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Abstract
Electronic exchanges of information between Businesses have continued to grow over recent decades. Though the emergence of new technologies, firms are facing new opportunities to build Interorganizational Information Systems (IOSs) to organize their electronic exchanges of data to update their own information systems. In this paper, we focus on flows from suppliers to retailers of product information, a set of data that describe the product manufactured by suppliers and retailed by wholesalers to the end consumer. We propose a new theoretical framework to analyze IOSs, by considering how suppliers build their sending systems, how retailers build their receiving systems and how their interconnections lead to the creation of IOSs. Through a qualitative research based on interviews and documentation reviews, we describe and discuss the possibilities of interconnections between sending and receiving systems based on data privacy, structural linkages and the nature of flows.

Keywords: Interorganizational Information Systems, typology, sending systems, receiving systems, interconnection, Structural linkages, Data privacy, Nature of flows, Product information management.

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UNDERSTANDING THE DIVERSITY OF INTERCONNECTIONS BETWEEN IS: TOWARDS A NEW TYPOLOGY OF IOS

Electronic exchanges of information between Businesses have continued to grow over recent decades. Though the emergence of new technologies, firms are facing new opportunities to build Interorganizational Information Systems (IOSs) to organize their electronic exchanges of data to update their own information systems. In this paper, we focus on flows from suppliers to retailers of product information, a set of data that describe the product manufactured by suppliers and retailed by wholesalers to the end consumer. We propose a new theoretical framework to analyze IOSs, by considering how suppliers build their sending systems, how retailers build their receiving systems and how their interconnections lead to the creation of IOSs. Through a qualitative research based on interviews and documentation reviews, we describe and discuss the possibilities of interconnections between sending and receiving systems based on data privacy, structural linkages and the nature of flows.

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INTRODUCTION

Defined in the 80s as "*automated information systems shared by two or more companies*" (Barrett and Konsynski, 1982), Interorganizational Information Systems (IOSs) are needed more and more to support interorganizational processes (Venkatraman, 1994). Christiansee, Van Diepen and Damsgaard (2004) explained that "*the IOS described by Barrett and Konsynski (1982) were based on proprietary systems requiring significant asset-specific investments*" (p.161). Indeed, Barrett and Konsynski (1982) described exchanges of structured flows of messages by the use of proprietary networks or Value-Added Networks. Electronic Data Interchange (EDI) is a well-known example of such an IOS in B2B exchanges. The Internet offers new opportunities to develop other types of IOSs in order to exchange data electronically (Zhu et al., 2006). In the past, companies were mostly concerned with the decision regarding whether to adopt a special IOS, that has predefined characteristics for both senders and receivers. Considering the evolution towards new technologies providing more flexible opportunities for electronic interconnection, companies are nowadays more concerned with how and to what extent they can interconnect with their partners systems that have been designed differently. In this context, our research question aims at understanding how different types of sending and receiving systems can be interconnected, thus leading to different forms of IOSs? Therefore, the objective of this paper is to propose a new theoretical framework to analyze IOSs following two steps: the first one is about the description of the systems senders build to communicate with receivers and receivers build to communicate with senders; the second step is to analyze interconnections between these sending and receiving systems. This kind of analysis allows to extract forms of IOSs, issued from interconnections between sending and receiving systems, that are different from market and hierarchical forms (Bakos, 1991). The question of existence, stability and value of these forms of IOSs is a major practical and theoretical contribution of this paper.

Whereas most literature on IOS only examines the relatively structured flow of information about transactions (e.g., sales or purchases), we investigate the much less structured flow of product information between buyers and sellers. Product information is defined as a set of data that represents the identifying, technical, logistical and marketing characteristics of a product (GS1, 2006; Nakatani et al., 2006). This research is needed to partially address one of the limits acknowledged by researchers that have previously investigated product information exchanges: "*The lack of models and empirical evidence related to the inter-organizational product information supply chain is reminiscent of the early stages of supply chain research and calls for a more extensive investigation of the inter-organizational interdependencies and coordination mechanisms*" (Legner and Schemm, 2008, p.144). Product information pushes the technical frontier of electronic data exchanges because: a) it contains unstructured and loosely structured information such as textual descriptions of products, b) it contains dimensional information (products come in many sizes, colors, and logistical units each of which must be unambiguously differentiated from the others), and c) it contains relatively invariable information (e.g., product descriptions) as well as variable information, which may be unique to each partner who purchases the product (e.g., price and delivery terms). Our empirical investigations focus on interorganizational product information management in the French retail and consumer goods industries. Over the last ten years, large retail industry has developed standards and technologies to exchange product information from manufacturer's to retailer's internal databases through the use of electronic catalogues. We define these as electronic data pools that contain data describing articles (Nakatani et al., 2006; Legner and Schemm, 2008). In retailer/manufacturer relationships, they do not play the role that is generally attributed to them; indeed, they are not implemented by sellers in order to present their products, waiting for buyers to visit their web sites (Nicolaou and McKnight, 2006; O'Reilly and Finnegan, 2007). Instead, electronic catalogues are designed to support push data flows from manufacturers to retailers. Considering these characteristics, we hypothesize that several types of IOSs could emerge to support the specific process of interorganizational product information management by synchronizing, in as close to real time as possible, the internal databases of manufacturers and retailers. We think that a theoretical framework to understand several

types of interconnection between sending and receiving systems to support a special process is a major advance for IS literature. Indeed we can hypothesize that the development and use of multiple types of IS in organizations leads to some incompatibilities between standards and to multiple ways of interconnecting IOS between organizations. Therefore, organizations will have more and more to resolve the question of interconnection between the part of IOS developed by themselves, correlated to their internal IS constraints, and the ones developed by their partners.

After reviewing the relevant literature on IOS, we develop several propositions regarding messages sent, messages received and the possibilities for interconnection between sending and receiving systems. We then describe the methodology, the results and discuss the findings and their implication, before conclusion.

1 RESEARCH FRAMEWORK

1.1 IOS concepts and Typologies

Several definitions of IOS can be found in the literature and all have at least the following components (Suomi, 1992, p94): "*sharing of data or other resources; two or more organizations; IOSs are based on computers*". We focus on types of IOSs that are designed to automate push data flows from company to company. With this automation perspective, no human intervention is needed (Suomi, 1992). However, automation can not be achieved without standardization. IOS standards are defined as "*a set of technical specifications that are agreed upon and used by IOS developers to describe data formats and communication protocols, which enable computer-to-computer communications*" (Zhu et al., 2006). In the literature dealing with standards two major forms of standards appear (Christiaanse et al., 2004; Markus et al., 2006). In the first case, a company can impose its proprietary standard on its partners. Alternatively, industry or global standards are standards that are shared by all the companies in a sector.

