INTERORGANIZATIONAL INFORMATION SYSTEMS AND DATA QUALITY IMPROVEMENT: THE CASE OF PRODUCT INFORMATION IN THE FRENCH LARGE RETAIL INDUSTRY

(Research Paper)

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Abstract: Electronic exchanges of information in Business to Business relationships have continued to grow over the last decades. In the retail industry, Product Information, defined as a set of data that represents the product, is now in the scope of retailers and their suppliers. Indeed, since the beginning of the century, projects for electronic exchanges of Product Information have accelerated because of the emergence of new technologies that facilitate them. This qualitative research focuses on Product Information exchanges in the French large retail industry and introduces Data Quality aspects in the adoption of an interorganizational information system (IOS). By using previous classifications of Data Quality dimensions [19; 47], this research aims to present Data Quality dimensions retailers and manufacturers consider to be relevant for Product Information. Secondly, it explains how IOS adoption is expected to contribute to Data Quality improvement.

Key Words: Data Quality, Interorganizational Information Systems, retail industry, Product Information, Data Quality dimensions

1. INTRODUCTION

Electronic exchanges of information in Business to Business relationships have continued to grow over the last decades. Organizations can benefit from adopting interorganizational information systems (IOS) in several ways: productivity, flexibility and competitiveness enhancement [8], transaction costs reduction [48], value creation [30], new market penetration [34]… Academics have analyzed IOS that support electronic exchanges of messages associated to supplying and purchasing processes, such as Electronic Data Interchange (EDI) [38; 41] or Electronic Marketplaces [1; 39], but there is a lack of research dealing with Product Information and its exchanges through IOS. Product Information is defined as a set of data that represents the product: its identifying, technical, logistical and marketing characteristics. For ten years, IOS supporting Product Information exchanges from the manufacturer's internal database to the retailer's one have been developed in the large retail industry in order to improve Data Quality.

Data Quality is a topic of growing interest since the beginning of the eighties. Poor Data Quality often induces costs and risks for organizations. Fisher and Kingma [14] illustrate that poor Data Quality can partially explain some disasters, such as the explosion of the space shuttle Challenger or the shot down of an Iranian commercial passenger jet by the US Navy Cruiser USS Vincennes. For US retailers, Raman [33] shows that the quality of point-of-sales data is poor and estimates that inaccurate data are costing them millions of dollars. In 1996, Wang and Strong published a fundamental article establishing a multi-dimensional construct of Data Quality [47]. Since that time, research in the field has produced conceptual frameworks and practical approaches for managing information quality in an organizational context [3; 19; 23]. But few researches focus on the quality of data exchanged between organizations. Some of them analyze cooperative information systems with autonomous organizations sharing common objectives [37] or develop methods to measure or enhance Data Quality in information systems already used in a supply

chain [11]. In the case of IOS adoption, Nicolaou and McKnight show perceived information quality constitutes an important factor influencing exchange adoption [29]. The objective of our research is to understand, in the case of Product Information exchanges in the French large retail industry, why companies adopt IOS in order to improve Data Quality.
The following part addresses a literature review on Data Quality definition and classification and a literature review on IOS definition and adoption. Then we will present Product Information and the systems that allow Product Information receiving or sending in the French large retail industry. After the description of our methodology, the results of the research show that IOS are expected to have significant impact on Data Quality of Product Information. We then conclude by addressing some insights, limitations and opportunities for further researches.

2. LITERATURE REVIEW

2.1. Data Quality

As noted by Reeves and Bednar [35], several definitions have been associated with the notion of quality: value, conformance to specifications, conformance to requirements, fitness for use and meeting and/or exceeding customer's expectation. With more and more computerized applications, companies have been seriously addressed by Data Quality problems and have realized that poor Data Quality induces costs and risks. Even if there is no single definition of Data Quality accepted by researchers, the wider adopted view is that quality data is "data that is fit for use" [23]. As Kahn, Pierce and Melkas [18] did not find pattern distinguishing the use of the terms *information quality* and *Data Quality*, we will consider them as synonymous.
In 1968, Feltham [13] observed that "*relevance, timeliness, and accuracy are often listed as desirable attributes of information*" (p. 684) and information quality is now recognized to be a multidimensional concept [7; 23; 45; 47]. Researchers have explored different ways to conceptualize Data Quality since Feltham's contribution. Zmud [50] found that high quality information was relevant, accurate, factual, complete, reliable, orderly, precise, readable and reasonable. Ballou and Pazer [2] also recognized that when focusing on Data Quality, accuracy alone is not sufficient and they integrated timeliness, consistency, completeness, relevance, and reliability. Wand and Wang [45] proposed a decomposition of Data Quality in four intrinsic dimensions: complete, unambiguous, meaningful and correct. Data Quality defects that can occur are identified by comparing the data in the information system with the part of real world it represents. To introduce the subjective aspects of Data Quality, Wang and Strong [47] analyze what Data Quality means to data consumers through 350 questionnaires and propose the following decomposition (figure 1):

