demand for ManCo's products could be more effectively and efficiently replenished.

The logistics and marketing departments across both firms worked to develop a Collaborative Planning System (CPS) facilitated by an extranet-hosted application that linked the four departments. By virtue of the use of significant levels of shared information, the CPS provided near real-time visibility of retail sales (at a store and distribution center level), monitored current promotional performance, acted as a joint planning tool for future promotions and facilitated sharing forecasts for inventory at the individual stock keeping units (SKUs) item level. The visibility, and thus reduced uncertainty, derived from the linkage facilitated the reduction of finished goods inventory levels from twenty to four weeks; drastically reduced promotional-related forecast inaccuracy (from $\pm 65\%$ to $\pm 5\%$) by virtue of a new process for joint forecasting for promotions built into the CPS; and increased product availability, which both firms suggested led to yet further increased sales of products that were on promotion.

“By putting the knowledge of our customers together with [ManCo's] knowledge of the total market, and then jointly monitoring daily and even hourly sales of promotional products, we got a great insight and increased certainty as to what the promotional volume was going to be—this made forecasting so much easier” (Logistics Director – RetailCo).

Additionally, a Customer Service Coordinator (CSC) was appointed, employed by ManCo but working predominantly in RetailCo's head office. The CSC facilitated significant personal interaction and problem solving between the various functional departments in both RetailCo and ManCo, thereby further enhancing the high level of visibility derived from the CPS between both firms.

Interestingly, ManCo's logistics and RetailCo's purchasing departments shared little information other than purchase orders. RetailCo's purchasing department would order products without realizing that they often already held more than five to six weeks of inventory of the product in their own distribution centers. This was perceived to be due to the ongoing lack of internal visibility within RetailCo, where apparently no one had foreseen the need for the purchasing department to have visibility of RetailCo's own inventory levels. ManCo's logistics department overcame this by creating a direct connection with RetailCo's logistics department (see **Fig. 2**) which provided them with visibility of RetailCo's inventory levels. As a result, they were able to advise RetailCo's purchasing department to revise their orders based on demand and existing levels of on-hand inventory.

4.1.2 *GlassCo ↔ ManCo*

As the sole supplier of glass jars, GlassCo was not required to change its product's specifications to meet the promotional needs of ManCo and its retail customers. It, however, experienced increased volatility of demand as ManCo's orders became more closely aligned to the replenishment of its own product demand. Additionally, due to a perceived increase in quality problems with GlassCo's products; ManCo sought to develop a closer

linkage with their supplier by increasing the visibility of its own promotional activity, demand patterns and inventory levels, to enable GlassCo to more effectively replenish its customer's orders.

The quality issues led to a visit to ManCo by GlassCo's marketing department together with one of its manufacturing department's production engineers. This proved to be valuable as they were able to establish that ManCo's filling line was not correctly setup leading to breakages that had nothing to do with the quality of GlassCo's products. The information sharing across the linkage between GlassCo's marketing and ManCo's production departments was facilitated by the use of Electronic Data Interchange (EDI), email and face-to-face meetings. This produced some minor improvements in responsiveness, in the form of reduced lead-times, to production requirements; however, despite high levels of information sharing (e.g., base and promotional-demand together with levels of on-hand inventory), the visibility across the linkage was still perceived to be low. This was due to the relatively limited proportion of ManCo's demand as a small percentage of GlassCo's overall production volume.

“[ManCo] is an important customer for us, but they only represent about a sixth of our total monthly volume. It helps, but only in a limited way” (GlassCo – Customer Account Manager).

In collaboration with GlassCo's marketing department, ManCo's purchasing department instituted a simplified version of the CPS, developed with RetailCo, (referred to as “CPS-lite”) to share its monthly requirements and product forecasts (base and promotional) with GlassCo. ManCo did not perceive that GlassCo was currently capable of utilizing any additional information, so none was shared.

GlassCo's logistics department held monthly face-to-face meetings with ManCo's purchasing department, but the information shared was limited to supplier development issues (e.g., problem resolution) and therefore failed to appreciably increase perceived levels of visibility.

4.1.3 LabelCo ↔ ManCo

ManCo endeavored to develop closer linkages with LabelCo with the objective of improving the availability of labels for its often-volatile promotionally driven demand while looking to reduce the overall level of its inventory holdings. As with GlassCo, the labels were not used for promotional purposes, but the often volatile increases in demand left ManCo holding significant levels of plasticized labels.