To rephrase, we are focusing on types of IOSs supporting new EDI forms designed to integrate data in standardized messages from the sender's to the receiver's internal database. The Internet and the development of electronic intermediaries are considered to be new opportunities for doing EDI. Whereas traditional EDI implies data integration between two companies (Damsgaard and Truex, 2000), new forms of EDI propose more centralized data integration, where data pools can integrate data from a large number of firms. Previous research has shown that EDI allows the external integration of data (Swatman and Swatman, 1991), from the boundaries of a company to the boundaries of another one. Moreover, companies can maximize benefits brought from EDI adoption and use when they also achieve data integration with their own internal IS (Truman, 2000; Mukhopadhyay and Kekre, 2002). Electronic catalogues are thought as IT that firms can implement in order to achieve both internal integration and external integration (Nakatani et al., 2006). So we do not consider only data transmission between two systems, but also data emission from internal sender database and data reception by receiver internal database (Figure 1). Indeed, understanding IOSs designed to synchronize internal databases of trading partners is dependent upon the description of data integration from senders' to receivers' internal databases.

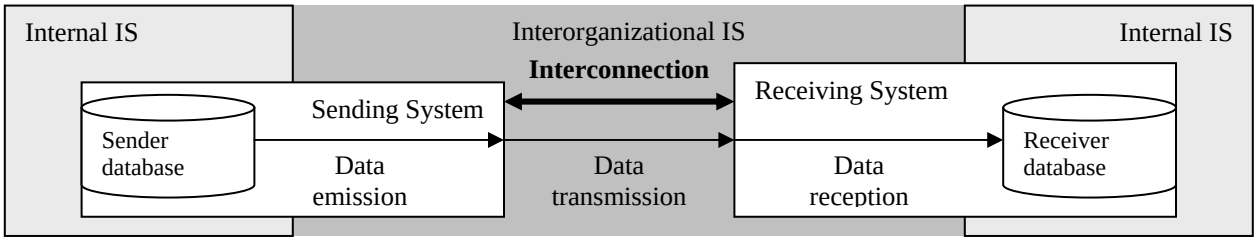


Figure 1. Data flows for interconnection

Though based on different theoretical backgrounds (Elgarah et al., 2005), IOS typologies are all derived from the concept of electronic interconnection. Indeed, IOS implementation means electronic interconnection between organizations in order to coordinate their data exchange. From the electronic interconnection perspective, we present IOS typologies that are based on the two main approaches to coordination: those based on electronic structures adapted from the economic structures of markets and hierarchies (Malone et al., 1987; Bakos, 1991; Choudhury, 1997); and those based on the interdependence view of data (Kumar et van Dissel, 1996; Liu and Kumar, 2003).

Researchers that have adapted transaction cost theory (Williamson, 1985) to data exchanges have defined electronic configurations of exchanges, such as electronic hierarchies and electronic markets. The typology of Choudhury (1997) is convenient to our research objectives because it is a starting point in addressing the electronic configurations of data exchanges between several sellers and several buyers. Choudhury (1997) specifies three types of IOS, electronic monopolies, electronic dyads and multilateral IOS. Because our objective is to emphasize the development of IOSs for a firm with its partners, we do not take it into account electronic monopoly which refers to the choice of a firm to implement a unique electronic link with one of its trading partners. Electronic dyads are bilateral IOSs where a firm establishes individual logical links with each of its trading partners. A multilateral IOS consists of building a single logical interorganizational link for a firm to communicate with all its trading partners (Table 1).

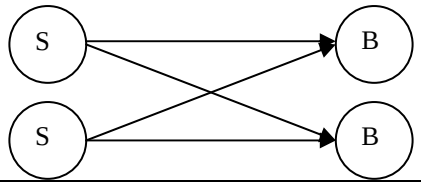
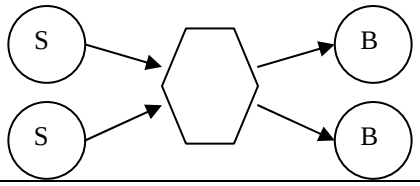
IOS types	Electronic dyads	Multilateral IOS
Logical linkage	For each firm, one electronic link per partner	For each firm, a unique electronic link to communicate with all its partners
Structure of data flows		

Table 1. Types of IOS from logical interorganizational linkage (Choudhury, 1997)

The logical structure of interorganizational linkage as the antecedent of electronic dyads and multilateral IOSs is a good way to understand how the flows of data from sender to receiver can be designed. Indeed, in light of our research question, electronic dyads and multilateral IOSs are two types of IOSs that can occur for product information exchanges. However we consider they can only partially explain the diversity of electronic exchanges. Indeed, it does not explain sufficiently how the data flows are related to these linkages.

Another way to address the coordination of data exchanges is the interdependence view of coordination. In the coordination theory, Malone and Crowston (1990; 1994) defined coordination as the management of dependencies between activities. Coordination theory can be applied to IOSs when defining the data to be the resources exchanged between senders and receivers. Using the three main types of interdependencies proposed by Thompson (1967), Kumar and van Dissel (1996) identified three types of IOS: hub-and-spoke IOS (Liu and Kumar, 2003), characterized by pooled interdependence since data are common resources shared by several companies in a hub; value/supply-chain IOS characterized by sequential interdependence since data are the output of the sender and become the input to the receiver; and networked IOS where interdependence is reciprocal between companies. Because we concentrate on flows from sellers to buyers, reciprocal interdependence of data does not fit with our conception of exchanges. Pooled interdependence of data means, in this conception, that data from sellers are shared with several buyers. So sellers send data to the hub, and this hub dispatches the data to the buyers concerned. Electronic catalogues are presented as hub-and-spoke IOSs (Nakatani et al., 2006; Legner and Schemm, 2008) to coordinate electronic data exchanges through a pooled interdependence of data

between companies. In the sequential interdependence of data, data are not shared with other companies than the two involved in the dyadic relationship, so we face a combination of parallel flows of data, each from one seller to one buyer. Traditional EDI is presented as a typical supply-chain IOS (Liu and Kumar, 2003) because data are only shared by the companies involved in a buyer/seller relationship. Looking at our research question, value chain IOSs and hub-and-spoke IOSs are two types of IOSs that can be used for product information exchanges. However, they can only partially explain the diversity of electronic exchanges. Indeed, it does not fully explain how the data flows are derived from these interdependencies.

