RFID and buyer-seller relationships in the retail supply chain

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Abstract

Purpose – The aim of this paper is to understand why a collaborative innovation, such as radio-frequency identification (RFID) technology, engenders seemingly opposite buyer-seller relationship reactions among members of a supply chain.

Design/methodology/approach – The researchers carried out a three year exploratory multiple case study using the grounded theory approach through participant-observation and collaborative action research. The research project culminated in a fully functional RFID proof of concept solution which involved multiple layers of a retail supply chain. The researchers chose the retail industry for the study because it provided the ideal conditions to answer the research question.

Findings – The results highlight the role of supplier-buyer relationships as both crucial antecedents that shape RFID infrastructure and the consequence of RFID implementation. Specifically, the impact on and of eight key dimensions was considered, namely communication and information sharing, cooperation, trust, commitment, relationship value, power imbalance and interdependence, adaptation, and conflict. The paper also positions open-loop RFID projects as supply chain inter-organizational systems and presents a model to analyze such initiatives.

Research limitations/implications – The choice of methodology has provided the insight necessary to answer the research question. Other researchers are encouraged to validate these findings through replication with other case studies or through quantitative data to reach analytical and statistical generalizability. The authors also encourage future research on this topic in other industries.

Originality/value – As more supply chains move forward with collaborative RFID initiatives, it is important that these companies be aware of the strategic role of supplier-buyer relationships as both crucial antecedents that shape RFID infrastructure and a consequence of RFID implementation.

Keywords Buyer-seller relationships, Identification, Supply chain management, Retailing, Radiofrequencies

Paper type Research paper

Introduction

Radio-frequency identification (RFID), a technology that facilitates the tracking and manipulation of physical items, is now a major technological trend. According to experienced early adopters, knowledgeable industry leaders and academic researchers, it facilitates collaboration between organizations (Cantwell, 2006; Lefebvre *et al.*, 2006; Lekakos, 2007; Roberti, 2006). In this context, it constitutes a supply chain management (SCM) enabling technology (Attaran, 2007; Pramatari, 2007).

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SCM is defined as the integration of business processes among companies that collaborate in an effort to bring a product, service or unit of information from the initial supplier to the final customer (Lambert *et al.*, 1998; Mills *et al.*, 2004). It has increasingly become the basis for competition (Angeles and Nath, 2000) between supply chains and networks (Gomes-Casseres, 1994). SCM provides many benefits including cost reductions (Spekman *et al.*, 1998) and a collaborative advantage, rather than a competitive advantage (Chen and Paulraj, 2004). Within the supply chain, buyer-seller relationships are the individual links, the dyads, among companies that tie it together. Without these links, there would be no supply chain. They are therefore of paramount importance for SCM. In fact, a literature review of over 400 academic articles on SCM has placed these links at the center of SCM research (Chen and Paulraj, 2004).

At first glance, RFID seems to support the move from a more adversarial stance towards collaborative relationships. Paradoxically, though, this does not always seem to be the case, at least in the retail industry where RFID has attracted the most interest (LoPrinzi, 2006). RFID implementations between major retailers and their suppliers seem to be far from collaborative. Several preliminary anecdotes from the industry indicate that RFID tends to upset relationships (Fogarty, 2004; Romanow, 2004; Schwartz, 2004) by the use of power (Williams and Moore, 2007) rather than solidifying them. More recently, a study in the UK grocery retail sector indicates that suppliers will implement RFID to satisfy their client's needs at their own short-term detriment (Hingley *et al.*, 2007). This finding is corroborated by a quantitative study in which case level tagging was found to result in substantial losses for manufacturers, but not their retailers (Bottani and Rizzi, 2008). These observations clearly seem contradictory to a collaborative approach. They therefore warrant additional empirical research and serve to remind us that little is known of RFID's impact on buyer-seller relationships and even less is known of the impact of RFID on all of the buyer-seller relationships in an entire supply chain. The goal of this paper is therefore to improve our understanding of this issue by answering the research question:

RQ. How do RFID and the buyer-seller relationships of an entire supply chain affect one another?

The paper is organized as follows. The next section will review the literature on how similar collaborative technologies have affected and been affected by buyer-seller relationships. Then the methodological approach will be presented. The results section will first present the model that was developed to organize the field data and communicate the findings. Then the findings will be presented with a focus on the key issues that emerged from the field data. Finally, the paper will identify how the key issues influence the dimensions of the buyer-seller relationship, how the study contributes to academia and practitioners and conclude with suggestions for future research.

Literature review

An RFID system can be briefly described as follows: an electronic tag containing historical, transactional or identifying data are affixed to or embedded in an object. The data are automatically downloaded wirelessly to a computer when the object nears the vicinity of an RFID reader. Once on the computer, the information can travel anywhere that is accessible by the internet or on a private network.

RFID as an IOS

RFID is a wireless technology that facilitates the identification of products without requiring a line of sight (Kärkkäinen and Holmström, 2002). It has the potential to replace all scanning activities in the supply chain. It can be implemented in a "closed-loop" setting where it is used internally by a single company, for example, in an employee authentication system or an electronic antitheft system. It can also be implemented in an "open-loop" setting where it is used to improve the efficiency of a supply chain. This is the case for Wal-Mart and other early adopting retailers (Smith, 2005). In this situation, RFID clearly fits the definition of an inter-organizational system (IOS):

> [. . .] an automated information system shared by two or more companies. An IOS is built around information technology, that is, around computer and communication technology, that facilitates the creation, storage, transformation and transmission of information. An IOS differs from an internal distributed information system by allowing information to be sent across organizational boundaries (Johnston and Vitale, 1988).

RFID can also replace barcodes, a form of IOS application (Vlosky and Wilson, 1994). Furthermore, it acts as an enabler of business-to-business electronic commerce (Lefebvre *et al.*, 2006), another form of IOS. IOSs structure the ties between companies by creating technological bridges among them that optimize information flow. Therefore, they can be thought of as a way of solidifying inter-organizational relationships or, at least, stabilizing them (Chae *et al.*, 2005). In today's digitalized economy, IOSs are essential for a competitive supply chain as they lead to better firm performance (Byrd and Davidson, 2003). Because RFID can be considered an IOS, the literature on IOSs and buyer-seller relationships can provide some insight into our research question.

IOS and buyer-seller relationships

Most studies perceive IOSs to be a positive influence on collaboration (Chae *et al.*, 2005), but their impact on buyer-seller relationships can be either positive or negative (Angeles *et al.*, 1998). In fact, trying to optimize SCM with an IOS technology can potentially be very disruptive to these relationships (Vlosky and Wilson, 1994), to the point that they may break down (Boeck *et al.*, 2006; Stump and Sriram, 1997) and new supply chain dyads are formed (Boeck *et al.*, 2006). Many researchers feel that additional research on the link between technology and buyer-seller relationships is needed (Deeter-Schmelz and Kennedy, 2004; Gemünden *et al.*, 2003; Leek *et al.*, 2003; Rao and Perry, 2003; Ryssel *et al.*, 2004).

Historically, research on IOS and buyer-seller relationships has been conducted on different types of IOS, starting with electronic data interchange (EDI) and barcodes and moving on to internet-based technologies such as extranets, e-procurement and e-marketplaces. The different types of IOSs have some similarities but since each kind functions differently, they can potentially influence buyer-supplier relationships in different ways. The literature review will show how IOSs have influenced or been influenced by the buyer-seller relationship through eight of its key dimensions identified and presented in Table I.