LabelCo was not technically capable of directly inputting data from ManCo into its production planning process. As a result, ManCo's production and purchasing departments shared production-related data (i.e., production schedules and net monthly requirements for labels, and consignment stock levels) via EDI and email with LabelCo's marketing department who shared this internally (via email) with their production colleagues, thus allowing LabelCo to more closely coordinate its production schedule with ManCo's orders for its labels.

Notably, in an attempt to develop personal relationships between ManCo and LabelCo, and despite recognition that LabelCo was not ready to utilize such information, orders and specific expected service quality information (e.g., delivery requirements) were shared between LabelCo's logistics and ManCo's purchasing departments via both telephone and email.

Despite sharing more information with LabelCo, managers at ManCo still perceived the level of visibility to be somewhat low, primarily due to LabelCo's inability to utilize the shared information in an effective manner.

“They [LabelCo] are just not ready to use the information that we can share with them, when they can we will share more with them... and their performance will get better” (ManCo – Purchasing Director).

While ManCo was able to slightly reduce its inventory levels due to the heightened levels of information sharing (LabelCo shared its own on-hand inventory levels with ManCo) and the subsequent degree of uncertainty reduction, the operational performance of the linkage did not otherwise increase.

4.1.4 LidCo ↔ ManCo

The primary linkage between LidCo and ManCo centered on the use of EDI, on a need to know basis, due to the dominant power of ManCo and the perception that their promotional activity had only limited effect on the volume of plastics lids supplied by LidCo.

“The customer [ManCo] shares information with us when they want us to know something, they tell us how many products they want and we make it. That's how it is in this industry” (LidCo – Managing Director).

ManCo's production department did appear to try to build a closer relationship with LidCo's marketing department; they held weekly face-to-face meetings and shared ad hoc information such as production schedules and net monthly requirements. Despite this ad hoc sharing of information, there was no perceived change in the level of operational performance.

ManCo's purchasing department also tried to develop a closer relationship with LidCo's marketing department by sharing product development plans in monthly face-to-face meetings. Again, despite this ad hoc sharing of information, there was no perceived change in the level of operational performance. ManCo's purchasing department only shared order-related information with LidCo's logistics department, providing the linkage with a perceived poor level of visibility and resulting in no change in operational performance.

“If they get more sophisticated with their planning and their internal systems, we can share more information with them that will improve their performance... but they have to want to improve” (ManCo – Purchasing Director).

Interestingly, LidCo reported that they had been contacted on a number of occasions by RetailCo, which was seeking face-to-face meetings to discuss product development issues. LidCo declined these requests and reported this contact to ManCo. LidCo's actions were perceived by ManCo to have created additional fidelity between them.

4.1.5 BoardCo ↔ ManCo

Due to widespread quality issues with all of its cardboard product suppliers, ManCo had moved from using multiple suppliers to a sole source supplier. BoardCo was selected as they were the most open of ManCo's existing suppliers to the idea of collaborating for mutual benefit in terms of eliminating quality-related issues. Subsequently, after BoardCo announced a fourteen day delay arising from ManCo's last-minute changes to some promotional artwork that is printed on cardboard trays, ManCo quickly realized that it was even more critically dependant on BoardCo, particularly during promotions; as such, delays would only give rise to retail stock-outs of ManCo's products. ManCo decided that it needed to extend the enhanced visibility of its promotions process to BoardCo with the aim of not only improving the supplier's responsiveness to replenishing promotional-related demand, but also of extending the awareness within ManCo of the widespread impact of “last-minute” decisions relating to promotional activity on not only ManCo and its customers but also on packaging suppliers in its supply chain

BoardCo's marketing and ManCo's production departments shared, via EDI, email and face-to-face meetings, a significant amount of product-related information (e.g., weekly and monthly forecasts, net monthly requirements, annual usage rates, and production plans/schedules), resulting in significantly increased levels of

flexibility from BoardCo (in terms of reduced lead times) in response to ManCo's frequently changing production schedule.