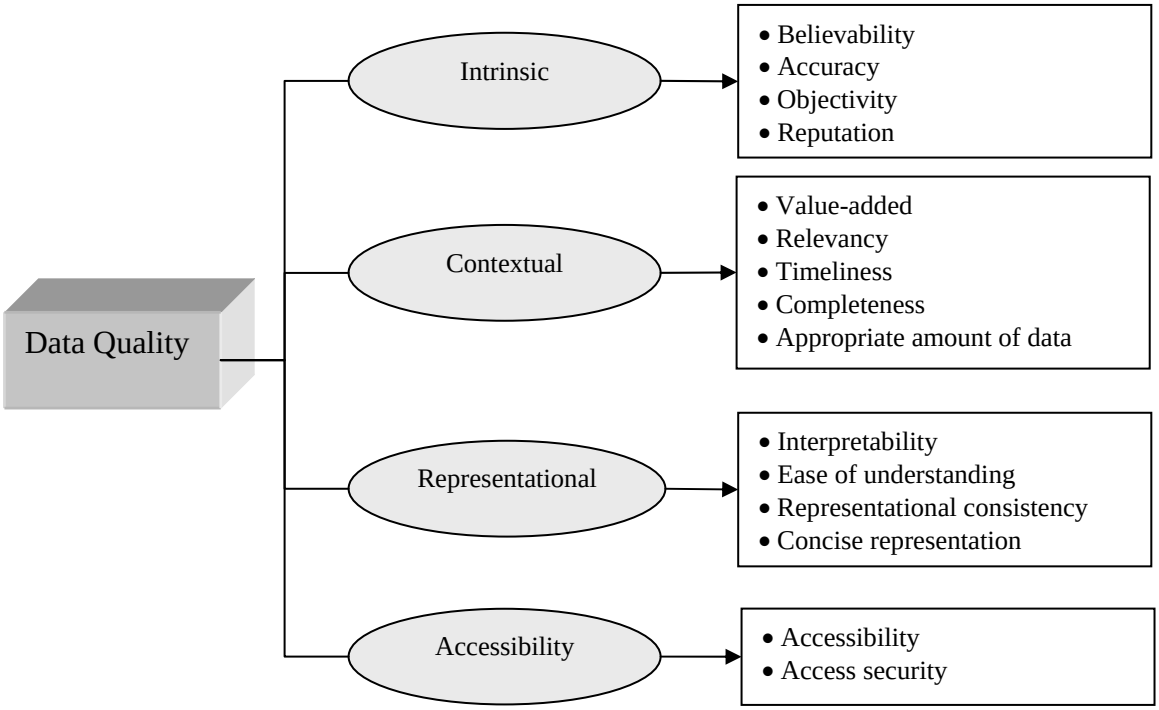

Figure 1: Data Quality dimensions, adapted from Wang and Strong [47]

Kahn, Strong and Wang [19] acknowledged that previous conceptual models of information quality dimensions treated information as a product [46] and noted that "*it can also be conceptualized as a service*" (p.186). Considering other ways to characterize quality, they integrated *conformance to specifications* and *meeting or exceeding customer expectations* to dress a 2 by 2 matrix called the PSP/IQ model, in which they classified information quality dimensions (figure 2):

	Conforms to specifications	Meets or Exceeds Expectations
Product	Soundness • Free of error • Concise representation • Completeness • Consistent representation	Usefulness • Appropriate amount of data • Relevancy • Understandability • *Interpretability* • *Objectivity*
Service	Dependability • Timeliness • Security	Usability • Believability • Accessibility • Ease of operation • Reputation • Value-Added

Figure 2: The PSP/IQ model, extracted from Kahn et al [19].

