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A methodological and conceptual review of inter organizational information systems integration

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A METHODOLOGICAL AND CONCEPTUAL REVIEW OF INTER-ORGANIZATIONAL INFORMATION SYSTEMS INTEGRATION

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Abstract

The proliferation of applications to support cross-enterprise processes has left companies nursing a collection of systems. The integration of such systems, within and across the organizational boundaries, remains a top issue of researchers and practitioners' agendas. Although integration has long been treated as a key variable in the IS field, the construct has received little conceptual scrutiny. In this essay we argue that the concept of IOIS integration (cross-enterprise integration of information systems) is still ambiguous and lacks an understanding on its nature. Thus we explore prior literature that has attempted to conceptualize IOIS integration. We examine dimensions that concern both the methodology used (epistemology, theoretical perspective, research approach, duration of the study, conceptual model and unit of analysis), and the construct (scope, layer of integration and conceptualization of the ICT artefact). Sixty-one articles are reviewed. We present the results and discuss different dimensions of the construct (definition, antecedents, consequences and measures). The purpose of this literature survey is to shed some light on the IOIS integration construct as well as to uncover areas for future research.

Keywords: Integration, Inter-organizational Information Systems, Review.

1 INTRODUCTION

Integration is "the act or process of making whole or entire" (Webster's Revised Unabridged Dictionary 1913). In the IS field integration has been attributed a diversity of meanings: integration as the interoperability of systems, as developing a whole new system, as combining existing systems into one logical system, as establishing communication between systems, as inter-organizational process reengineering, as standardizing existing systems (imposing uniformity), as becoming a natural extension of the users or a routine (assimilation), or as the adoption or diffusion of a system.

From an enterprise perspective the statement "if a company's systems are fragmented, its business is fragmented" (Davenport 1998) shows that businesses at their core rely on integration of internal systems not only to maintain consistent information, but also to avoid fragmentation of their organizational structures (i.e. having autonomous management of business units or multiple views of their customers). This fragmentation problem discourse has been a catalytic driver of the enterprise systems vision.

From an inter-organizational perspective the fragmentation argument is also adequate. In the recent years the proliferation of applications to support cross-enterprise processes has left companies nursing a collection of systems (i.e. e-procurement, CRM), meanwhile practitioners have started to pay increased attention to the systems integration that bridges a firm's boundaries (Waters 2005). They consider integration as a businesses imperative which can generate value in terms of cost and time savings for businesses (Low 2002) or give them a distinct advantage (Iansiti and Levien 2004) though when lacking can put the business at risk (Girard 2004). Accordingly integration remains a top issue of researchers and practitioners' agendas.

In this essay we examine the concept of Inter-organizational Information Systems (IOIS) integration, which we define as the integration of systems that belong to different organizations. IS researchers have long treated IOIS integration as a key variable, but have used a diversity of terms such as electronic integration (Venkatraman and Zaheer 1990), EDI integration (Swatman et. al. 1994), application integration (Linthicum 2001), systems integration (Hasselbring 2000) or e-business integration (Markus 2000) to refer to the IOIS integration concept. We argue that the concept of IOIS integration is still ambiguous and lacks an understanding on its nature. The purpose of this paper is to review prior uses of the IOIS integration concept in IS research aiming to present what has been done, and uncover areas for future research (Webster and Watson 2002).

The paper is organized as follows. First, we present how several research IS domains conceptualize systems integration. Next, the research design for this literature survey is presented. Then we present the results. Next we discuss the features of the literature survey and propose an agenda for future research. Finally, we conclude by summarizing the findings, the contributions and the limitations of the study.

2 PAST CONCEPTUALIZATIONS OF INTEGRATION

A wide analysis of the IS literature reveals that besides the systems integration area (Hasselbring 2000), there are other research areas that implicitly or explicitly tackle the concept of systems integration (see Table 1).

The extensive research on *IOIS Adoption* has looked at systems integration as a result of adopting the system (Iacovou et. al. 1995) and as determining IOIS use (Hart and Saunders 1997;Hart and Saunders 1998). During the integration the firm alters its business practices (policies, procedures, values) and systems in order to interface with the IOIS (Chwelos et. al. 2001;O`Callaghan and Kauffman 1992).

Research on *IOIS Standard development* (Damsgaard and Truex 2000;Gosain et. al. 2003;Graham et. al. 2003) considers that the existence of standards as a precursor to systems integration. Thus integration is dependent on the existence of standards.