Using a simpler version of its CPS, i.e., "CPS-lite", ManCo's purchasing department created significant visibility of its promotional activities (e.g., promotional changes, packaging changes, promotional obsoletes and discontinues), revised forecasts and even live updates of the POS data that it was receiving from RetailCo. In addition to the use of the "CPS-lite", the level of personal interaction was very significant between BoardCo's marketing and ManCo's purchasing department. BoardCo heavily utilized its Customer Service Manager (CSM), who spent half of their time at ManCo's head office and facilitated a considerable flow of information related to promotional activities. This enhanced visibility resulted in the reporting of significantly increased flexibility and responsiveness on the part of BoardCo, due primarily to the reduced uncertainty and improved alignment with ManCo's production schedule.

"The service numbers will show you that we are more flexible and respond better to their changes in volume. The data they give us helps, but being able to be involved with their decision-making reduces the guessing on our part" (BoardCo – Customer Service Manager).

ManCo's purchasing department also shared promotional plans and product orders with BoardCo's logistics department in exchange for case/pallet configurations and stock levels. This resulted in a reasonably improved level of visibility, which resulted, via reduced uncertainty and better informed decision making, in improved product availability from BoardCo and slightly lower levels of on-hand inventory for ManCo.

4.2 Internal linkages

4.2.1 RetailCo

There are three internal linkages within RetailCo: Marketing ↔ Logistics; Marketing ↔ Purchasing and Logistics ↔ Purchasing. Despite holding significant real-time information related to its customers and extensive visibility of its own levels of on-hand inventory across its distribution centers and retail stores, its traditional organizational culture, e.g., where information is not shared, coupled with the functional departmental structure within RetailCo led to mistrust of internal data resulting in weak visibility. For example, the marketing department shared, via internal systems and email, forecast-related information with their logistics colleagues but neglected to share promotional plans, which resulted in promotional inventory being held up at RetailCo's distribution centers rather than being delivered to the retail stores where it was needed for promotional activity. Additionally, the marketing department also only shared, via internal systems, its monthly product forecasts with the purchasing department, with no breakdown between base demand and promotionally driven demand. The purchasing department was left to place orders with ManCo without clear visibility of whether product was actually required

"We place orders and then a few minutes later get a call from them telling us that we already have a bunch of this stuff in the DC. It's a little frustrating but at least they are helping us to make better decisions" (RetailCo – Beverages Buyer).

The logistics department shared, via internal systems and email, supplier performance data and retail store-level POS data with the purchasing department. Despite this sharing of information, there was still a relatively low perceived level of visibility, especially so far as the purchasing department was concerned. This relatively low level of visibility resulted in the purchasing department placing orders with ManCo, only to have the orders questioned in light of the visibility of RetailCo's on-hand inventory levels that ManCo possessed by virtue of the linkage between ManCo's logistics department and RetailCo's logistics department.

Information sharing was very formal, utilizing internal systems, and primarily based on POS, performance and forecast related data. There was no direct positive impact on operational performance as a result of such internal information sharing. Indirectly, RetailCo experienced increasing sales volume of ManCo's products that were on promotion and endured less significant stock-outs of ManCo's products, primarily due to increased levels of service by ManCo. RetailCo was perceived to be relying on the improved performance from ManCo and the verification of their own decision-making that resulted from the visibility that was created by sharing information with their supplier.

4.2.2 *ManCo*

There are five (four established and one new) internal linkages within ManCo: Marketing ↔ Logistics; Marketing ↔ Production; Logistics ↔ Production; Production ↔ Purchasing; and Logistics ↔ Purchasing. Prior to the development of the collaborative planning system, ManCo experienced significant problems with meeting the demand for its products from RetailCo, resulting in ManCo having to hold significant levels (e.g., twenty weeks) of finished goods inventory. ManCo's logistics director realized that the lack of visibility (of demand and inventory positions) and coordination of promotional activities were the major causes of these problems. The main roles of the linkages were to extend the visibility derived from the information shared by RetailCo and to facilitate closer coordination of the planning and replenishment of their demand.

As part of the development of the CPS, a significant amount of promotional-related information (e.g., promotional uplifts, advertising activities, filling plans, promotional forecasts and plans, new product introductions and rolling forecasts) was shared by the marketing department with their logistics colleagues, who in return made the POS data that they received from RetailCo available together with visibility of on-hand inventory levels. By virtue of the visibility derived from the information sharing and the coordinated and joint decision making by ManCo and RetailCo over their promotional activities, ManCo enjoyed significantly improved forecasting accuracy; increased sales volume (from increased in-store product availability at RetailCo) and significantly less finished goods inventory holding.