Moreover, considering these developments, sequential interdependencies seem to be in line with the structure of data flows proposed in electronic dyads and pooled interdependencies with the structure of data flows proposed in multilateral IOSs. Therefore, this research asks whether this is a logical outcome or if other forms exist and are stable. Secondly, because of the importance of data privacy in B2C relationships (Culnan and Amstrong, 1999) and e-commerce (Dinev and Hart, 2006), this research also asks how the nature of data, from their privacy perspective, influences the choice of a particular form of electronic exchange.

1.2 Propositions

As introduced earlier, our research framework will be divided into two parts. First, we will present eight propositions, based on the literature review, to characterise IS thanks to the combination of three factors: nature of data, type of flows and logical linkages. However, contrary to past literature, these eight first propositions do not aim at defining different forms of IOSs but different types of sending and receiving systems firms may build. Then, the ninth proposition is about the IOSs that should occur from the interconnection between this set of sending and receiving systems.

Considering the nature of data, our research framework addresses several propositions that reflect how the privacy of data influences the nature of the flows between senders and receivers. We distinguish two types of message flows: point-to-point flows, where a message is sent to one and only one receiver; and point-to-multipoint flows, where a message from a sender is shared by several receivers. The distinction between these types of flows constitutes a first approach of coordination mechanisms structuring data exchanges. When companies exchange shared data, e.g. data that are not dependent upon a specific dyadic relationship, the messages containing these data can be designed through point-to-point flows or point-to-multipoint flows. The data can be sent in a message per dyadic relationship, from a seller to a buyer, or sent in a common message from a seller to several buyers. When companies exchange private data, the messages containing these data can only be designed through point-to-point flows, between the seller and the buyer involved in the dyadic relationship concerned with these private data.

P1a : a message containing shared data can be sent through a point-to-point flow
P1b : a message containing shared data can be sent through a point-to-multipoint flow
P2 : a message containing private data can only be sent through a point-to-point flow
P3a : a message containing shared data can be received through a point-to-point flow
P3b : a message containing shared data can be received through a point-to-multipoint flow
P4 : a message containing private data can only be received through a point-to-point flow

Combining the typologies of Choudhury (1997) for logical electronic linkage and Kumar and van Dissel (1996) for interdependency of data, our research framework includes several propositions that reflect how the structural linkage influences the nature of the flows between senders and receivers. In electronic dyads, a company builds one dyadic linkage with each of its partners, so a message can only be exchanged through point-to-point flow. Indeed, the message is sent from a supplier to a retailer. In multilateral IOSs, a company builds a multilateral linkage to communicate with all its partners, so messages can be exchanged through point-to-point flows or point-to-multipoint flows: a company can send a private message to one receiver or a shared message to several receivers.

P5 : In dyadic linkages, a message can only be sent through a point-to-point flow

P6a : In multilateral linkages, a message can be sent through a point-to-point flow
P6b : In multilateral linkages, a message can be sent through a point-to-multipoint flow
P7 : In dyadic linkages, a message can only be received through a point-to-point flow
P8a : In multilateral linkages, a message can be received through a point-to-point flow
P8b : In multilateral linkages, a message can be received through a point-to-multipoint flow

With these first eight propositions, we arrive at five types of sending system (thanks to the combinations of propositions P1, P2, P5 and P6) and five types of receiving system (thanks to the combinations of propositions P3, P4, P7 and P8). These are described in table 2.

Sending or receiving system	Nature of data	Structural linkage	Nature of flows
System 1	Shared	Dyadic linkages	Point-to-point
System 2	Private	Dyadic linkages	Point-to-point
System 3	Private	Multilateral linkage	Point-to-point
System 4	Shared	Multilateral linkage	Point-to-point
System 5	Shared	Multilateral linkage	Point-to-multipoint

Table 2. Types of sending systems and receiving systems

The first objective of this research is to find empirical evidence to corroborate these propositions about sending and receiving systems. Our final proposition, about the interconnection, is more concerned about the conditions of emergence of interconnections between these types of sending system and receiving system. For each dyadic relationship, we distinguish symmetric systems and asymmetric systems by considering the three characteristics previously discussed: nature of data, nature of flows and structural linkages. For instance, sending and receiving systems are said symmetric in terms of nature of data, when both the companies designed their own systems to exchange private data. And they are said asymmetric when one company designed its system to exchange private data and when the other one designed its system to exchange only shared data.

P9a : Between sending and receiving systems that are symmetric in terms of nature of data, structural linkages and nature of flows, interconnection is possible (for instance sending system 1 and receiving system 1)
P9b : Between sending and receiving systems that are asymmetric in terms of nature of data and symmetric in terms of structural linkages and nature of flows, interconnection is possible (for instance sending system 1 and receiving system 2)
P9c : Between sending and receiving systems that are asymmetric in terms of structural linkages and symmetric in terms of nature of data and nature of flows, interconnection is possible (for instance sending system 3 and receiving system 2)
P9d : Between sending and receiving systems that are asymmetric in terms of nature of flows and symmetric in terms of nature of data and structural linkages, interconnection is possible (for instance sending system 4 and receiving system 5)
P9e : Between sending and receiving systems that are asymmetric in terms of nature of data and structural linkages and symmetric in terms of nature of flows, interconnection is possible (for instance sending system 1 and receiving system 3)
P9f : Between sending and receiving systems that are asymmetric in terms of nature of data and nature of flows and symmetric in terms of structural linkages, interconnection is possible (for instance sending system 3 and receiving system 5)
P9g : Between sending and receiving systems that are asymmetric in terms of structural linkages and nature of flows and symmetric in terms of nature of data, interconnection is possible (for instance sending system 1 and receiving system 5)
P9h : Between sending and receiving systems that are totally asymmetric in terms of nature of data, structural linkages and nature of flows, interconnection is possible (for instance sending system 2 and receiving system 5)

2 METHODOLOGY

The methodology we employed was defined in order to find empirical evidence of sending and receiving systems that are designed differently, leading to interconnections the previous literature on IOSs has not yet presented. Systems interconnection is very important in the retail industry in order to synchronize internal databases of manufacturers and retailers (Legner and Schemm, 2008). This is particularly the case in France where discount operations are very frequent and where a large products assortment is offered in every point-of-sales. Moreover, product information exchanges between manufacturers and retailers are relevant to test our propositions. Indeed product information exchanges include considerations about data privacy and structural linkages that question the nature of flows.