2.2. Interorganizational Information Systems

Kaufman [20] set the basis for IOS by asking why not extending modern computer technology beyond company boundaries. Called interorganizational information sharing systems, interorganizational information systems, interorganizational data systems or interorganizational systems [42], there is no unique definition of IOS. Cash and Konsynski [8] propose to define these systems as "*automated information systems shared by two or more companies*" (p. 134). A literature review on the concept of IOS performed by Suomi [42], let him conclude that "*all the definitions seem to have at least the following components: sharing of data or other resources; two or more organizations; IOSs are based on computers*" (p. 94). Automated exchanges through IOS contribute to Data Quality enhancement by the fact that errors are avoided because data need only to be entered once [24]. For Bergeron and Raymond [5; 6], enhancement of information quality is one of the advantages that companies can benefit from Electronic Data Interchange (EDI) adoption and integration.

Literature on IOS adoption has a long tradition. Researchers have often use diffusion of innovations theory of Rogers to identify factors that influence technologies adoption [9; 17; 31; 32; 43; 44]. In this theory, innovations are defined through five characteristics: relative advantage, compatibility, complexity, testing possibility, and visibility. Chewlos, Benbasat and Dexter [9] underline that because diffusion theory focuses on characteristics of individual technology that encourage or inhibit adoption, it only offers a technical perspective of adoption. Two other perspectives can be taken into account, an organizational one and an interorganizational one. Organizational factors are not dependent from technology characteristics but from organizational ones. They are company size [5], top management support [32], capabilities of the firm [17]. Interorganizational factors represent environment characteristics that influence technology adoption as power of a partner [16] or external pressure from competitors [4; 15].

3. PRODUCT INFORMATION AND IOS

3.1. Product Information

Product Information is defined as a set of data that represents the product in a BtoB exchange between the manufacturer and the retailer. It involves:

- Data that identify the product and the company that manufactures it: trade item description, brand name, GTIN (Global Trade Identification Number), information provider name, information provider GLN (Global Location Number), target market…
- Technical characteristics of the product: components, height, width, depth of the consumer trade item (the one that is scanned in the point-of-sale)…
- Logistical characteristics: height, width, depth of non-consumer trade item (cases or pallets), numbers of consumer trade item per cases and/or pallets…
- Marketing characteristics: packaging, publication date, last changed date, start availability date…

At the time of the study, only public data, independent of the dyadic relationship, are contained in Product Information, so a manufacturer sends the same information to all the retailers it works with.

3.2. Global Data Synchronization

Data Synchronization is a concept representing the fact that trading partners have always data with the same values, both in their own internal information systems. So any modification of a Product Information in the internal information system of a manufacturer induces a real-time modification of this

Product Information in all the internal information systems of retailers that have this product in their points of sales. To achieve such a goal, Global Data Synchronization Network (GDSN) has been proposed (figure 3). The idea is to create a network of data pools, or electronic catalogs, defined as databases stocking Product Information. The GDSN implements eXtensible Markup Language (XML) over the Internet to operate exchanges of Product Information among the various data pools used by retailers and manufacturers around the world. Source data pools receive information from suppliers in any of a number of formats, such as XML, EDI, and Microsoft Excel spreadsheet formats. They translate it into a common set of XML schema for interconnection with recipient data pools of retailers. Then recipient data pools send information to retailers, translated in the requested format. Using secure AS2 connection offers distinct advantages over HTTP, including increased verification and security achieved through the use of receipts and digital signatures.