While the marketing department shared, via the CPS, their rolling forecasts and some brand performance data with the production department, there was little if any perceived visibility across the linkage which resulted in no visible impact on operational performance. The heightened levels of visibility derived by the linkage between the marketing and logistics departments did not flow through the rest of ManCo, as seen in the extremely hostile relationship between the logistics and production departments.

“I got an email recently from my counter-part in production – basically telling me to (expletive) out of his factory” (ManCo-Head of Supply Chain Development).

The hostility stemmed from the conflicting performance objectives held by both departments. Production was looking to minimize their unit production costs and thus generated significant levels of finished goods inventory. Logistics was looking to simultaneously reduce finished goods inventory levels and improve their customer service performance.

As a result of this visibility “gap” between logistics and production, a “bridging” linkage with the purchasing function was developed. Logistics shared, via the CPS, promotional-related information (e.g., promotional forecasts and plans, new product introductions, rolling forecasts) with the purchasing department, which extended the visibility derived from their external linkages with RetailCo upstream to ManCo's packaging suppliers. While the shared promotional-related information created significant visibility within parts of ManCo, the benefit derived from this visibility, i.e., reduced finished goods inventory holding, was negated to some extent by an additional inventory “buffer” of two weeks of inventory that was held by the logistics department due to the lack of information sharing between itself and the production department.

Finally, the production department shared, via internal systems and email, its net monthly requirements and some brand performance data with the purchasing department. This linkage and limited information sharing created little, if any, perceived visibility and resulted in no perceived impact on operational performance.

4.2.3 GlassCo

Within this packaging supplier, there were four (existing) linkages that were explored in the research: Marketing ↔ Logistics; Marketing ↔ Production; Logistics ↔ Production and Production ↔ Purchasing. Despite significant information sharing by ManCo, the perceived visibility derived from this was typically low, due to the lack of information sharing across the internal linkages between GlassCo's very traditionally structured departments.

The information sharing, via internal systems and email, across the four linkages is summarized as follows. The marketing department shared some, but not all, of the promotional plans it received from ManCo with the logistics department. The production department shared its filling line performance data with the marketing department. Logistics shared some of the supplier development information that it received from ManCo with the production department. There was no information shared between the production and purchasing departments, often resulting in delays in production due to the uncertainty of raw material deliveries.

Although there was some, albeit limited, information sharing, this resulted in low perceived levels of visibility, and, as such, there was no visible impact on operational performance. Information sharing within GlassCo was formal, utilizing email and memos. As such, the level of trust and openness between the departments was extremely limited despite the shared recognition that ManCo wanted to share more information with GlassCo.

4.2.4 LabelCo

Within this packaging supplier, there were four (existing) linkages that were explored in the research: Marketing ↔ Logistics; Marketing ↔ Production; Logistics ↔ Production and Production ↔ Purchasing. Information sharing within LabelCo was formal, e.g., utilizing email and memos, and primarily based on product orders, volumes and inventory levels within the firm.

The marketing department shared (via email) all the information (e.g., forecasts, line changes, net monthly requirements, consignment stock levels, production schedule) it received from ManCo with both the logistics and production departments. However, despite this there was no information shared across the linkages between the logistics and production departments and the production and purchasing departments.

As a result of traditionally structured functional departments, visibility was perceived to be very low within LabelCo. Due to the lack of direct information sharing between the production and logistics departments, deliveries to ManCo were frequently delayed due to the uncertainty of products being released from the production process. Despite this lack of direct information sharing internally, LabelCo did report some reduced level of inventory holding of finished products. This was perceived by the marketing and logistics departments to be due to the uncertainty reduction that resulted from the use of ManCo's production-related information, which the marketing department had proactively sought from ManCo in order to share it with their colleagues in logistics in an attempt to alleviate customer concerns from ManCo about the frequency of delays of product shipment.

4.2.5 LidCo

Within this packaging supplier, there were four (existing) linkages that were explored in the research: Marketing ↔ Logistics; Marketing ↔ Production; Logistics ↔ Production and Production ↔ Purchasing. Information sharing was formal and extremely limited, utilizing emails and memos across the traditionally structured functional departments.

Beyond basic monthly purchase orders from ManCo, the marketing department shared, via email, net monthly order requirements with the logistics department to aid planning of outbound shipments to ManCo and, similarly, with the production department to balance LidCo's manufacturing schedule. Additionally, no information was shared across the linkages between the logistics and production departments or between the production and purchasing departments.