2.1 Product information management in the retail industry

Product Information is defined as a set of data that represents the product in a B2B exchange between the manufacturer and the retailer. GS1, the global organization of standardization in the large retail industry, has developed a standard for product information exchanges, based on XML messages (EAN.UCC). It involves data that identify the product and the company that manufactures it, technical characteristics of the product, logistical characteristics, and marketing characteristics. For each product of each manufacturer, these data are shared data, because they have the same value for all the retailers. But the standard also includes complementary data that manufacturers and retailers can decide to exchange, such as prices and delivery terms. These are private data since their value is dependent upon the contractual relationship between one manufacturer and one retailer for each product.

The existing literature about product information exchanges (Nakatani et al., 2006; Legner and Schemm, 2008) mainly presents GDSN (Global Data Synchronization Network) as a mechanism to update product information between manufacturers and retailers. GDSN is based on flows of GS1 standardized messages which synchronize external catalogues: the source data pool of the manufacturer and the recipient data pool of the retailer. With several retailers and manufacturers, GDSN is a typical multilateral IOS as described by Choudhury (1997). Indeed, ideally, every company builds a unique electronic link with its external data pool, and data pool interoperability leads to communications with all its partners. Therefore, external electronic catalogues and GDSN promote external integration of data between companies (Nakatani et al., 2006). To achieve internal integration of data, some companies have also implemented an internal electronic catalogue, also called Product Information Management (PIM). PIM structures product information but it also acts as an intermediary between existing internal databases and the external data pool of the company (figure 2).

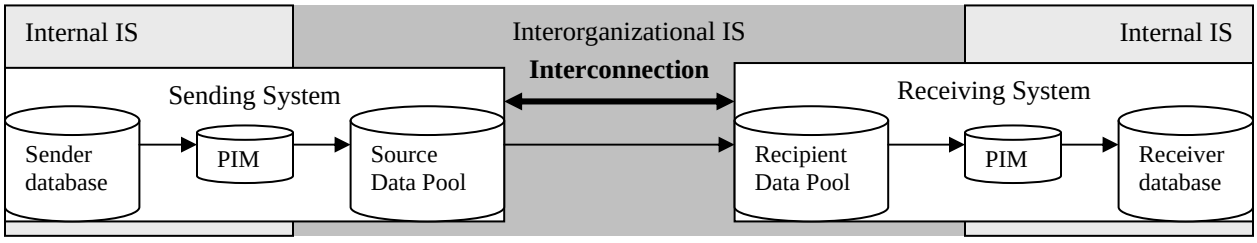


Figure 2. Data flows using Data Pools in Sending and Receiving Systems

Empirical evidence found in previous works (Nakatani et al., 2006; Legner and Schemm, 2008) shows that GDSN use is not widely adopted by companies in the retail and consumer good industries. Some of them estimate the standard does not cover their data needs (especially for private data described above), others that the use of an external catalogue incurs costs that can be avoided by the use of internal electronic catalogues. These considerations have led some companies to only implement a PIM, to

manage product information within their own systems, but also to exchange messages without external catalogues (figure 3). Interconnection between PIMs constitutes typical electronic dyads (Choudhury, 1997), since a company builds one link from its PIM to the PIM of each its partners.

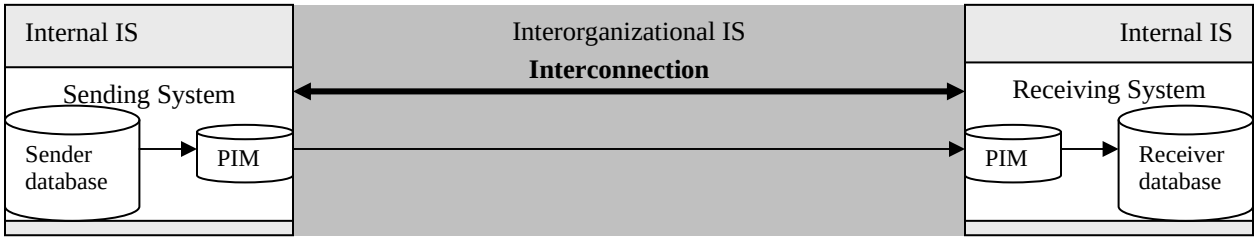


Figure 3. Data flows without the use of Data Pools in Sending and Receiving Systems

2.2 Research design, Data Collection and Analysis

Qualitative methods seemed to be the most appropriate methods to address our research question, as they are recommended when the research aims to address a comprehensive framework of a contemporary phenomenon. The research design is a "multiple case, multiple embedded units" design (Yin, 2003), where the cases in this study are the individual manufacturers and retailers embedded in dyadic supplier-buyer relationships. Indeed, considering our exploratory research about types of IOSs that can co-exist to support a special process in a sector, we decided to analyze numerous cases, even with little data collected per case, in order to have a sample that allows the discussion of several types of interconnection. Here we give a specific explanation of the IOSs we analyze. We only focus on systems that allow to integrate data from manufacturers' internal databases into retailers' ones. So we do not include IOSs such as Extranets proposed by some retailers for their suppliers to re-enter the data in their own information system. This type of IOS allows the integration of data from the retailer point of view, but not from the manufacturer point of view. The concentration in the French mass retail industry allowed us to include all the seven major French retailers in our analysis (Carrefour, Auchan, Casino, Système U, Leclerc, Intermarché, Provera). In 2008, they shared 95% of the market. On the manufacturers' side of the relationships, we were limited to a sample of the population due to their number and diversity. We analyzed companies implementing electronic catalogues in order to automate their sending of product information. We focus on global companies, and on French companies that have national brands that consumers can find in every point-of-sale. At the end of data collection, 10 global manufacturers (e.g. Nestlé, Krat foods, l'Oréal and Danone) and 8 national ones (e.g. Fleury Michon and Tipiak) were included in our sample.