Electronic data interchange. It is difficult to come up with an exact date for the origin of EDI but most academic and industrial authors agree that it was first introduced in the 1960s (Clarke, 2001; Ramaseshan, 1997). EDI consists of "a computer-to-computer exchange between trading partners of agreed and structured business documents such

Table I.
The link between IOS and eight key dimensions that characterize buyer-seller relationships

Key dimensions of buyer-seller relationships	Definition	The link between IOS and the key dimensions of buyer-seller relationships
Communication and information sharing	The amount, frequency and quality of the information flow between trading partners (Palmatier *et al.*, 2006)	EDI alters the relationship which may result in greater coordination in the flow of inputs (O'Callaghan *et al.*, 1992) The top strategic factor motivating the adoption of EDI is better communication with trading partners (Reekers and Smithson, 1994)[a] Improved accuracy of information is perceived to be a major advantage of EDI (Ramaseshan, 1997)[a] EDI trading partners share more information faster (Dupuy and Vlosky, 2000)[a] Barcoding connects data systems and encourages information sharing (Manthou and Vlachopoulou, 2001)[a] Extranet partners exchange more information in terms and quality and quantity (Vlosky *et al.*, 2000)[a] Internet users tend to communicate with suppliers and customers more frequently using traditional modes than non-users (Boyle, 2001)[a] E-procurement technologies increase the frequency of communication between trading partners (Carr and Smeltzer, 2002)[a] E-marketplaces improve coordination activities and increase the speed of information sharing (Murtaza *et al.*, 2004)
Cooperation	The willingness to undertake complimentary actions to achieve mutual goals (Palmatier *et al.*, 2006; Wilson, 1995)	Initial EDI investment costs must be borne by both firms (O'Callaghan *et al.*, 1992)[a] Under conditions of low dependency, there is a danger that the level of cooperation in trading relationships will be compromised as a result of EDI imposition (Iacovou *et al.*, 1995)[a] Extranet implies a considerable degree of information sharing (Vlosky *et al.*, 2000)[a] E-marketplaces can make it easier for suppliers to collaborate with clients (Gulledge, 2002; Howard *et al.*, 2006; Lancastre and Lages, 2006)[a]
Trust	Confidence that the trading partner will uphold its obligations and act in the best interest of its partners (Palmatier *et al.*, 2006; Wilson, 1995)	EDI tends to promote a long-term buyer-supplier relationship that can lead to increased mutual trust (Sriram and Banerjee, 1994)[a] Under conditions of low dependency, there is a danger that the level of trust in trading relationships will be compromised as a result of EDI imposition (Iacovou *et al.*, 1995)[a] Trust on which the relationship is built is not easily shaken when IOS in the form of EDI enters the relationship mix (Wilson and Vlosky, 1998)[a]

(*continued*)

Table I.

Key dimensions of buyer-seller relationships	Definition	The link between IOS and the key dimensions of buyer-seller relationships
		For the most part, respondents trust their extranet partners (Vlosky *et al.*, 2000)[a]
		Adoption of e-procurement was not related to trust between the trading partners (Carr and Smeltzer, 2002)[a]
		E-marketplaces can contribute to building trust (Ratnasingam, 2005)[a]
Commitment	An enduring desire to ensure that the relationship continues (Palmatier *et al.*, 2006; Wilson, 1995)	Specific EDI investments impose exit barriers in the form of heightened switching costs (O'Callaghan *et al.*, 1992)
		The establishment of a sophisticated EDI computer linkage between firms reflects a significant commitment to the relationship (O'Callaghan *et al.*, 1992)
		EDI trading partners generally feel fairly committed to long-term relationships (Dupuy and Vlosky, 2000)[a]
		EDI trading partners perceive that they have a privileged long-term relationship with one another (Dupuy and Vlosky, 2000)[a]
		A buyer's satisfaction with a seller's use of technology-mediated communication, such as EDI, directly affects their intention to do business with the seller in the future (MacDonald and Smith, 2004)[a]
		Companies intend to increase future sales or purchases with their extranet partners (Vlosky *et al.*, 2000)[a]
		It would be disruptive to the company to sever the business relationship with their extranet partners (Vlosky *et al.*, 2000)[a]
		There is a positive association between commitment to a supplier and the efficient use of the internet by a buyer (Boyle, 2001)[a]
		E-procurement provided greater information transparency which may lead to increased outsourcing, supply base reduction, partnership relationships, and long-term supply contracts (Croom, 2000)
		E-procurement leads to a reduction in the supplier base (Boeck *et al.*, 2006; Stump and Sriram, 1997)[a]
		E-marketplaces are associated with a reduction of the supplier base (White and Daniel, 2004)[a]

(*continued*)

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Key dimensions of buyer-seller relationships	Definition	The link between IOS and the key dimensions of buyer-seller relationships
Relationship value	The trade-off between the benefits and sacrifices regarding all aspects of the relationship (Walter *et al.*, 2000)	EDI has the unusual quality of providing significant benefits to both sides of the dyad (O'Callaghan *et al.*, 1992)[a] Adopters of barcoding experience relationship disruptions in the short-term and strengthened relationships in the long-term (Vlosky and Wilson, 1994)[a] E-procurement increases sales volume available to the remaining suppliers and provides a closer relationship (Stump and Sriram, 1997)[a] The type of e-marketplaces will influence value creation in the relationship (Hartmann *et al.*, 2002)[a] The use of e-marketplaces provides deeper relationships with the remaining suppliers (White and Daniel, 2004)[a]
Power imbalance and interdependence	A trading partner's ability to influence the other partner to do something it normally would not do (Anderson and Weitz, 1989)	The source firm attempts to induce EDI adoption in the target firm (O'Callaghan *et al.*, 1992)[a] Both suppliers and buyers have been known to encourage EDI adoption (Sriram and Banerjee, 1994)[a] Powerful buyers can force EDI adoption on their suppliers (Webster, 1995)[a] Large suppliers can also be forced to adopt EDI (Webster, 1995)[a] The strongest explanatory variable influencing SMEs to adopt EDI is the external pressure from EDI initiators (Iacovou *et al.*, 1995)[a] Large organizations perceive that their own power would influence the changes in use of EDI in their organization (Ramaseshan, 1997)[a] Buyers push sellers to adopt IOS technologies such as EDI and barcodes (Wilson and Vlosky, 1998)[a] Companies believe they give into their partner's EDI requirements (Dupuy and Vlosky, 2000)[a] External pressure is a considerably more important predictor of intent to adopt EDI than are perceived benefits (Chwelos *et al.*, 2001)[a] The process of EDI adoption is significantly governed by buyer-supplier power relationship (Iskandar *et al.*, 2001)[a] Suppliers that adopt barcoding believe that customers are somewhat dependent on them due to a short-term scarcity of UPC barcoded product suppliers (Vlosky and Wilson, 1994)[a]

(continued)