“We would like more information from the customer, but I don’t believe they think we know what to do with it” (LidCo – Production planner).

Bearing in mind the minimal information sharing, the perceived level of visibility within these linkages was seen as extremely low to non-existent. There were frequent delays in product shipments to ManCo and similar delays in production due to uncertainty of raw material deliveries. While the marketing department tried to proactively address these issues by sharing information with both the logistics and production departments, there was no visible or perceived impact on operational performance.

4.2.6 BoardCo

Within this packaging supplier, there were four (existing) linkages that were explored in the research: Marketing ↔ Logistics; Marketing ↔ Production; Logistics ↔ Production and Production ↔ Purchasing. In return for being made the sole supplier by ManCo, BoardCo sought to create a culture that supported information sharing with the objective of creating visibility that would enable them to improve their performance as a supplier to ManCo and to work with their customer to improve their operational performance. To facilitate greater information sharing, BoardCo agreed to implement and utilize a more simplistic version of the collaborative planning system (referred to as “CPS-lite” and hosted via an extranet between BoardCo and ManCo) that ManCo had developed in conjunction with their customer, RetailCo. This system was further supported by BoardCo's customer service manager who, through personal interaction with ManCo, facilitated additional information sharing for the marketing and logistics departments in the supplier

BoardCo's marketing department utilized the “CPS-lite” to share ManCo's production and forecast data (e.g., forecasts, net monthly requirements, production plan, production schedule, annual usages) with their colleagues in both the logistics and production departments. Based on this information sharing, there was a high perceived level of visibility which, by virtue of reduced uncertainty and more coordinated decision making, enabled BoardCo to reduce its levels of finished goods inventory. This also led to improved customer service levels for delivery of cardboard-based products to ManCo from 95% to 98%.

While some promotional-related data (e.g., product orders, promotional plans) was shared between the logistics and production departments via the “CPS-lite”, only a low level of perceived visibility was observed. This was primarily due to the production department not yet being able to directly utilize this additional information in its production planning. No visible impact on operational performance from the visibility was reported.

Finally, there was no information shared across the linkages between the production and purchasing departments. This resulted in a perceived lack of visibility which potentially limited the benefits that BoardCo was able to derive from the information it received from ManCo.

5 Results and development of propositions

In this paper, we have considered the specific roles of internal and external information-based linkages as facilitators of visibility, i.e., information and process data which, if utilized efficiently and/or effectively, can positively impact decision making through the reduction of uncertainty and can, in turn, improve operational performance. Additionally, we consider the nature of any relational links that exist in the presence of downstream and upstream external linkages.

We have found a number of subtle differences between the specific roles and ramifications of both external and internal linkages. We have also found differences across linkages when these are viewed individually or together as “composite” linkages, e.g., all of the external linkages between two firms. We now discuss the results of the research and then present the development of a number of propositions.

5.1 Composite linkages

Instead of considering individual linkages, we began by exploring all of the external linkages between ManCo and RetailCo and then between ManCo and each of its four packaging suppliers. We also explored the internal linkages within each of the six firms. This produces eleven *composite* (i.e., clusters of internal and external) linkages that have the potential to create broader levels of visibility between and within firms than individual linkages can achieve on their own. For example, the composite (external) linkage between the respective departments of ManCo and RetailCo (as per **Table 6** above) benefited from considerable information sharing both upstream and downstream, which led to a *high* level of visibility derived from the combination of the deployment and utilization of the CPS-based technology together with significant personal interaction, as highlighted by the deployment of the CSC.

As a result, the composite linkage (ManCo ↔ RetailCo), with its high levels of visibility led to significantly improved operational performance. The heightened level of visibility and subsequent coordination of the process for promotional planning and replenishment resulted in dramatically improved forecasting accuracy, improved availability of inventory and significantly reduced levels of on-hand inventory following each promotion.