The *ICT business value* literature treats systems integration as an independent variable leading to higher value for the organization (Barua et. al. 2004;Mukopadhyay and Kekre 2002). What delivers value is not just the ICT artefact but also the ICT-related organizational components (i.e. integrated ICT architecture and processes) (Bharadwaj 2000;Melville et. al. 2004;Zhu et. al. 2004).

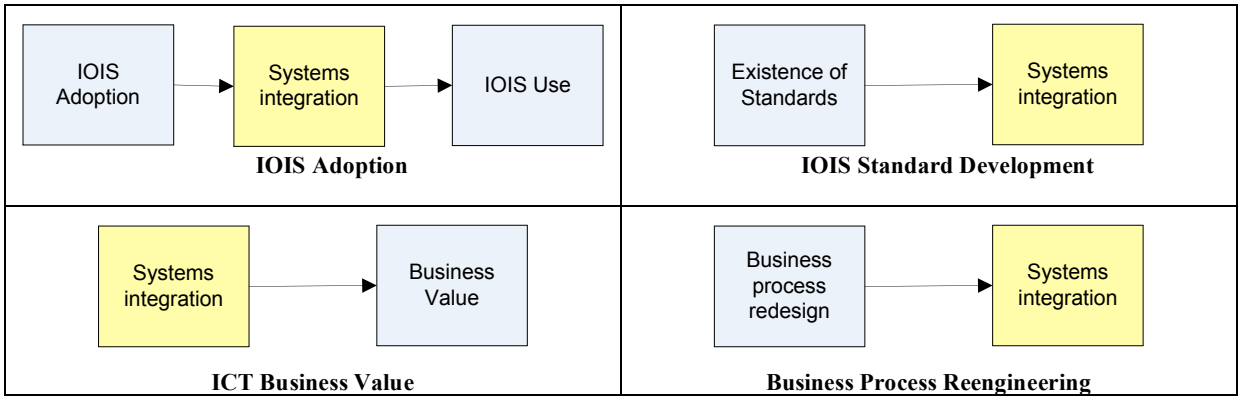
Similarly, *Business Process Reengineering* literature (Brousseau 1994;Davenport and Short 1990;Hammer 1990) argues that ICT connectivity alone is not sufficient to generate value for the organizations and organizational changes in the form of process changes are necessary. Once processes are redesigned ICT may be used to support those intra- and inter-organizational processes. Therefore, integration –consisting of ICT and data integration- can be interpreted as following the redesign of business processes.

The *supply chain* domain views systems integration –consisting of ICT and data integration- as an antecedent to supply chain integration –integration of the activities both inside and outside of an organization- (Fawcett and Magnan 2002;Lee 2000;Simchi-Levi et. al. 2000;Spekman et. al. 1998) or business process improvement (Bhatt 2000). The *supply chain* domain looks at the integration of key business processes from end user through suppliers that provide products, services, and information to the focal firm (Lee 2000;Rai et. al. 2006;Simchi-Levi et. al. 2000). More intensive supply chain integration might result in higher levels of supply chain performance and effectiveness, even though it may also increase the dependencies between the organizations which have made relationship specific investments (Lee 2000;Muckstadt et. al. 2001;Spekman et. al. 1998).

Research on *mergers and acquisitions* (M&A) has also focused on the integration of information systems (McKiernan and Merali 1995;Robbins and Stylianou 1999;Stylianou et. al. 1996). These researchers regard systems integration as a relevant phase of the merger process which precedes M&A success or failure.

Another group of researchers views the interaction of different systems as a conversation between these systems. Communication is not just transformation of information (or data flows), it is also action. Hence these researchers analyse the communication within and between organizations by decomposing it into basic communicative actions. This line of research called *Language Action Perspective* (Goldkuhl and Lind 2002;Kimbrough and Moore 1997;Weigand et. al. 1998) is guided by the theory of communicative action (Habermas 1984) and speech act theory (Searle 1969).

Finally, some researchers theorize about the development of *information infrastructures* (Hanseth 2002;Star and Ruhlender 1996) which define as a shared, evolving, heterogeneous installed base of IT capabilities based on standardized interfaces. These authors view the information infrastructure as the result of an evolving process where heterogeneous IT artefacts become integrated into complex socio-technical systems (Hanseth and Lyytinen 2004).