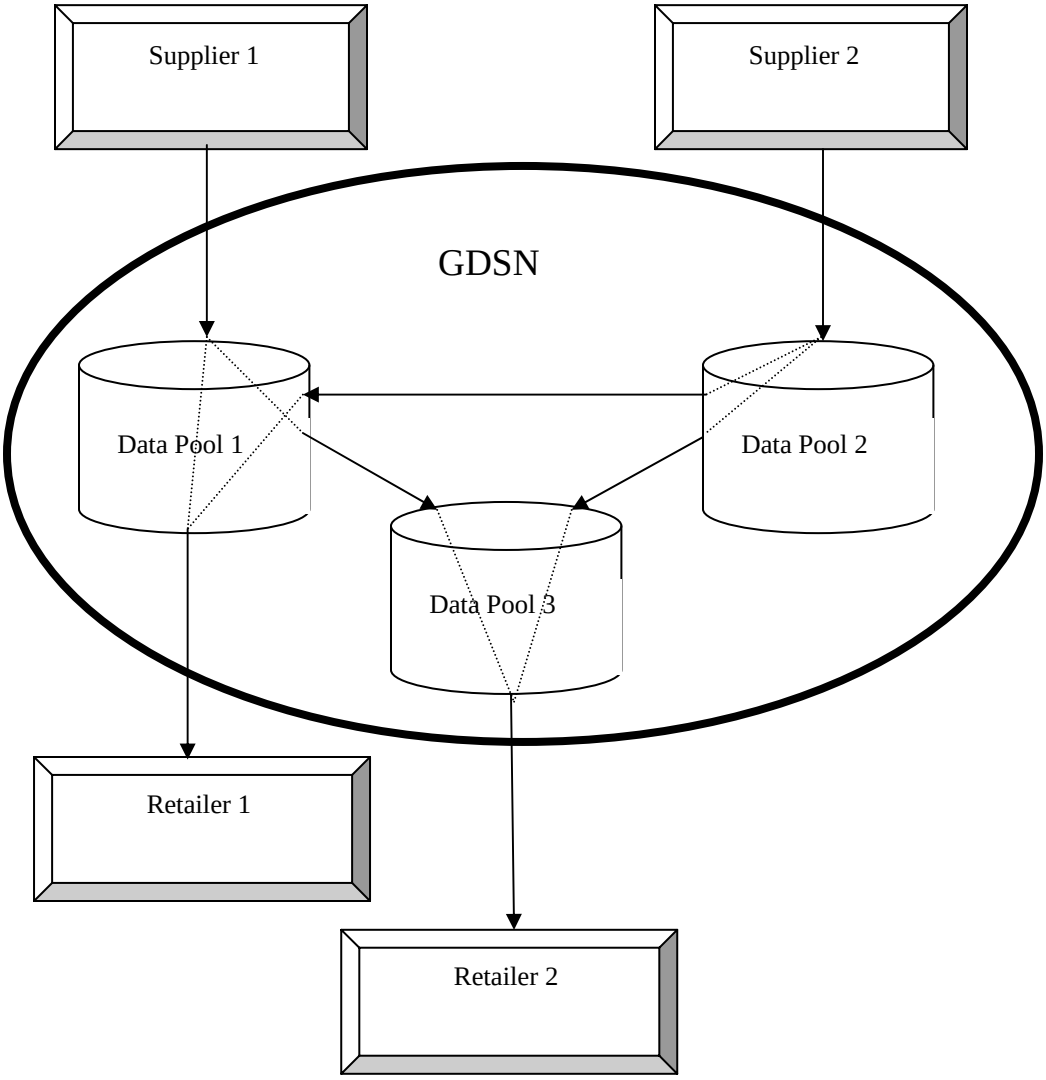

Figure 3: Global Data Synchronization Network.

With such a network, a company needs only to be connected to a unique Data Pool in order to communicate with all its trading partners. However, GDSN is not the only way to exchange Product Information.

3.3. Product Information exchanges

Traditional methods already in use in the retail industry to exchange Product Information are not automated methods. In the absence of the technology, retailers face a combination of manufacturers sending Product Information by fax, another by Excel spreadsheet, another by phone, sometimes through several exchanges for a solely Product Information. Without the automation, the retail industry proposes a very manual, error-prone process.

In the French retail industry, retailers can adopt from one to three different ways to receive electronic Product Information:

- Receiving through its Recipient Data Pool
- "Direct link" between its internal system and the manufacturer internal system or the manufacturer Data Pool.
- Via its Extranet where suppliers can enter manually the data required.

On the other side of the relationship, the manufacturer can adopt from one to three emergent solutions to send Product Information:

- Sending through its Source Data Pool
- "Direct link" between its internal system and the retailer internal system or the retailer Data Pool.
- Via the Retailer Extranet in which it enters manually the data required.

For our research, we only focus on data pools and direct links because data synchronization can be achieved through their use.

4. METHODOLOGY

Our objective is not to measure Data Quality to verify it is improved by the use of IOS. We aim to understand how IOS can contribute to Data Quality improvement and more especially why retailers and manufacturers adopt IOS in order to improve Data Quality.

To conduct our research, we have selected qualitative methods because they are recommended when the research aims to address a comprehensive framework of a contemporary phenomenon. Moreover, "*Case studies are the preferred strategy when how or why questions are being posed, when the investigator has little control over events, and when the focus is on contemporary phenomenon within some real-life context*" (p.1) [49]. We performed a single case study, the case of Product Information exchanges in the French retail industry.