We saw similar, if not quite as significantly improved, operational performance for the composite (external) linkage between BoardCo and ManCo, and the composite (internal) linkages within ManCo and BoardCo. It should be noted that in the composite linkages between RetailCo and ManCo, and also within ManCo additional individual “bridging” linkages were developed to close a number of “gaps” in the flow of visibility across the linkages. ManCo recognized that these “gaps” would limit the level of visibility created by the information sharing and would diminish the potential improvements in operational performance. Although these additional information-based linkages appeared to close the “gaps”, the improvement of operational performance for the composite (internal) linkage within ManCo was less than could have been expected. Had ManCo's production department shared information directly with its logistics colleagues, then the logistics department would not have had to circumnavigate the hostile relationship with its production colleagues to share information with its purchasing department that could in turn be used to increase the performance of its upstream packaging suppliers.

5.2 Individual linkages

In comparing the individual external and internal linkages, a number of intriguing differences have emerged. There was clearly more information being shared externally between firms than internally. This may be due to the nature of ongoing internal relationships, or the lack thereof (e.g., the openly hostile relationship between the logistics and production departments within ManCo), combined with traditional firm-specific cultural norms relating to information sharing. For example, RetailCo's purchasing department had no internal visibility of their own levels of on-hand inventory, even though this was readily available to their own logistics colleagues, and thus to some extent had to rely on ManCo's logistics department to guide their purchasing decisions.

While there is more information shared via external linkages, the nature and volume of information is moderated by the efficiency and effectiveness of available mediums (e.g., the CPS developed by ManCo versus more traditional systems such as EDI) for sharing such information combined with the perceived capability of the recipient to utilize the information by the holder of such information. For example, ManCo could have

shared more information with both LabelCo and LidCo but perceived that both firms currently could not utilize the information that could positively impact operational performance.

As an outcome of the information sharing via individual external and internal linkages there were different types of visibility occurring. The external linkages share internally held information that creates “dependent” visibility for the recipient, while the internal linkages share both internally held and externally derived information, thereby creating both “independent” and “dependent visibility” for the recipient.

In terms of operational performance, while sharing information and creating visibility via internal and external linkages are both important, the type of linkage serves broadly different purposes. The visibility created by sharing information via external linkages has more potential for positively impacting the *effectiveness* of performance in the form of improved service levels and responsiveness. On the other hand, the visibility created by information shared via internal linkages has more potential for positively impacting the *efficiency* of performance in the form of reducing inventory levels. For internal linkages, the location in the supply chain appears to drive the extent of the impact on performance. For internal linkages in the downstream end of the supply chain, e.g., RetailCo, the information shared improves the general awareness of what is happening within the firm, i.e., it gets all functionally based departments on to the “same page”. However, for firms further upstream along the supply chain, where the level of uncertainty about downstream-related demand increases, e.g., ManCo or BoardCo, information shared via internal linkages has more potential to impact both the efficiency and effectiveness of operational performance than for their downstream counterparts.

5.3 Development of propositions

As organizations across the supply chain strive to efficiently and effectively meet customer demand they endeavor to do so against widespread uncertainty. Such uncertainty can be reduced by sharing information across linkages between organizations and their respective functional departments. The current literature on information sharing is limited in terms of the specific roles that such information-based linkages should take.

We have seen that composite linkages can be developed to create a broad base of visibility both between organizations, e.g., ManCo-RetailCo, and internally between various functional departments, e.g., ManCo. Individual linkages can be developed to create functionally based visibility internally, e.g., concerning the planning and replenishment of promotions between ManCo's marketing and logistics departments.

***P1(a) 1.** Composite linkages (internal or external) facilitate the sharing of information between and within firms that leads to the creation of visibility, which if utilized can positively impact operational performance.*

***P1(b) 1.** Individual linkages (internal or external) facilitate the sharing of information between and within firms that leads to the creation of visibility, which if utilized can positively impact operational performance.*

Finally, we have seen from the research that individual linkages can be used in both internal and external contexts to “bridge” gaps in visibility. Internally within ManCo, it was recognized that due to the lack of a linkage between its logistics and production departments, which resulted in a lack of information sharing and a significant lack of coordination of production and logistics activities, that there was effectively a “structural hole” (Burt, 1992; Akbar and Bell, 2005). Information-based linkages can act as a bridge across any gaps in visibility within an organization, thereby overcoming to some extent any “structural holes” (Tiwana, 2008). While the bridge is beneficial, it is not as strong as if there were integration or a strong linkage in place of the “structural hole” (Akbar and Bell, 2005). The internal individual linkage between the logistics and purchasing departments enabled ManCo to coordinate the upstream and downstream parts of their supply chain, but not as efficiently

and effectively had the production department been prepared to directly share information with the logistics department.