As Yin (2003) and George and Bennett (2005) advise researchers to proceed, data from companies were collected through a variety of methods: semi-structured interviews, reviews of company and project documentation. Moreover, through semi-structured interviews and reviews of documentation, data were also collected from intermediaries proposing electronic solutions for product information exchange. This triangulation of data collection techniques provides multiple perspectives on the issues studied (Eisenhardt, 1989) and enhances the validity of the findings. The primary source of data is semi-structured interviews conducted between 2005 and 2007 in the 7 retailers and the 18 manufacturers in our sample. Because we focused on building technologies, we interviewed managers that were responsible for electronic catalogue implementation. 40 interviews were tape-recorded and transcribed for data analysis. Interviews were approximately two hours in length and were aimed at:

- understanding the company strategy on electronic data exchange and, in particular, product information.
- describing the receiving system (or the sending system) the company is implementing.
- understanding how the company perceives the interconnection with the systems being developed by its trading partners.

As recommended by Miles and Huberman (1994), a thematic qualitative analysis of the interviews was carried out through two steps of analysis. In descriptive analysis, data are summarized in line with pre-determined themes or categories issued from our research framework. Through this method, data are first described in a logical and meaningful way to define the types of sending and receiving systems the companies are implementing. Then, in thematic analysis, the researchers analyze cause-and-effect relationships between themes. This second step was performed in order to extract the types of IOSs issued from the interconnections between sending and receiving systems we empirically found. Coding was performed with QSR N'Vivo software, in which sentences or paragraphs were linked to the themes. This software has a function that allows the extraction of relationships between themes through tables, which was very useful in understanding the interconnections between receiving systems and sending systems implemented by companies.

Finally, instead of focusing on a specific IOS and explaining its characteristics and its adoption by companies, we concentrate on the characteristics of the part of the IOS developed by each of the companies to define sending systems and receiving systems and then we propose to analyze their interconnection leading to IOSs.

3 CASE STUDIES RESULTS

3.1 The sending systems

All the propositions about sending systems are corroborated. For each proposition we give the number of manufacturers whose receiving system corroborates our propositions in parentheses: P1a (1 manufacturer), P1b (5), P2 (14), P5 (8), P6a (7) and P6b (5). This first result constitutes empirical evidence of the relevance of the three criteria we considered to describe the sending systems for product information exchanges in the consumer goods industry. Indeed, some manufacturers designed their sending systems by the constitution of multiple dyadic linkages, and the others with one multilateral linkage. Some of them designed their system to exchange only shared data, whereas the other ones include private data. Finally, part of them designed the messages with a point-to-point coordination when the others use point-to-multipoint flows. Table 3 of results combines the structural linkage, the nature of data and nature of flows for each manufacturer. In italics, we specify the manufacturers that have designed their sending system, but not implemented it at the time of data collection.

Manufacturer	Structural linkage	Nature of data	Nature of flows	Sending system
Lactalis	Dyadic linkages	Shared	Point-to-point	Sending system 1
Kraft foods, Colgate	Multilateral linkage	Shared and private	Point-to-point	Sending system 2
Georgia pacific	Multilateral linkage	Shared and private	Point-to-point	Sending system 2
Cadbury, Coca-Cola	Multilateral linkage	Shared	Point-to-multipoint	Sending system 5
Pernod	Multilateral linkage	Shared	Point-to-multipoint	Sending system 5
L'Oréal, Danone, Lesieur, Cecab, Tipiak, Fleury M.	Dyadic linkages	Shared and private	Point-to-point	Sending system 3
Lavazza, Gastronome, Saucissserie	Multilateral linkage	Shared and private	Point-to-point	Sending system 2
Nestlé	Multilateral linkage	Shared	Point-to-multipoint	Sending system 5
	Dyadic linkages	Private	Point-to-point	Sending system 3
Reckitt	Multilateral linkage	Shared	Point-to-multipoint	Sending system 5
	Multilateral linkage	Private	Point-to-point	Sending system 2

Table 3: Diversity of sending systems

We did not find the five anticipated forms of sending systems. Indeed, the use of multilateral linkages to exchange shared data, does not lead to two types of sending systems because the flows are always designed in point-to-multipoint. Therefore, sending system 4 is not empirically found. The four sending systems are finally dependent upon two variables (logical linkages and nature of data), because the nature of flows is derived from the combination of these variables (Table 4).

	Dyadic linkages	Multilateral Linkages
Containing some private data	Point-to-point (Sending system 2)	Point-to-point (Sending system 3)
Containing only shared data	Point-to-point (Sending system 1)	Point-to-multipoint (Sending system 5)

Table 4: Types of sending systems

3.2 The receiving systems

Among the seven French retailers, two of them have still not implemented their receiving system. The five other retailers have implemented different receiving systems. For each proposition we give the number of retailers whose receiving system corroborates our propositions in parentheses: P3a (3 retailers), P3b (2), P4 (5), P7 (5), P8a (3), P8b (2). Similarly to sending systems, this first result constitutes empirical evidence of the relevance of considering structural linkages, nature of data and nature of flows to describe the receiving systems for product information exchanges in the retail industry. Table 5 presents the results in terms of forms of receiving systems we empirically found.

Retailer	Structural linkage	Nature of data	Nature of flows	Receiving system
Leclerc	Dyadic linkages	Shared	Point-to-point	Receiving system 1
Casino	Multilateral linkages	Shared and private	Point-to-point	Receiving system 3
Système U, Intermarché	Multilateral linkages	Shared and private	Point-to-point	Receiving system 3
Auchan	Multilateral linkages	Shared	Point-to-point or Point-to-multipoint	Receiving system 4 or 5
Provera	Dyadic linkages	Shared and private	Point-to-point	Receiving system 2
Carrefour	Multilateral linkages	Shared	Point-to-point or Point-to-multipoint	Receiving system 4 or 5
	Multilateral linkages	Shared and private	Point-to-point	Receiving system 3
	Dyadic linkages	Shared and private	Point-to-point	Receiving system 2

Table 5: Diversity of receiving systems

We did not find the five anticipated forms of receiving systems. The use of multilateral linkages to exchange only shared data (Auchan and Carrefour) does not lead to two types of receiving systems. Whether the flows are designed from the manufacturers' IS in point-to-point or point-to-multipoint, the retailer receives the message without distinction. So receiving systems 4 and 5 are merged, since the design of the flows is not the concern of the retailer but only of the manufacturers. The four receiving systems are finally dependent upon two variables (logical linkages and nature of data), because the nature of flows are derived from the combination of these variables (Table 6)

	Dyadic linkages	Multilateral Linkages
Containing some private data	Point-to-point (Receiving system 2)	Point-to-point (Receiving system 3)
Containing only shared data	Point-to-point (Receiving system 1)	Point-to-point or point-to-multipoint (Receiving system 4')

Table 6: Types of receiving systems

3.3 Interconnections leading to IOSs

The present section is concerned with the question of interconnections between the four sending systems manufacturers have implemented and the four receiving systems retailers have implemented. We present in table 7 the interconnections between the systems, leading to different forms of IOS. In each case, we explain if the referred proposition is corroborated (bold proposition) by a manufacturer and retailer pair, which agree on the interoperability of their own systems (IOS already built or being built).