Data were collected through a variety of methods: semi-structured interviews, reviews of company and project documentation, and reviews of intermediaries documentation. This triangulation of various techniques of data collection provides multiple perspectives on issues studied [12] and enhances the validity of the findings. Documentation was used to identify the type of IOS adopted by the companies we analyzed and to verify data quality improvement was an objective of IOS implementation for Product Information exchanges. Because we are focusing on IOS adoption, interviews were conducted with project managers. All interviews were tape-recorded and transcribed for data analysis [27]. Each transcription was sent to the concern interviewee for agreement. Our analysis includes 17 interviews, 8 from 4 major retailers, and 9 from 7 manufacturers.

Interviews were approximately two hours in length and were divided into three main parts:

- The first one was conducted to identify objectives and constraints that induce the decision to exchange Product Information electronically. So we asked managers to describe the traditional ways they used to exchange Product Information and then the reasons for which they had chosen to go from traditional ways to electronic ways. This allows us to verify that Data Quality improvement was one of the objective of electronic exchanges adoption
- In the second one, each manager had to describe the IOS selected and processes associated. In addition to obtain this description, we expected that some dimensions of Data Quality that are

relevant for him should occur in the answers. For each dimension mentioned, we asked him to explain us how IOS can contribute to Data Quality improvement for this particular dimension

- In the last one, to continue our data collection on Data Quality, we asked each interviewee to describe Data Quality problems his firm had faced with traditional ways of exchange. So we should identify dimensions of Data Quality he did not mention earlier but that are relevant for him. We finally asked him if he think the IOS adopted can contribute to Data Quality improvement for the problems he talked about and why.

By using the 15 dimensions of Wang and Strong [47] for coding interviews, we decided relevant dimensions to be those occurring at least once in more than 50% of the interviews.

5. RESULTS

Analysis of companies' documentation presenting electronic exchanges of Product Information shows that Data Quality improvement is the main objective of these projects. Moreover, websites of intermediaries (Electronic Catalogs[1]) or internal solution provider (Product Information Management[2]) are explicitly presenting Data Quality improvement as a benefit that occurs when using their solutions. When they talk about the project of electronic exchanges of Product Information, all interviewees present Data Quality as a key component of this project. Data Quality improvement is a key factor of IOS adoption. Indeed, Data Quality improvement is associated to benefits such as fewer time spent on complaints, fewer invoice disputes, fewer orders defects. Moreover, several retailers and manufacturers we analyzed estimate that product introduction lead time and product promotion lead time will be reduced.

However, both documentation and interviews pointed out that if IOS adoption is considered to be an accelerator of Data Quality improvement, it is not a sufficient condition. Indeed, it is recognized that using IOS for synchronizing data of poor quality will not deliver the promised benefits. Both manufacturers and retailers need also to tackle Data Quality internally. Manufacturers need to clean and centralize Product Information to send quality data and retailers need to distribute the quality data received across their systems.

The major dimensions of Data Quality that are perceived relevant by interviewees in the case of Product Information are accuracy, completeness, timeliness and security. Indeed, they are the four dimensions that were identified in at least 9 interviews. The following subsections present examples of Data Quality problems for each dimension, and why or why not IOS adoption can contribute to Data Quality improvement.

5.1. Accuracy

The dimension that occurs the more often is accuracy. Interviewees consider inaccurate data to be responsible of a lot of problems in the dyadic relationship between a retailer and a manufacturer and some of them are perceived critical. For example, retailers explain us that inaccurate length, height or depth of a pallet induces transportation troubles to transfer products from their inventories to their points of sale. Inaccurate GTIN can produce errors in orders or invoices: a retailer that wants to order a product finally orders another product and a manufacturer that wants to send an invoice for a product sends it for another product.

Managers all estimate that IOS are a real opportunity to respond to inaccuracy problems. Indeed, automated exchanges reduce risks of inaccuracy by the fact data are only entered once. In that way, IOS described above are perceived by project managers as a solution to improve accuracy of Product

[1] See http://www.1sync.org/home.html for example

[2] See http://www.gxs.co.uk/products/synchronisation/data_sync.htm for example

Information because their use limits risks of errors. Moreover, coherence controls are performed to detect inaccurate data when it is possible. For instance, tools can not detect a ten centimetres error in the height of a pallet but can alert a firm when the value given to the height of the pallet is too small – 1,5 millimetres instead of 1,5 metres for instance - or too large – 3 metres for instance-.