P1(c) 1. Individual linkages can act as “bridges” thereby overcoming, at least to some extent, any “structural holes” that may exist within or between organizations.

Internal linkages, in the form of individual or composite linkages, can act as conduits or mediums for extending visibility across the organization. These internal linkages create the opportunity to provide an organization's suppliers with information that may potentially improve their operational performance. For ManCo, its internal linkages between its marketing and logistics, marketing and production, production and purchasing, and logistics and purchasing departments were used to extend the visibility created by the sharing of information through its external linkage with RetailCo. This was also the case for BoardCo, in terms of extending the visibility of ManCo's promotional activities that it had derived from the external linkages with ManCo.

P2 1. Internal linkages act as a conduit for extending visibility derived from external linkages with other organizations.

In the context of the supply chain, internal linkages (either individual or composite) in combination with external linkages act as a conduit (medium/channel) for extending visibility upstream (or downstream) along the supply chain. ManCo has derived a high degree of visibility of its downstream activities, of RetailCo's processes and of the nature of demand, with particular reference to promotional demand for its products. In line with trying to streamline and more closely coordinate its supply chain, ManCo has utilized its internal linkages and external upstream facing linkages with key suppliers in its supply base to share and extend this downstream visibility with its supply base. In doing so, it enabled its suppliers, e.g., BoardCo, to improve their flexibility and responsiveness.

P3(a) 1. Internal linkages when combined with external linkages act as a conduit for extending downstream visibility upstream along the supply chain.

While firms endeavor to create wide-spread visibility across their supply chains, there are however a multitude of potential gatekeepers that can inhibit the flow of information. For both upstream and downstream information flows, at specific points in the supply chain, gatekeepers may inhibit the flow of information based on their perceptions of the ability of suppliers to utilize the information or because they do not perceive that the information will facilitate any change. For example between ManCo and LidCo, plastic lids were supplied in vast quantities due to shipping costs, and as such there was a shared perception across the purchasing and production departments that sharing downstream derived promotional information with LidCo would have little if any impact on the general volume of plastic lids being supplied. Additionally, gatekeepers who receive information may inhibit its onward sharing, simply because they themselves do not know how to utilize shared information, e.g., LidCo's marketing department, which received information from both ManCo's production and purchasing departments.

Further, gatekeepers do inhibit the flow of information due to the nature of their relationships with suppliers, customers, or internal colleagues. For example, in ManCo, as a result of their adversarial relationship with their production colleagues, the logistics department colleagues simply went direct to the purchasing department by creating a “bridging” linkage, thereby circum-navigating the gate-keeping efforts of the production department. Also, in the case of LidCo, while their marketing department wanted to improve their internal planning capabilities, they were to some extent hampered by the presence of their managing director who insisted on being involved in all meetings with ManCo.

P3(b) 1. *The extension of visibility along the supply chain by the development of internal and external linkages is moderated by the information flow inhibiting actions of gatekeepers.*

Across the three tiers of the supply chain under investigation, there were four main categories of information that were being shared: (1) demand-related information, such as POS data; (2) inventory-related information, such levels of on-hand inventory; (3) promotional-related information, including specific POS for promotional products; and (4) production-related information, such as production schedules and net requirements. While the POS data traverses all three tiers of the supply chain, e.g., from RetailCo to ManCo to BoardCo, its relevance, in terms of certainty of demand, diminishes in value relative to the proportion of volume of business (measured in units) of the firm sharing (e.g., RetailCo) to the recipient firm's (e.g., ManCo) total volume of business. In the case of RetailCo, they represented approximately seventeen percent of ManCo's total volume of business (measured in units), and ManCo represented only one quarter of BoardCo's total monthly volume. This acts as an incentive for recipient firms to encourage more of their downstream customers to share information with them in order to provide a great proportion of certainty relative to their total volumes. The inventory and production-related information appears to only traverse from one tier to the next upstream tier, while the promotional-related information traverses all three tiers, subject to the relevance of the potential impact on the nature and volume of the recipient's product.

P3(c) 1. *The impact of visibility on operational performance created from internal and external linkages is moderated by the proportion of the volume of business (measured in units) of the firm sharing information relative to the recipient firm's total volume of business).*

6 Discussion, contributions and future research

From a single case study stretching across six firms and containing multiple incidences of two sub-units of analysis (i.e., fourteen external and twenty-four internal linkages), we have developed six propositions related to the specific roles of information-based internal and external linkages and one proposition relating to the relational links that exist between downstream and upstream external linkages.