	Sending system 1 (dyadic, shared, p2p)	Sending system 2 (dyadic, private, p2p)	Sending system 3 (multilateral, private, p2p)	Sending system 5 (multilateral, shared, p2mp)
Receiving system 1 (dyadic, shared, p2p)	P9a: Lactalis and Leclerc	P9b: L'Oréal and Leclerc	P9e: Georgia P. and Leclerc	P9g: Nestlé and Leclerc
Receiving system 2 (dyadic, private, p2p)	P9b: ?	P9a: L'Oréal and Carrefour	P9c: Georgia P. and Provera	P9h: Nestlé and Provera
Receiving system 3 (multilateral, private, p2p)	P9e: ?	P9c: L'Oréal and Casino	P9a: Kraft and Carrefour	P9f: Nestlé and Casino
Receiving system 4' (multilateral, shared, p2p or p2mp)	P9c: ?	P9e: L'Oréal and Auchan	P9b: Georgia P. and Auchan	P9a: Coca and Auchan

Table 7: The different interconnections

We now present the main conclusions that can be extracted from table 7 through examples of interconnections

From the nature of data perspective, our results show that interconnections are possible between companies that design their system for messages containing only shared data and those that design their system for messages containing also private data. Thus, P9b is corroborated. For instance, a dyadic linkage from the PIM of L'Oréal and the PIM of Leclerc is already in use. In this case, we find an electronic dyad for the point-to-point exchange of the smaller model of data. L'Oréal sends the data that Leclerc asks for, the shared data of the GS1 standard. However, we found incompatibilities between Lactalis and Carrefour and Provera. Carrefour and Provera do not want to only receive shared data in an electronic dyad. They ask for a second message that complements the first one with private data. Since Lactalis is the unique manufacturer of our sample that has implemented sending system 1 and refuses to send private data electronically, we can wonder about the relevancy of its choice. Dyadic linkages to exchange shared data does not seem to be a good strategic choice. Indeed, the manufacturer can not benefit from mutual messages for all its retailers, and the retailers do not agree to build a private link for such data. Leclerc is the only one that accepts it for the moment, because of historical reasons. Dyadic linkages for shared data were chosen by Leclerc before the emergence of external electronic catalogues in the industry, and they are now thinking about changing their receiving system.

From the structural linkages perspective, we have found empirical evidence that a multilateral linkage and a dyadic linkage can interconnect. Hard grey tinted cells for P9c and P9e represent different types of such an interconnection. These interconnections occur between the PIM of Provera, which has chosen dyadic linkages, and the external data pool of Georgia Pacific, which has chosen multilateral linkage. Between L'Oréal and Auchan or Casino, interconnection is technically possible since tests had been validated, but is threaten by an economic problem. The external electronic catalogue of the retailers asks for a financial contribution from the suppliers for building electronic links with their PIMs. Powerful manufacturers such as L'Oréal or Danone refuse this financial contribution.

From the nature of flows perspective, since sending and receiving systems can not be asymmetric in terms of nature of flows and symmetric in terms of nature of data and structural linkages, P9d can not occur. Indeed, the nature of flows of receiving system 4' is determined by the nature of flows of the sending

system. Receiving systems 4' thus presents point-to-multipoint flows when interconnected with sending system 5 and point-to-point flows when interconnected with the other sending systems. But from the manufacturers' side, we can extract significant insights from soft grey tinted cells. Indeed, we found empirical evidence that manufacturers which want to use point-to-multipoint flows (sending system 5) can interconnect with retailers which have a system designed for point-to-point flows. Indeed, Nestlé sends to its external catalogue a common message containing only shared data for several retailers. Then, its catalogue dispatches the message, to the external catalogue of the retailers which have implemented one, but also to the PIMs of the retailers which have not implemented an external catalogue.

Finally, our results confirm that sequential interdependence by the use of point-to-point flows of messages is the only mechanism that allows to exchange private data. Moreover, pooled interdependency by the use of point-to-multipoint flows of messages can only exist in multilateral linkages. Therefore we can conclude that multilateral IOSs which support point-to-multipoint flows of messages containing only shared data is the extreme opposite of electronic dyads which support point-to-point flows of messages containing private data. Apart from these extreme types of IOSs, we found empirical evidence showing that other types of IOSs can emerge through the interconnection of systems that are different from a structural linkages perspective, a nature of data perspective and a nature of flows perspective. Our discussion will mainly focus on these three interconnection perspectives.

4 DISCUSSION

From a structural linkage perspective, the configurations of interconnected sending and receiving systems show three main forms of IOSs. As proposed by Choudhury (1997), we found two forms of IOSs: Dyadic IOSs, in which all the companies build dyadic linkages; and Multilateral IOSs, in which all the firms build multilateral linkages. In addition, there are interconnections between some firms that build dyadic linkages and others that build multilateral linkages. Since Dyadic IOSs and Multilateral IOSs are derived from the economic forms of governance issued from transaction cost theory (Williamson, 1985), we define hybrid forms of IOSs as IOSs that interconnect partners with different designs of structural linkages, some implementing dyadic linkages and some multilateral linkages. Thus, these hybrid forms of IOSs can be placed on a continuum between two extremes, which are dyadic IOSs and multilateral IOSs. Figure 4 presents this continuum in the interconnection of eight firms: four senders (S1, S2, S3 and S4) and four receivers (R1, R2, R3 and R4). S1, S2, R1 and R2 use dyadic linkages and S3, S4, R3 and R4 use multilateral linkages. Thus, the interconnection between S1, S3 and R1, R3 is an example of an hybrid form of IOS.