5.2. Completeness

When project managers talk about Product Information, completeness is also presented as a key dimension of Data Quality. Incomplete Product Information can also be the starting point of troubles. With traditional process, if an important data is missing for routing pallets from an inventory to a point of sale (as the number of products per pallets or a dimension of the pallet), a retailer has to solve the problem. In the case of the length of a pallet, it can measure it in its inventory; it can call the manufacturer to ask him the value of the missing data, or if it knows the length of the pallet is smaller than 2 meters in length, it can suppose the pallet to be 2 meters in length to secure shipments, but the result is that trucks are partially loaded.
Using IOS means completeness enhancement because Product Information with missing data will be rejected.

5.3. Timeliness

The third Data Quality dimension outlined in our case is timeliness. Product Information that is not received on time by retailers can also have a heavily impact on transportation, orders or invoices. For example, when a manufacturer proposes a promotion for one of its product (33% free during two weeks for instance), it has to send the revised Product Information with modified marketing information: 33% free, start availability date and end availability date. With traditional process the revised Product Information can be received by the retailer after the beginning of the promotional event, and so the manufacturer and the retailer disagree about invoices sent between the start availability date and the moment the retailer received the revised Product Information.
IOS contribute to improve timeliness of Product Information thanks to data synchronization. As soon as the manufacturer modifies Product Information, the retailer receives the revised Product Information.

5.4. Security

Security aspects are cited in most of the interviews. But because only public data are contained in Product Information at the time of our study, security is not considered as a key dimension of Data Quality. Security occurs when managers discuss about the possible evolutions of the standard, and especially about the integration of private data in the standard. Indeed, managers think security will be important when they will exchange data that are relationship dependent, as negotiated prices.

CONCLUSION

Retailers and Manufacturers are really concerned with Data Quality of Product Information. Four dimensions of Data Quality are cited by almost all the project managers we interviewed. They are accuracy, completeness, timeliness and security. Results show that adoption of an IOS supporting Product Information exchanges in the retail industry is perceived by project managers as a lens to Data Quality improvement, especially concerning accuracy, completeness and timeliness. On the other hand, Data Quality is not perceived to be enhanced in its security dimension. Because private data are not contained in the current standard of Product Information, security is not presented as a far dimension of Data

Quality but it stays in consideration by project managers for two reasons. First, some retailers are asking for private data that are not in the current standard. Secondly, groups in the retail industry are working to integrate these data into the international standard of Product Information.
Product Information standards should be address by further researches. IOS standards can be 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*" [51] (p.519). In the retail industry, standardization of Product Information poses numerous problems in the definition of attributes: which attributes are needed and how to define a particular attribute? For instance, do prices need to appear? And how to clearly define the length, the height and the depth of a product and of a pallet? A considerable work has been achieved through International instances to resolve these possible ambiguities. But, by using the example of EDI, Markus, Steinfield, Wigand and Minton argue that massive standardization efforts do not always induce widespread diffusion of a technology [26]. Moreover standards can sometimes appear as a limit to technology adoption [10]. A research on Product Information standardization in this industry is necessary to analyze the emergence of a standard, that arises when actors find a consensus and widely adopt the solution [25].

We found that the four relevant dimensions are categorized by Strong, Lee and Wang [40] in the conformance to specifications view of Data Quality. This is quite in line with our methodology because we focus on project managers' perception. We can suppose that dimensions categorized in the meeting or exceeding expectations view of Data Quality should have appeared more largely if we had taken into account data users' perception. This is a point that can be developed through further researches.

Otherwise, thanks to existing classifications French researchers have developed [21; 28], manufacturers we analyzed can be separated into two groups. Manufacturers of the first group are very powerful manufacturers working all around the world with leader brands the retailer needs to propose to the end consumer. So they have capabilities to develop their own strategy for sending Product Information and can resist to retailer pressure, if necessary. Manufacturers of the second group are manufacturers which products are well-known in France through leader brands or all around the world but through second brands in France. These manufacturers are more dependent upon the retailers and they can not totally resist to retailer pressure. Perceived benefits, and in particular Data Quality improvement, is cited as a factor that influences IOS adoption for all the 7 manufacturers we analyzed. But interorganizational factors, represented in our case by the power of retailers [16], seem to confirm the manufacturers' classification. Indeed, the 3 manufacturers of the first group we analyzed did not mention pressure of retailers as a factor that influences IOS adoption whereas the 4 manufacturers of the second group we met acknowledged that they also adopt IOS to respond to the retailers demand. In that way, further research should be conducted to evaluate Data Quality dimensions by comparing supplier cases of unforced adoption and supplier cases of forced adoption.

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