Key dimensions of buyer-seller relationships	Definition	The link between IOS and the key dimensions of buyer-seller relationships
		Power does not seem to be manifested in extranet respondents (Vlosky *et al.*, 2000)[a]
		A marginal level of dependence arises from the difficulty of replacing extranet partners (Vlosky *et al.*, 2000)[a]
		Large customers team up to form e-marketplaces (Gulledge, 2002)[a]
Adaptation	Behavioral or organizational modifications carried out by an organization to meet the specific needs of another (Brennan *et al.*, 2003)	Target firms adjust their internal systems to permit the EDI interface with the source firm (O'Callaghan *et al.*, 1992)
		Suppliers have made efforts to adapt to their customer's EDI requirements (Wilson and Vlosky, 1998)[a]
		Companies had to modify corporate business procedures to accommodate EDI (Dupuy and Vlosky, 2000)[a]
		Suppliers that have adopted barcoding believe that they have made significant investments in time and expense to satisfy customer requirements (Vlosky and Wilson, 1994)[a]
		There is a slight need to modify business procedures to adapt to extranet partner requirements (Vlosky *et al.*, 2000)[a]
		Supplier adaptation to e-procurement and e-marketplaces is done through an iterative process based on the level of the relationship (Boeck *et al.*, 2006)[a]
Conflict	Overall level of disagreement between trading partners (Palmatier *et al.*, 2006)	Competition, which continues to express itself in supply chain relationships, leads to coercive EDI implementations and entails conflict (Webster, 1995)
		Sellers have reacted in a defensive mode to buyer EDI requirements (Wilson and Vlosky, 1998)[a]
		The differences in perceived value of barcoded products between buyers and suppliers contributes significantly to short term relationship deterioration (Vlosky and Wilson, 1994)[a]
		Suppliers feel that customers do not appreciate the challenges they face in adapting to barcoding requests (Vlosky and Wilson, 1994)[a]
		SME sometimes offer some form of resistance to e-marketplaces (Gulledge, 2002)[a]

Note: [a]Supported by empirical findings

Table I.

as purchase orders, invoices, consignment notes, remittance advice and customs documents" (Power and Sohal, 2002, p. 192). Before its adoption, inter-firm communications were conducted mainly through mail, telephone and fax. EDI was primarily perceived as a way to reduce costs, and then as a means of acquiring a competitive advantage and improving the accuracy of information (Ramaseshan, 1997).

Two dimensions of the buyer-seller relationship, namely commitment and communication and information sharing, have both been influenced by investments in EDI technology (O'Callaghan *et al.*, 1992). EDI trading partners generally feel fairly committed to long-term relationships and also perceive that they have a privileged long-term relationship with one another (Dupuy and Vlosky, 2000). The buyer's future purchase intentions are influenced by its satisfaction with the seller's use of EDI (MacDonald and Smith, 2004). They also share more information faster (Dupuy and Vlosky, 2000).

The process of adopting EDI can be viewed as an internal decision (Ramaseshan, 1997) initiated either by the buyer or the seller, as both have been known to encourage its adoption (Sriram and Banerjee, 1994), and benefit from such a joint initiative (O'Callaghan *et al.*, 1992). However, the perceived advantages of EDI sometimes entice powerful buyers to force its adoption on their suppliers (Webster, 1995), thereby introducing conflict in their relationships. Inducing the adaptation of a trading partner so that it will adopt EDI has been done to transfer competitive pressures from the marketplace to suppliers (Reekers and Smithson, 1994). External pressures from trading partners are indeed an important factor explaining the adoption of EDI by SMEs (Iacovou *et al.*, 1995), even more than its perceived benefits (Chwelos *et al.*, 2001). However, since large suppliers can also be forced to adopt EDI (Webster, 1995), low-bargaining power (Iskandar *et al.*, 2001) may be a stronger explanatory factor than size. Power imbalance and interdependence would therefore better explain EDI adoption, as about a third of suppliers have also strongly or very strongly encouraged their buyers to adopt EDI (Sriram and Banerjee, 1994).

Barcodes. Barcoding can also be considered an IOS technology (Vlosky and Wilson, 1994). A barcode consists of a label with alternating black and white lines often representing a Universal Product Code (UPC) that can be read by an optical scanner (Fiorito *et al.*, 1998). They are used to improve the accuracy of information and data transmission speed (Manthou and Vlachopoulou, 2001) and to encourage information sharing. In the retail sector, IOSs such as EDI and UPC barcoding enable modern logistic strategies like just-in-time for manufacturers and its quick response (QR) equivalent for retailers (Levy *et al.*, 2004; Wilson and Vlosky, 1998).

Although it was commercially introduced later than EDI, in 1974 (Varchaver, 2004), barcoding's widespread use in the retail sector preceded the use of EDI (Abernathy *et al.*, 2000). One possible reason is that, in order for EDI to function, an accurate product identification method is required for each stock keeping unit. Barcoding constitutes such an identification method and therefore enables advanced retail strategies. For example, immediate point of sale data cannot be transmitted via EDI without barcodes (Fiorito *et al.*, 1998), which in turn support a QR system that can reduce lead time by a week or more (Levy *et al.*, 2004).

These benefits of barcoding have encouraged some buyers to ask their sellers to adopt the technology (Wilson and Vlosky, 1998), which in turn has influenced their relationships. In a study conducted in the retail industry, focusing on wood products

(Vlosky and Wilson, 1994), it was demonstrated that UPC barcoding resulted in a poorer-quality buyer-seller relationship in the short-term, but later and paradoxically, in a stronger relationship. Additionally, suppliers believe that their own adoption of barcoding will make buyers somewhat more dependent as they have to rely on them. Sellers also feel that they adapt to barcoding requests and have made significant investments to satisfy buyers' requirements, whereas the latter feel that the opposite is true. This dichotomy in perception contributes to the fact that suppliers feel that the challenges linked to their adaptation are not sufficiently appreciated by buyers (Vlosky and Wilson, 1994). A more recent study (Dupuy and Vlosky, 2000) of a different form of IOS supports these findings: suppliers feel that they give into their customers' EDI requirements and that they invest a lot of time and money in order to adapt their internal processes to accommodate buyers.

Internet and extranets. The internet was created in 1969, but it was only after the introduction of the world wide web (the web) that its utilization grew rapidly. It serves as a backbone for data transmission and promised to aid in the large-scale adoption of EDI by replacing the more costly value-added networks that were used to exchange documents. It also supported the next waves of IOS like the web and extranets as well as more complex forms of electronically mediated processes using e-procurement and e-marketplaces. A study on internet use in industrial channels (Boyle, 2001) indicates that internet use increases commitment towards the supplier and that internet users communicate more frequently with suppliers and customers.

Extranets consist of private web pages that are accessible only to privileged trading partners. An empirical study (Vlosky *et al.*, 2000) found that companies that use extranets exchange a larger quantity and new types of information and communicate more frequently with extranet partners. They also feel a deeper commitment towards their trading partners (Vlosky *et al.*, 2000). Although a certain degree of adaptation is required by the trading partners, no use of power was perceived. This finding is different from other types of IOS where adaptation often results in some form of conflict. It should be noted though, that extranets are less invasive. They generally consist of a web interface where information is simply shared with a trading partner rather than integrated with internal systems.

E-procurement. E-procurement systems started to appear around the mid-1990s (Howard *et al.*, 2006). They electronically link buyers' procurement systems with their suppliers (Puschmann and Alt, 2005). Their main benefits are the reduction of operating and searching costs (Dai and Kauffman, 2001).