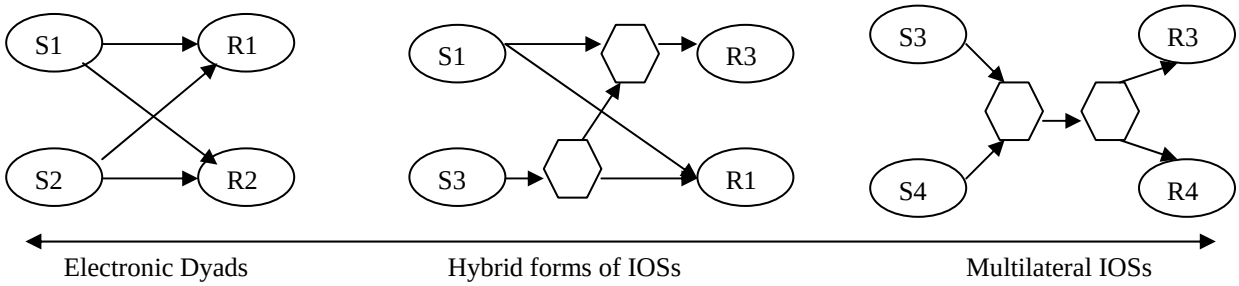


Figure 4. The continuum of IOSs types

Williamson (1985) considers hybrid organizational forms to be unstable economic forms that necessarily evolve towards hierarchies or markets. Thus, hybrid forms of IOSs may also be unstable forms evolving towards electronic dyads or multilateral IOSs. Hybrid forms are not necessarily stable forms. However, in hybrid forms each firm's choice will tend to last longer for at least three reasons and thus hybrid forms of

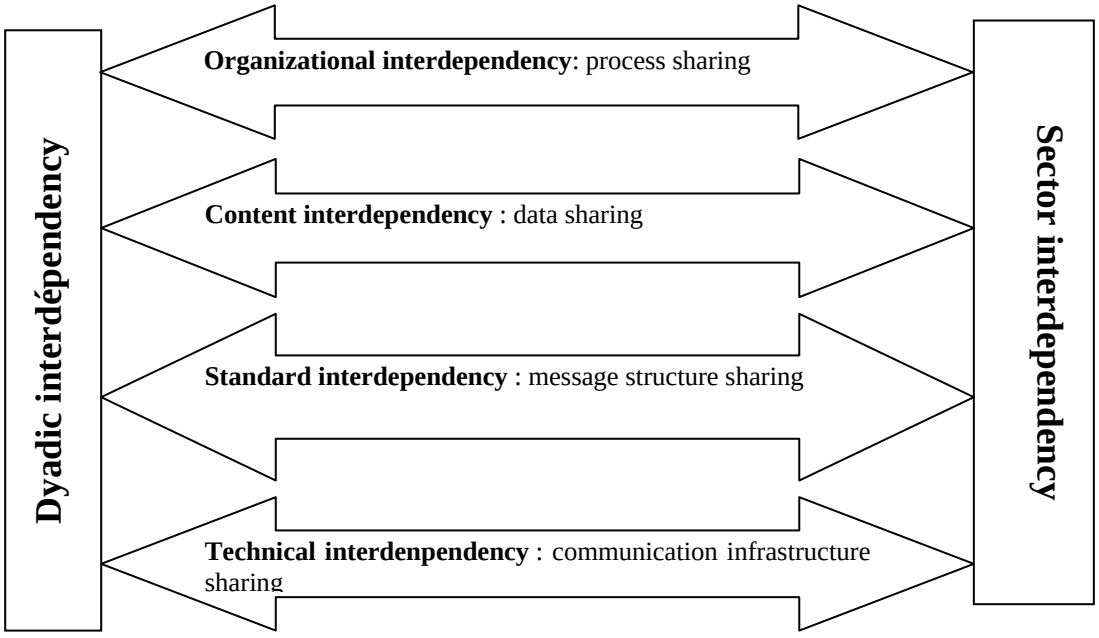
IOSs may not be less stable than electronic dyads and multilateral IOSs. First, if one firm changes its connection (linkage) others do not have to do the same due to greater interconnection flexibility. Second, from the beginning of the IOS implementation each firm has greater choice and thus is less prone to change over time. Finally in the results, we found several firms that defend the choice to use multilateral linkages and several others that defend the choice to use dyadic linkages. In this case, a company faces a risk if it refuses to interconnect with its trading partners that propose different electronic linkages. Indeed, the critical mass (Markus, 1987) of partners that justifies the investments in the technology for electronic exchanges would not be attained. In an industry analysis, technical interoperability between systems that are different from a structural linkages perspective is a necessary condition to avoid this risk since hybrid forms of IOSs allow a firm to interconnect with all its partners. Discussing the strategic value of the structure linkages of IOSs needs also to consider which and how data can be exchanged.

From a nature of data perspective, both private and shared data can be exchanged in all the structure of the continuum we have built. Though being presented as a key element for IOSs adoption and diffusion (Markus et al., 2006; Zhu et al., 2006), we will not discuss standards. At first, interconnection between different technical standards does not appear as a problem. Indeed, electronic catalogues, both internal (PIM) or external (Data Pool) can perform the translation between different technical standards in order to achieve external integration with the standard of the partner and internal integration with the internal standard. Because of the importance of internal integration in order to achieve benefits promised by electronic data exchanges (Mukhopadhyay and Kekre, 2002), the technology of electronic catalogues, both internal and external, is a real opportunity for companies. However, the data model is more problematic even if we have shown interconnection was possible between companies that want to exchange shared data, and those that want to exchange additional private data. In such a way, we can say that the interconnection between different data model leads to the implementation of the smaller data model, only composed of shared data. Outside the emergence of a global standard (Markus et al., 2006), the question is therefore about the emergence of a global standardized data model which may appear when all the firms of a specific sector find a consensus about the data that have to be exchanged and about their signification. Moreover, the macro-level perspective on data privacy can be extended to a micro-level perspective on each data included in messages. Indeed, a company can refuse to exchange a shared data, so that its partner can not exchange this data in the dyadic relationship. Outside the industry standard, we face proprietary standardized messages, since the data included in the message are dependent upon the negotiation of the data model between two companies. Thus, buyer/seller negotiations are the core condition of exchanges emergence for optional data - i.e. data that are included in the industry standard but not compulsory yet - and sometimes for additional data - i.e. data that the industry standard does not include -.