This research gives rise to a number of contributions: (1) It captures how information flows across a large supply chain by virtue of a combination of multiple external and internal linkages; (2) It suggests whether information flows, either via individual or composite linkages, improve operational performance; (3) It sheds light on the previous “black box” that is the firm in terms of how external information travels in, through and out of a firm; and (4) It identifies specific roles and ramifications of different types of supply chain linkages.

This paper provides both theoretical and practical implications. From a theory-building perspective, the propositions provide insight into the specific roles of internal and external information-based linkages and how the linkages impact operational performance. It also offers insights concerning three types of linkages (e.g., composite, individual and bridging) and the level of visibility that can be derived from each type. However, as with any inductive study, our study suffers from a lack of external validity. Nonetheless, the study offers valuable insights for directing future research into the role, location and nature of information-based linkages.

The practical implications of the study provide insight as to how managers operating retail supply chains must evaluate where they need to share information in order to extend visibility and thereby reduce the levels of uncertainty that they face. Also, the study provides some insights into the implications of varying degrees of integration between departments within a firm and into how this variability can limit the extent of improvements in operational performance that can be derived from creating visibility by the deployment of information-based linkages.

6.1 Future research

After developing the propositions in this paper, the next step would be to deductively test the constructs in a survey of multiple organizations at different levels/positions in retail supply chains and then in other industries, all in order to improve the external validity of the propositions. In the course of the research, we have seen that the performance of some linkages, e.g., RetailCo ↔ ManCo and ManCo ↔ BoardCo is enhanced when there is considerable face-to-face communication coupled with the deployment of innovative technology. This suggests a need to consider to what extent does the medium of the linkage (i.e., technology-mediated or face-to-face) affect the linkage's performance impact? There is also the need to consider the extent to which perceptions of a firm's capabilities to utilize shared information shapes decisions about how much information to share, and the subsequent success of these information-based linkages. During the research, as we moved further upstream from ManCo, the four packaging suppliers were clearly at very different stages in terms of the level of sophistication in their supply chain operations and decision-making capabilities.

We have seen, in two instances, that certain internal linkages have not been developed, e.g., between the production and logistics departments within ManCo, or that important information has been withheld, e.g., the lack of visibility that RetailCo's purchasing department had of its own levels of on-hand inventory. Drawing on this research, the issue appears to be related to remnants of organizational cultures that were adverse to information sharing, even across functional departments.

Finally, during the research, we observed an instance of opportunistic behavior on the part of RetailCo, which had approached one of ManCo's packaging suppliers with the intent of discussing a variety of product-related issues. This behavior runs counter to the mutually collaborative behavior reported in the linkages between ManCo and RetailCo and, as such, is worthy of further investigation.

Appendix A. Sample questions from interview tool

<i>General information and overview</i>	
1.	Get organization background—history, # of employees, annual sales, products. What are your roles and responsibilities across the linkage?
<i>Information sharing/visibility</i>	
2.	Through which medium is information shared? How effective is this medium? How unique is this medium to the linkage? What other factors facilitate the exchange of information in the linkage? How unique are these factors to the linkage?
<i>Current and potential information shared</i>	
3.	What information is shared and should be shared? Between whom? When and how frequently? In what format? What is the quality of the information shared? Is the information time sensitive?
4.	How is the information used? If not—why not? What are the barriers to using shared information in the supply chain? What would need to change to make the information usable? For what purpose is the information used? What mechanisms are in place for using the information?
<i>Benefits from information sharing</i>	

5.	In what ways does/would information sharing between functions or supply chain partners enhance their business activities? What are the potential benefits of sharing information with other internal functions or supply chain partners? What are the actual benefits (e.g., operational performance) accruing from information being shared internally and externally across the supply chain?
6.	Are there any disadvantages from sharing information with other functions or supply chain partners?
7.	What has been the impact of sharing information internally with other functions and partners across the supply chain? What is the perceived usefulness of the information that is shared?
8.	What are the key enablers of information sharing/exchange in the supply chain?
<i>Visibility across the linkage</i>	
9.	How much visibility has been gained from sharing this information? How useful is this visibility?
10.	What operational performance benefits are derived from the visibility arising from the information sharing across the linkage?

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