More transparent information may lead to increased outsourcing, improved procurement processes and more strategic management of certain types of indirect purchases (Croom, 2000), which can completely redefine the nature of buyer-seller relationships in the supply chain and even of the supply chain itself. For example, investing in e-procurement leads to a reduction in the supplier base, thereby making more sales volume available to the remaining suppliers (Stump and Sriram, 1997). Another study has also concluded that the introduction of e-procurement can trim back the supply chain through an iterative process of supplier adaptation (Boeck *et al.*, 2006). The suppliers that survive the "trimming" have a significantly closer relationship with their buyers (Stump and Sriram, 1997).

The existence of a relationship between the use of e-procurement and the buyer-supplier relationship has been quantitatively verified (Carr and Smeltzer, 2002).

In the study, e-procurement was defined in terms of automated purchasing systems that electronically link buyers with key suppliers and that could include EDI. It was proven that e-procurement technologies increase the frequency of communication between trading partners. It was less clear, though, whether this increased frequency also meant an increased richness of the communication content. Equally interesting was the fact that the adoption of e-procurement was not related to trust between the trading partners.

E-marketplaces. Introduced at the end of the 1990s (Puschmann and Alt, 2005), e-marketplaces are digital intermediaries in which members can participate in buying and selling activities (Dai and Kauffman, 2001). They can also be used in conjunction with an e-procurement strategy (Boeck *et al.*, 2006). E-marketplaces attempted to compensate for some of the shortcomings of earlier IOSs. For example, for a supplier to adapt to its buyers' e-procurement systems, it had to electronically link to many proprietary IOSs, which was very costly.

E-marketplaces are similar to other IOSs in the sense that they can change the inter-organizational processes between buyers and sellers and thus reshape buyer-supplier relationships (Murtaza *et al.*, 2004). For example, the use of e-marketplaces can contribute to building trust (Ratnasingam, 2005). They can also improve coordination activities and increase the speed of information sharing (Murtaza *et al.*, 2004). It was also found that e-marketplaces are associated with a reduction of the supplier base and a deepening of the relationship with the remaining suppliers (White and Daniel, 2004). Again, the adoption of e-marketplaces is often encouraged by buyers, especially when SME suppliers are involved (Boeck *et al.*, 2006); sometimes the latter feel their margins being squeezed and choose to offer some form of resistance (Gulledge, 2002), thus fostering conflict.

However, e-marketplaces differ from other IOSs in certain distinctive characteristics. Contrary to other forms of IOS, which are based on one-to-one or one-to-many relationships, e-marketplaces are based on many-to-many relationships (Murtaza *et al.*, 2004). This fundamental difference from other forms of IOS enables new electronic relationships to emerge among buyers, who may team up to form consortiums (Gulledge, 2002). They also differ in that they can be more collaborative in nature than e-procurement (Gulledge, 2002) and other IOSs because the electronic interactions between buyers and suppliers can go beyond basic buying and selling to include cooperation (Howard *et al.*, 2006; Lancastre and Lages, 2006). However, based on their classification, their market characteristics and the types of collaborative tools they offer, certain e-marketplaces are more appropriate to transaction-oriented relationships or to strategic relationships (Skjott-Larsen *et al.*, 2003), which would explain the adoption of transactional or cooperative e-marketplaces (Markus and Christiaanse, 2003). In a purchasing context, it is therefore suggested that the fit between the purchase situation and the e-marketplace be managed to maximize relationship value (Hartmann *et al.*, 2002).

Methodology

Research design

This paper's objective is to discover the link between RFID and buyer-seller relationships in one supply chain in the retail industry. Nowhere else is the use of RFID, as a collaborative tool, creating such a seemingly opposite response among supply chain members. The retail industry was thus ideal for answering the research question raised. The study was exploratory in nature because RFID research in a business setting is still in its infancy (Sellitto *et al.*, 2007). Consequently, it was guided by a general intent to seek an understanding of the phenomenon rather than by a specific research proposition (Yin, 2003).

The research design relied on two exploratory research methods: carrying out a multiple case study while building on the grounded theory approach. The case study method allowed us to set and limit the scope of the research design to a specific group of companies and to gain an in-depth understanding of the phenomenon under investigation. It also provided guidelines and a framework (Eisenhardt, 1989; Yin, 2003). The grounded theory approach was used as a guiding philosophy of keeping an open mind to allow for the discovery of unbiased new concepts revealed by emerging patterns in the data itself (Glaser and Strauss, 1967). Special care must be taken when combining the two methods (Fernández *et al.*, 2002) since the case study's more structured approach can limit the theory-generating approach of grounded theory. Using both methods seems particularly appropriate when exploring an emerging phenomenon such as RFID adoption and investigating complex behavioral issues related to buyer-seller relationships. Other authors have also combined both methods (Correia and Wilson, 1997; Lehmann, 2000) and the overall approach has already been operationalized in several steps, as outlined by Eisenhardt (1989).

Firms involved in the study. The field study was conducted in one retail supply chain. Ten companies were involved: three manufacturers, referred to, respectively, as "Bottler A," "Bottler B," and "Bottler C"; one first-level distributor (called here "Distributor 1") through which all products must transit; three second-level distributors, referred to, respectively, as "Distributor 2A," "Distributor 2B" and "Distributor 2C," who distribute to the three retailers called "Retailer A," "Retailer B" and "Retailer C." The buyer-seller relationships link the buyer-seller dyads together. The bottlers are linked to Distributor 1; Distributor 1 is both a customer of the bottlers and a supplier to the level-2 distributors; and these distributors are linked to the retailers. These supply chain members are responsible for a bottled beverage destined for human consumption. Approximately, 180 million units flow through these companies each year.

Researchers' roles. The researchers played the role of participant-observers since they were actively involved not only in the different data collection activities but also in the formulation of the technological scenarios and the organization and conducting of focus groups. The participant-observer approach, which has been used successfully in studies of inter-organizational relationships (Nordin, 2006), in the retail industry (Geiger, 2007) and in a similar RFID setting (Pålsson, 2007), provides several advantages which are otherwise difficult to attain (Creswell, 2003; Yin, 2003). In particular, it allowed the researchers to gain access to sensitive and confidential internal reports, strategic documents and detailed written operational procedures. It also provided a unique understanding of the supply chain which only someone "from the inside" can acquire after a certain immersion. For example, the researchers required several meetings to understand the companies' idiosyncratic expressions and references, which in a sense constituted a unique language for which a short dictionary was created to facilitate later interactions during the study. This approach also led to additional insights and understanding that contributed to a much better interpretation of the field data. It generally falls in the realm of collaborative action research

(Miles and Huberman, 1994) as respondents on the project were constantly briefed on new findings and would jointly determine the next stages of the research project.

Data collection

The collected data consisted of structured, semi-structured and non-structured interviews with 52 individuals from ten functional teams; focus groups with several managers of the same company and with several companies of the supply chain; on-site visits of the factory, warehouse and retail locations; multiple on-site observations for process mapping and time-and-motion studies also involving videos of interviews and of work being performed; personal memos and field notes; internal reports and other documents such as debriefing notes. The research followed the steps outlined in earlier work to determine the impact of RFID in a supply chain (Lefebvre *et al.*, 2006). This was done to assist in data collection and adds to the validity of the construct (Yin, 2003). The process approach, which is central to this tool, has already been used in previous RFID studies (Lefebvre *et al.*, 2005; Subirana *et al.*, 2003) and is consistent with the study of buyer-seller relationships (Izquierdo and Cillán, 2004).