Considering the nature of data is not constrained by the structural linkages of IOSs, the main question is about the coordination mechanisms that manage interdependencies of data (Kumar and van Dissel, 1996; Liu and Kumar, 2003). Our results show that the main consideration of interdependencies is about the coordination of messages. Using the coordination theory (Malone and Crowston, 1990; 1994), we consider the messages to be the resource exchanged. Malone and his colleagues define three main coordination mechanisms: fit, flow and sharing (Malone et al., 1999). In this perspective, retailers conceive the reception of the message through a flow coordination whereas manufacturers conceive the emission of the message in a flow or a sharing coordination. Indeed, retailers receive a message in a flow coordination from the supplier that manufactures the product. If the manufacturer only includes shared data in a message and uses a multilateral linkage, it can send the message in a sharing coordination, since this message is then sent to several retailers. Otherwise, the manufacturer can send a message to a specific retailer, especially when the message contains private data, in a flow coordination perspective. Our main consideration is that the type of coordination of messages does not need to be the same for receivers and senders because we found possibilities of interconnection between sharing coordination and flow coordination. In this case, from a coordination perspective, we face hybrid forms of IOSs. It should be

interesting to extend these considerations for fit coordination, so when a company receives a message that contain data sent by several partners, these ones sending their data in a flow coordination.

Beyond our results and the discussion we have already performed, we propose to go further with a theoretical IOS typology based on interdependencies. We propose to characterize the coordination of data flows through the combination of the levels of interdependencies defined by Kumar and van Dissel (1996): technical, informational and organizational. Moreover, we subdivide informational interdependency into content interdependency, which reflects data sharing, and standard interdependency, which reflects message structure sharing. For each of the four levels of interdependencies, the coordination mechanims (Malone et al., 1999) used by each firm allows to define the types of interdependency in a sector. Indeed, if all the firms use flow coordination (Malone et al., 1999), we face dyadic interdependency since the resource (communication infrastructure, data, message structure, process) is only shared by pair of companies embedded in dyadic relationships. At the opposite, if all the firms use fit and sharing coordination (Malone et al., 1999), we face sector interdependency since the resource is shared. Between these extremes, we face hybrid forms of interdependency. We develop after the figure the type of interdependencies for each of the four levels (figure5).



Technical interdependency reflects how communication infrastructure is shared by the firms involved:

- If the technical structure is shared by all the firm, IT are implemented through a sharing coordination, so that each firm uses a single logical link to communicate with all its partners. We face Multilateral IOSs described by Choudhury (1997).
- If the technical structure is shared by dyads, IT are implemented through a flow coordination, so that each firm builds one logical link per partner. We face electronic dyads described by Choudhury (1997).
- If some firms implement IT from a sharing coordination perspective, and others from a flow coordination perspective, we face hybrid forms of IOSs we have previously highlighted.

Analysis of interconnections between sending and receiving systems from the structural linkages perspective is the only way to underline these hybrid forms of IOSs between the two extremes proposed by Choudhury (1997).

Content interdependency reflects how messages are shared by the firms involved.

- If the sender uses sharing coordination, a message is sent for several retailers.
- If the sender uses flow coordination, a message is sent for one receiver.
- If the receiver uses fit coordination, the message is received from several senders.
- If the receiver uses flow coordination, the message is received from one sender.

Similarly, we face two extremes. On one hand, when all the senders and all the receivers use flow coordination, messages are exchanged in dyads. This is point-to-point flows we have discussed. On the other hand, when all the senders use sharing coordination and all the receivers use fit coordination, each company exchange one message for all its partners. We can call this type of exchanges multipoint-to-multipoint flows. Between these two extremes, we find hybrid forms of messages exchanges, such as point-to-multipoint messages we have described.

Standard interdependency reflects how message structure are shared by the firms involved.

- If all the firms use sharing coordination, we face a sector standard (Markus et al., 2006).
- If all the firms use flow coordination, we face dyadic interdependency since each dyad have its own standard.
- If some firms use sharing coordination and some others flow coordination, we face hybrid forms of standard, such as proprietary ones (Markus et al., 2006)

We propose to iterate these propositions for organisational interdependency even if it was not the purpose of this paper, focused on flows of data.

5 CONCLUSION

Beyond the structural linkages perspective, we have discussed about the nature of data and the coordination mechanisms. The diverse hybrid forms of IOSs we have underlined have strategic value to interconnect firms that design different types of sending and receiving systems, in terms of structural linkages, nature of flows and nature of data. We have shown the diversity of IOSs considering the interconnection between sending and receiving IS for interorganizational product information management. Previous research presented simplistic types of IOSs, based either on structural linkages (Choudhury, 1997) or on interdependency of data (Kumar and van Dissel, 1996). In relationship with the private nature of data, we could conclude from this literature that:

- electronic dyads (Choudhury, 1997) are more convenient with sequential interdependency of data flows (Kumar and van Dissel, 1996), especially when companies exchange private data, which are dependent upon each dyadic relationship.
- multilateral IOS (Choudhury, 1997) are more convenient with pooled interdependency of data flows (Kumar and van Dissel, 1996), especially when companies exchange shared data, which are independent of dyadic relationships.

However the three dimensions were not systematically analyzed together and all their combinations had never been empirically investigated for one sector. Thanks to the new theoretical framework we propose

to analyze IOSs, and though our investigation is limited to a push mode, we found empirical evidence that shows the existence (real or potential) of IOSs other than the main types. We call them hybrid forms of IOSs, since they come from the interconnection between sending and receiving systems that present asymmetries in terms of nature of data, structural linkage or nature of flows. These hybrid forms are important not only because they allow a greater development of IOSs and foster new possibilities for automated updating of different sending and receiving systems, but by doing so they allow for a greater integration effect at the macro level. More importantly, for each company this integration effect can be achieved in a flexible way. Thanks to the IOS typology built at the end of the discussion, we expect these results to be extended to other messages or sectors, in order to confirm that combining interdependencies of data, flows and technical structures allows to better characterize IOSs.

One of the limitations of this research is related to the characteristics of the companies we have analyzed. We have distinguished the firms on their role as sender or receiver. From the retailers side of the relationships, this may be sufficient since they are all very powerful companies in France that retail the same products. But from the manufacturers side, it would be relevant to distinguish the manufacturers thanks to several characteristics, such as their bargaining power over retailers or the type of products they deliver. Further research should investigate if the type of sending system chosen is influenced by the type of manufacturer (global ones, national ones, SMEs) or the type of product (for instance fresh food) and which reasons motivate these choices.

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