Reliability of the data was ensured by having several researchers collect data individually and in groups. A total of ten researchers were involved at one time or another during the study. After each event, personal notes were written and compared and consensus was reached. Both qualitative and quantitative data were collected and triangulated through several methods. The data collection process was highly iterative and lasted until the information derived became redundant and saturation was reached (Glaser and Strauss, 1967). This lengthy process of moving back and forth between data collection, coding and analysis spanned three years from spring 2004 to 2007.

Data coding and analysis

Field notes were individually transcribed and coded as soon as possible after being taken. Coding was compared among the researchers and, once adequate, was centrally stored with the raw data. For the purpose of this specific study, the researchers extracted all data pertaining to buyer-seller relationships. This was done by extracting from the raw and coded data all information that contained the following elements:

- words and codes relating to "customer;"
- words and codes relating to "supplier;"
- all aspects pertaining to trading partners; and
- all aspects pertaining to their relationships with one another.

This information was then clustered into key issues or categories in a manner inspired by studies using similar methods in similar settings (Geiger, 2007; Lee, 2001). The analysis consisted of within- and between-case exploratory analysis (Miles and Huberman, 1994). The resulting categories indicate how RFID is linked to buyer-seller relationships. They were agreed upon by the senior researchers, who were present throughout the entire study, and are supported by both field data and theoretical generalization (Hillebrand *et al.*, 2001). Respondent quotes, examples from observation and anecdotes are provided to support the categories that are presented in the findings.

In the conclusion of this paper, content analysis is undertaken to clarify how these categories influence the key buyer-seller relationship dimensions presented in Table I.

The RFID scenario retained

The technological scenario retained for the proposed RFID infrastructure was validated with senior RFID specialists. Its technical feasibility was tested and a simulation with real-life data was conducted using a working laboratory proof of concept (Bendavid *et al.*, 2006).

The study used Alien M tags, which are passive write-many read-many Electronic Product Code (EPC) Class 1 Generation 2 RFID labels that operate at 915 MHz and are commonly referred to as Gen2 UHF tags. The information contained within the tag is the product description, lot number, quantity in pallet, order number, case identification and pallet identification when appropriate. These labels can be affixed to any packaging unit, such as a bottle, a case or a pallet. The readers used are Symbol XR400 attached to AN400 high-performance antennas, Symbol MC9060R handheld readers and Symbol RD5000 mobile readers positioned at strategic locations throughout the supply chain, such as the entry and exit points, as well as on the forklifts. The trucks can interrogate the contents of their shipments and transmit this information in real time using a reader connected to a wireless network. The study assumes perfect readability of the RFID tags and an ideal transmission environment where radio interference is at a minimum. It also assumes perfect signal propagation in the near and far field, thus making dual tagging unnecessary (Harmon, 2006). This implies that the antenna can scan an item when it is packaged into cases and pallets. By making this assumption, we are eliminating the problem of "tag shadowing" (Maloni and DeWolf, 2006) which is created when multiple tags are in very close proximity. The researchers and the participants believed that temporary technical limitations on RFID should not limit the findings because RFID technology is speedily evolving towards improved read rates in difficult conditions. For example, UHF tags can now be used for near-field scanning through liquids, a feat that was not possible only a few months ago (Desmons, 2006).

Results and discussion

Current processes in the retail supply chain

Figure 1 shows the usual flow of the products among supply chain members (as indicated on the horizontal axis) under normal conditions. These flows were mapped by literally following a product though its entire supply chain and by interviewing the employees who handle the products and their direct supervisors. The higher-level managers also validated these flows.

Figure 1 also takes into account the level of granularity (as illustrated in the vertical axis) of the shipping and packaging levels that must be taken into account in the analysis. In the group of companies studied, the lowest level of granularity is the item level or bottle. The other levels included in the analysis are the case, pallet and truck levels.

The numbered boxes in the figure represent the major supply chain processes through which most products travel to reach the final customer, the consumers. The processes travel up and down the vertical axis as the product changes shipping and

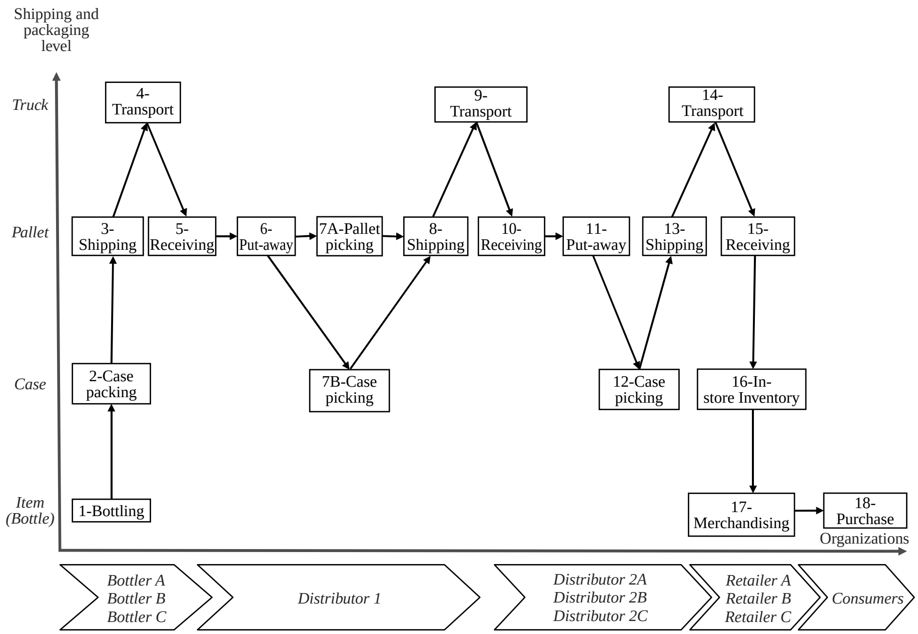

Figure 1.
The RFID supply chain flow model depicts the physical flows in the retail supply chain

packaging levels. The supply chain process starts at the bottlers, where the components of the product are assembled as described below:

- *Bottler processes.* On a fully automated conveyor belt, the product is assembled when the beverage is poured into glass bottles. A label with a UPC barcode for identification purposes is then glued to the bottle (referred to as process "1 – Bottling" in the lower left-hand corner of Figure 1). At the end of the conveyor belt, the products are packaged in corrugated boxes that contain barcodes called shipping container codes (SCC) for identification purposes (process "2 – Case packing"). These cases are then bundled onto pallets to facilitate their handling. Next, license plate (LP) barcodes are affixed to the pallets. It should be noted that UPCs, SCCs and LPs serve the same general purpose but at different tracking levels. The pallets of identical items are briefly stored in the staging area near the shipping docks until they are moved into the trucks (process "3 – Shipping"). The shipment leaves the bottlers and moves on to Distributor 1 (process "4 – Transport").
- *Distributor 1 processes.* The shipment is unloaded in the staging area near the receiving docks where the nature and quantities of the packages are verified manually and by scanning the LPs and the SCCs (process "5 – Receiving"). A forklift driver then moves the pallet to its appropriate storage rack and confirms the location and pallet by scanning both (process "6 – Put-away"). The next step depends upon the order that has been received from the retailer. When the retailer requests a pallet of a single type of product, the forklift driver simply removes the pallet while rescanning both the LP and the storage bin to confirm

that the right product has been chosen (process "7A – Pallet picking"). Normally, if more than one pallet of the product is available, the forklift driver should pick the first one that was warehoused rather than the closest one available in the usual inventory first-in, first-out (FIFO) mode. If, however, the retailers request different types of products, then a clerk must walk the aisles to pick individual cases, thus breaking down the pallet into its lower handling units. At this point, the pallet's LP is no longer valid as the pallet has lost its integrity. The clerk scans each case's SCC to validate that the right product has been picked. When all cases have been picked, a new pallet is now formed with mixed cases and a new LP is printed and affixed to the "mixed pallet" (process "7B – Case picking"). Pallets of various products are deposited in the staging area near the shipping docks. The pallets' LPs are scanned as they enter the truck in order to confirm their identification. Mixed pallets undergo the additional step of being manually verified by a controller beforehand (process "8 – Shipping"). The shipment leaves Distributor 1 by truck and is tracked through global positioning system until it arrives at the second-level distributors (process "9 – Transport").

- *Distributor 2 processes.* The pallets are unloaded from the truck and quantities are manually verified and a handwritten paper-based report is generated (process "10 – Receiving"). The pallet is taken from the staging area and deposited in the warehouse. The clerk scans the put-away label and enters the storage rack information into the warehouse management system (WMS) (process "11 – Put-away"). Based on the order to fulfill, the WMS informs the clerk where to find the case to pick through a voice interface. Picking is done in FIFO mode and performed with the equivalent of a big shopping cart. The process was described during the on-site interviews as "doing the groceries for the grocery stores"; in fact, the purchase order presents the disparities of a "shopping list" (process "12 – Case picking"). At this point, the odd shapes of various items on the pallet make its general form less rectangular and more incongruent. It is nearly impossible to determine with the naked eye the content at the center of the heavily shrink-wrapped pallet as it waits to enter the truck (process "13 – Shipping"). The shipment leaves the distributor and may make several stops and travel several hundred kilometers before reaching its destination at the different retailers (process "14 – Transport").
- *Retailer processes.* Once the shipment arrives at the retailer, it is unbundled to the case level in order to manually verify that its content matches with the purchase order. This is very time-consuming due to disparate items (process "15 – Receiving"). The products are then kept in the back-store (process "16 – In-store inventory") until a clerk is available to move it to the front-store as shelf space is made available. The product finally returns to its initial item level as it is displayed (process "17 – Merchandising") for the consumers who may decide to buy it. The UPC is scanned during checkout (process "18 – Purchase").

This model was developed in order to provide a visual representation of relevant RFID information in a supply chain environment. The following section presents our findings on the influence of RFID on buyer-seller relationships in a supply chain environment, referring to the Figure 1 and its description as background.

Key issues

The adoption of RFID raises a number of key issues that affect or are affected by buyer-seller relationships. These are discussed in the following paragraphs.

RFID benefits travel downstream to customers as externalities. Once a product is tagged, it can be read at any later time. Therefore, later processes also benefit from the RFID tag as it travels down the supply chain. If the bottler affixes a tag during a manual slap and ship operation, which consists of simply having an employee place a tag by hand on the product immediately before it ships out, as shown in Figure 2 (process "3 – Shipping"), then the same tag can also be read by Distributors 2 when the pallet is placed in storage (process "11 – Put-away"). The RFID-enabled process is more efficient because it reduces errors caused by manual verification. The second-level distributors benefit from information within RFID tags whose costs were covered by the bottlers. The benefits thus diffuse to subsequent processes after tagging is performed until, as will be explained in the next paragraph, the shipping and packaging level declines below the level at which the tagging was performed. In the current illustration, where tagging is performed at process "3 – Shipping," the benefits cease to propagate through the supply chain when either process "7B – Case picking" or process "12 – Case picking" is performed.

RFID benefits can also travel upstream to suppliers with the EPC network. This second issue is complementary to the first issue, which stated that benefits travel downstream, and can only be realized if RFID data reside in a centralized location to which all supply chain members have access. This is the case when using the EPC network rather than having the data reside exclusively in the tag itself: RFID-related information can then travel anywhere in the supply chain from the point where the tag is scanned and benefits derived from this shared information can be obtained throughout the supply chain. For example, when an item is sold at the retailer (process "18 – Purchase"), the centralized database is updated and the bottlers can

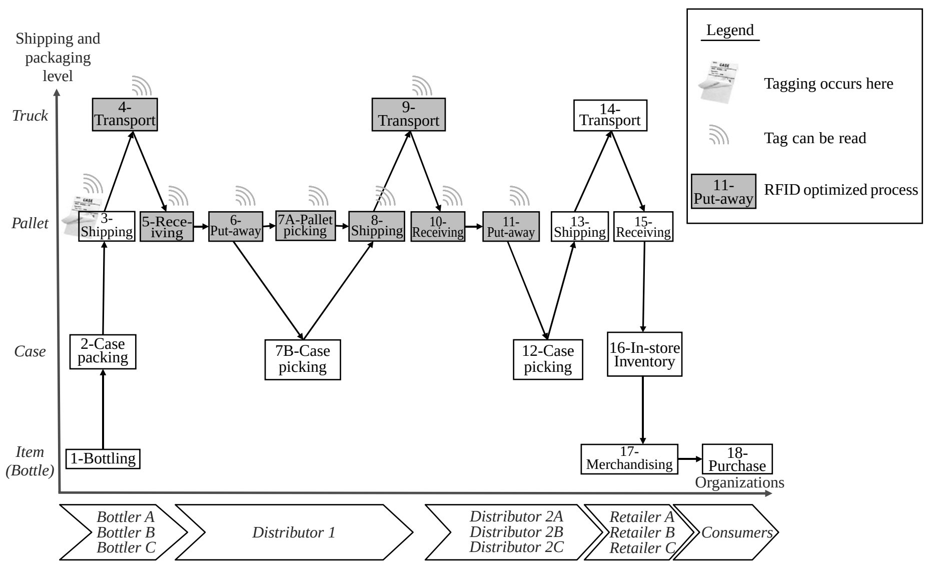

Figure 2.
Propagation of RFID benefits when tagging occurs at process "3 – shipping" and if process "7A – pallet picking" is performed instead of process "7B – case picking"

instantaneously be told to replenish the store. Receiving the information directly from the retailer and at the exact moment when it occurs instead of letting it travel through several layers of companies increases information flow. Previous research has already demonstrated that this can reduce the "bullwhip effect" (Paik and Bagchi, 2007) whose ripple effects on demand can cause inefficient work orders (Disney *et al.*, 2004) for the manufacturers. Currently, the bottlers have no direct view of the items at the retailer and produce to capacity regardless of consumer demand. Another example raised by participants in the field was discussed at length. The supplier would benefit from the visibility of its own shipment when it is received at the customer's receiving dock. The bottlers have unsettled claims with Distributor 1 because of shrinkage. Shrinkage occurs when quantities decrease between two specific control points. It may be due to breakage, misplaced items, poor bookkeeping or even theft (Levy *et al.*, 2004). If the merchandise is scanned as it leaves their location and rescanned once it arrives at Distributor 1, the two quantities can be compared and reconciled instantaneously. This reduces shrinkage and improves cash flows by allowing billing to be done more quickly.

The tagging level influences the supply chain benefits. What makes an RFID project different from other IOS initiatives is that the information is physically linked to the products. As such, when products aggregate or break down, the information tied to an item can be increased or lost. If tag placement occurs at the case level, such as during process "2 – Case packing" or process "7B – Case picking," then tracking can still occur at the pallet and truck level because the case entity which was tagged still exists. It is simply aggregated into a more encompassing unit. Conversely, when tracking is performed at the pallet level by affixing a tag at process "3 – Shipping," then tracking is lost if process "7B – Case picking" is performed because the pallet is broken down into its individual cases (Figure 2). Since the tag was on the pallet and the pallet is now broken down, it thus no longer exists and the tracking is lost.

Empirical evidence supports this statement. In fact, participants in the focus groups identified this issue when discussing the benefits of managing inventory levels at process "16 – In-store inventory." A vice-president mentioned that if tracking was done only at the case level, inventories would be inaccurate as soon as the case was opened. Sometimes only half of the bottles are placed on the shelf and the box returns to the backroom half full. The tag on the case would not let clerks know how many bottles were removed and they might assume it is still full. Tagging at the item level would eliminate this problem. Additional empirical evidence to this effect comes from the simulation of the technological scenarios. The initial scenario envisioned tagging at the pallet level in the bottlers' facilities during process "3 – Shipping." However, Distributor 1 experiences most RFID benefits at the case level during process "7B – Case picking," which is one level lower than in the initial scenario. Because tagging at process "3 – Shipping" provided no benefits to process "7B – Case picking," it became clear that the level of granularity for tagging influences the benefits.

There is a strong tendency to push tagging upstream. Since later processes benefit from the RFID tag after it has been affixed, it is logical to push the tagging back as early as possible. For example, it would not make much sense to choose to tag the products during process "7A – Pallet picking" in order to benefit from RFID at process "8 – Shipping" when the same tag could be affixed at the same shipping and packaging level during process "5 – Receiving" and thus also benefit process "6 – Put-away" and process "7A – Pallet picking". This would involve the same tag and the same readers on the forklifts and dock doors. No additional hardware investment would be necessary in order to benefit from RFID in these earlier processes.

A lot of time and effort was spent in the field study to optimize case picking. For Distributors 2A, 2B and 2C to benefit from RFID during process "12 – Case picking," only two tagging options exist: Distributor 1 must affix the tags during process "7B – Case picking" or the bottlers must affix them during process "2 – Case packing" (Figure 3). In both cases, the supplier or the supplier's supplier must tag the case for the benefit of the level-2 distributors. This demonstrates how organizations will tend to push the tagging to their suppliers to maximize their own RFID benefits. The same occurs at the pallet level. During the field study, it was demonstrated that Distributor 1 would have a more efficient process during process "5 – Receiving" if the pallets came in already tagged since less manipulation would be necessary to verify quantities and content at the receiving dock: this would therefore translate into fewer employees required at the dock. However, for Distributor 1 to benefit from RFID during this process, the tagging must be performed before the pallets arrive. This implies that tagging must be performed by the bottler during process "3 – Shipping" or by the transport company during process "4 – Transport."

There is a tendency to push tagging back to the bottlers. Another factor besides process optimization contributes to pushing the tagging back to the bottlers. Distributor 1 indicated that if it were to attach the tags itself, the process would be manual because the conveyor belt is only at the bottler's location. Manual intervention proved to be error-prone on more than one occasion during the study. In fact, reducing manual intervention is an important RFID benefit for the respondents. They believe it is up to the bottler to program and affix the tags on the products while they are on the

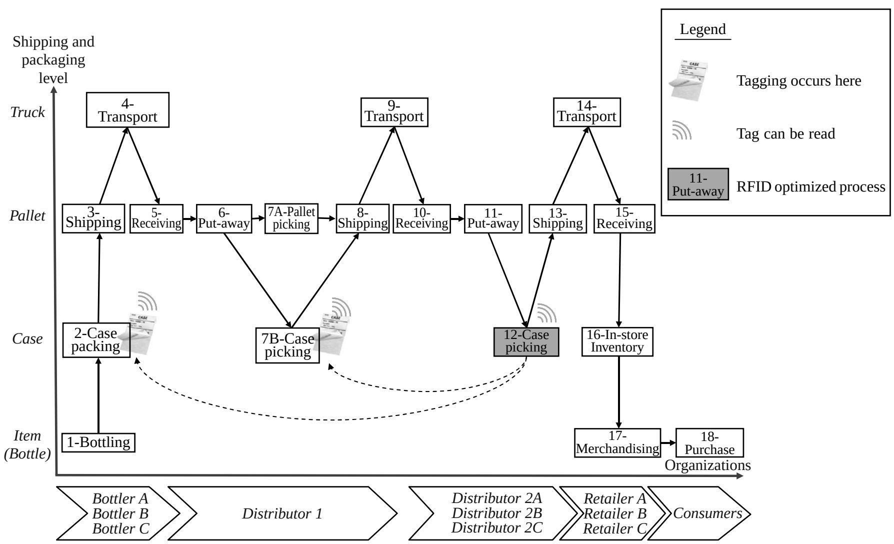

Figure 3.
In order for second-level distributors to optimize process "12 – Case picking," tagging must occur either at Distributor 1 or at the bottlers

automated assembly line in order to reduce the introduction of errors in the supply chain's data. A manager at Distributor 1 said: "The Bottlers should put on the tag, because we don't want to introduce errors, which can be costly. The other day, 40-ounce bottles sold as 26-ounce bottles because of errors between the SCC on the box and the UPC on the bottle."

Two other potential factors were initially thought to favor having the bottlers tag the products. However, validating these factors with the respondents revealed that this was not the case. Specifically, it was first proposed by the researchers that another advantage of pushing the tagging to the bottlers could be to unload the cost of the RFID tag onto other supply chain members. When asked if this was an advantage for them, respondents answered that it was not because "our supplier will just end up charging it back to us one way or another." Secondly, our model indicates that more benefits are gained if tagging occurs at lower levels (Figure 2). As such, tagging at the item level should provide benefits for all the processes in the supply chain. Because this can only be performed by the bottlers at process "1 – Bottling," bottlers would eventually be pressured by all the other supply chain companies. However, this was not the case in our study. Both Distributor 1 and the level-2 distributors were concerned with optimizing processes at the case level, not the item level. Indeed, the model shows that these companies do not handle the goods at this level. As the cost of tags goes down, perhaps the retailers will demand that the bottlers tag their items. Item tagging implies 12 times more tags than case tagging because each case contains 12 bottles. According to our study, based on current pricing the cost of the RFID system would outweigh the benefits.

The efficiency of inter-organizational processes can be improved. Many observed inefficiencies in the inter-organizational processes could be resolved by RFID. For example, shrinkage was recognized as a major irritant throughout the entire supply chain studied. Much shrinkage occurs between the time a product was accounted for at shipping and its arrival at the customer's receiving dock. However, the exact cause and location of shrinkage cannot be proven, and so the supplier has the burden of proof and regularly absorbs the cost of missing products. This constitutes a major irritant for all members of the supply chain. Based on our fieldwork, RFID has the potential to provide the necessary proof to indicate when the shrinkage occurred. By removing this uncertainty, unfounded accusations, feelings of being manipulated and arguments can be reduced, consequently improving the relationships between customer and supplier. Reducing shrinkage is seen as the major RFID benefit for Distributor 1: "the day when you'll be able to validate the content of a pallet at the case level during shipment to a customer is the day we will go forward with the RFID project."

Numerous additional inter-organization processes can also be improved with RFID. The retailer has been known to return truckloads of shipments although only a single pallet was missing or the shipment arrived only five minutes late. These problems, which strain the relationship between organizations "are the worst and are frustrating," as mentioned by one dock worker. Errors due to an inefficient verification process can be avoided with RFID.

RFID cannot compensate for lack of trust, which is an a priori condition. Some level of mistrust was present throughout the entire supply chain as exemplified by the following comments:

> It's funny how claims are more frequent on higher-ticket items.

> Our customers are trying to make some money off of us [. . .] by pushing unfounded claims, but if they receive a case that wasn't on their order then we won't hear about it [because they will keep it].

When the proposed RFID solution was presented, the respondents quickly and often tried to see how the system could potentially be manipulated by their trading partners. Comments such as:

> Can the system be tricked with cell phones, for example?

> The supplier could decide to put on two tags per case in order to double-charge us.

> They could close the reader when they receive certain products to avoid being billed for them.

Clearly indicate a lack of trust. An RFID system will never be full-proof and cannot compensate for a lack of trust.

RFID is a supply chain management IOS. The influence of RFID goes beyond the boundaries of any specific organization as information sharing can impact every member of the supply chain. RFID represents an IOS technology that piggybacks on products as they travel through the entire supply chain. As such, it has the potential to be a powerful SCM technology. This was emphasized by one senior executive from Distributor 1: "This RFID project is truly the first initiative to move throughout our whole supply chain and impact our customers as well as our suppliers."

Aligning the supply chain to a common project is therefore seen as a prerequisite for implementing RFID. A high-level director mentioned that gaining buy-in from suppliers is essential: "We need to be able to demonstrate to our suppliers what their benefits will be for them to support our RFID initiative." In another company (Distributor 2A), alignment among the supply chain members is believed to require strong leadership that a powerful firm could provide.

Conclusion

The interplay between RFID and buyer-seller relationships in a supply chain is an intricate phenomenon. Based on the empirical evidence from the ten firms involved in the field study, the following summary observations can be made:

- *Communication/information sharing*. Access to shared information is at the heart of an RFID initiative. The information related to a specific product is shared among trading partners as the product travels downstream through the supply chain. Information can also travel upstream if the EPC network is used. Currently, the information related to case level quantities and shrinkage interests the respondents the most.
- *Cooperation*. The desire to make a shared RFID supply chain project a reality clearly necessitates a deep desire for cooperation from all members of the supply chain. Respondents were aware of this and were constantly looking for ways to demonstrate the shared benefits of the system to encourage cooperation. Once the technological infrastructure is in place, it should also facilitate supply chain initiatives, thereby enabling the supply chain to work as a more collaborative team.
- *Trust*. An RFID system has the potential to reduce a major part of the shrinkage that has caused a lack of trust among some of the organizations in the study.

By acting as a constant verification system, it provides accountability for quality and volumes of shipments. Shrinkage will tend to diminish, thus making the trading partners more trustworthy. However, as demonstrated in the field, an initial inherent level of trust that partners will not try to bypass the RFID system is necessary if it is to be effective.

- *Commitment.* The companies included in the proof of concept were identified and chosen by the respondents as being long-term partners. Implementing the RFID system will initially necessitate a considerable investment in specific investments. A portion of this investment therefore represents sunk costs that will not be recovered should the relationship end. By investing in the system, these companies expect the relationship to last. Additionally, once RFID is implemented, the relationship should be more profitable. The natural tendency would be to build on the relationship as long as possible in order to recoup the initial investments and increase profits.
- *Relationship value.* Additional information will be accessible to members of the supply chain who use RFID together. Shrinkage in the supply chain will be reduced. New opportunities for collaboration will increase the value provided by customers and suppliers who use RFID. The relationships with trading partners who use RFID will therefore be increased when compared to those with partners who do not use the technology.
- *Power imbalance and interdependence.* Both suppliers and buyers feel that an RFID initiative will give the other party more power. Suppliers feel that an investment and the associated sunk costs may lock them in *vis-à-vis* the buyers. Buyers feel that those suppliers who use RFID technology will gain a more competitive position.
- *Adaptation.* Some organizations that are lured by the benefits that RFID promises may use their power to influence their trading partners to adapt to the new RFID requirements. As RFID technology improves, there will be a trend to push the technology further back and further down in the supply chain. As this happens, the company in the role of manufacturer is likely to be increasingly pressured by its trading partners to adopt RFID. In our study, the retained RFID scenario was developed by minimizing the required adaptation so that the technological initiative be the least disruptive possible.
- *Conflict.* The ten organizations in this study are aware of potential conflicts related to RFID adoption and use positive reinforcements to get their trading partners to join the RFID initiative. If the trading partner does not want to go in this direction, pressure may eventually be applied. The situation could potentially create conflict in the buyer-seller relationship.

Some deep practical implications arise out of these findings. Wal-Mart's initiative acted as the flagship for RFID as an IOS project but now other supply chains are currently evaluating or going forward with similar RFID initiatives. It is important that these companies be aware of the strategic role of supplier-buyer relationships as both crucial antecedents that shape RFID infrastructure and a consequence of RFID implementation. Furthermore, the continual improvement of RFID technology will tend to strain relationships among supply chain members since the use of power to urge adaptation may lead to conflict. RFID technology brings business partners one step closer to the vision of aligning their supply chain and raising the competition to the level of "chain versus chain," thus moving closer to acquiring a collaborative advantage. For researchers, the results point to the importance of considering the different layers of the supply chain when investigating collaborative technologies such as RFID, relationships between business partners, or competitive positioning. This is particularly interesting for academic fields such as SCM, industrial marketing and diffusion of innovation research.

Further research

The results presented in this paper should be interpreted in the light of certain limitations. First, the observer's role is intermingled in this field research with that of the participant. This has the potential risk of influencing the participants by advocating a particular position, the risk of supporting a group of individuals when neutrality is required, and the risk of the participant role's requiring too much attention for good observations to take place (Yin, 2003). The researchers were aware of those potential pitfalls and tried to remain as neutral as possible. Second, the technological scenario is based on current improvement trends in the RFID industry. More specifically, perfect read rates are an optimistic extrapolation of today's state-of-the art technology but this is seen as a temporary technical obstacle. Third, the study was conducted in a single supply chain in the retail industry, which allowed us to gain in-depth knowledge of a complex phenomenon.

Future research could attempt to validate these findings in other supply chains in other industries. Moreover, future studies could delve deeper into this phenomenon. For example, a longitudinal study of an RFID initiative implemented in a supply chain could indicate whether relationship quality diminishes in the short-term only to increase later, as has been found to be the case with barcode and EDI implementations. It would also be interesting to identify the RFID adoption antecedents and the contributing factors that make trading partners want to either collaborate or resist.

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