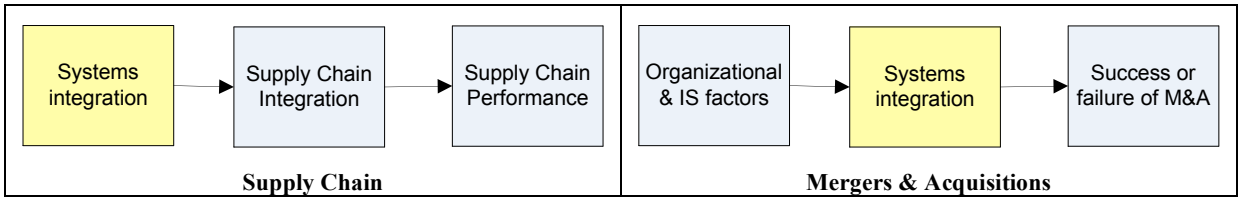


Table 1: Past conceptualizations of systems integration

3 RESEARCH PROCEDURE

3.1 Sampling

To support our analysis, we use the published research literature that tackles the issue of integration. The initial set of articles was identified by a combination of keyword search at EBSCO and Proquest. The keyword used was "integration". Next we read the abstracts to reject those articles that did not explicitly tackle the systems integration concept. In this step we chose new papers that were referred in the initial list and that comply with our selection criteria. We have finally analysed 61 papers.

The journals included are: European Journal of Information Systems (3), Journal of Information Technology (3), International Journal of Electronic Commerce (2), MIS Quarterly (8), Information Systems Research (1), Management Science (2), ACM Transactions on Information Systems (1), Journal of Management Information Systems (4), Communications of the AIS (2), Decision Sciences (2), Journal of Organizational Computing & Electronic Commerce (1), Journal of Strategic Information Systems (1), The Database for Advances in Information Systems (1), Communications of the ACM (7), Electronic Markets (1), Information & Management (7), Information Systems and e-Business Management (2), Journal of Enterprise Information Management (3), Benchmarking: An International Journal (2), Business Process Management Journal (2), Information Technology and Management (1), International Journal of E-Business Research (1), International Journal of Operations & Production Management (1), International Journal of Physical Distribution & Logistics Management (2), and Journal of Business Logistics (1).

3.2 Coding

In the next step we chose the dimensions that would guide our analysis. For this purpose we created two groups of dimensions: 1) those that concern the paradigmatic and methodological issues (Orlikowski and Baroudi 1991) of IOIS integration research, and 2) those that concern the integration construct.

The dimensions we chose to analyse the paradigmatic and methodological issues were:

1. The underlying *epistemology* that guided the research: positivist, interpretative, and critical studies (Orlikowski and Baroudi 1991). Positivist studies assume the existence of a priori relationships and try to investigate them. They can be grounded on existing theory or descriptive. In contrast, interpretive studies assume people create and associate their own subjective and inter-subjective meanings as they interact with the world around them. Interpretive research rejects the possibility of an objective or factual account of events and situations. Finally, critical studies "aim to critique the status quo, through the exposure of what are believed to be deep-seated, structural contradictions within social systems, and thereby to transform these alienating and restrictive social conditions" (Orlikowski and Baroudi 1991).
2. The underlying *theory* or the theoretical perspective that the researchers used for the data analysis.

3. The *research approach* used: laboratory experiment, field experiment, survey, case study, conceptual, field study, review (Orlikowski and Baroudi 1991).
4. The *duration of the study*. We use the four categories: one-shot cross-sectional (data is collected through one snapshot at a particular point in time), cross-sectional over multiple time periods (involves more than one single data-collection period), longitudinal (the study evolves over an interrupted period of time and focuses in process), and process traces (the study is conducted as various time periods to examine how a phenomenon evolves at various time periods) (Orlikowski and Baroudi 1991).
5. The *conceptual model* which concerns the logical formulation of the theoretical argument (or the nature of the relationship between elements identified as antecedents and those identified as outcomes). We build on (Markus and Robey 1988) who distinguish between variance (or factor) and process theories. Variance theories provide explanation for phenomena in terms of relationships between independent and dependent variables. The outcome will occur when necessary conditions are present. In contrast, process theories provide explanations in terms of sequence of events, activities and choices leading to an outcome. Outcomes may not occur when conditions are present.
6. The *unit of analysis* of the phenomenon. In this case we consider four levels: 1) the business unit or division (usually IOIS integration initiatives are initiated at the business unit level); 2) the firm (integration within the firm or between firms but being the focus the firm); 3) the dyad (there is integration between two firms and the research considers the dyad); 4) the network level (integration takes place within a network of firms and the research examines not only the firm and the dyad, but also the network).

The dimensions we chose that concern the integration construct were:

1. The *scope* of integration. Traditionally, literature on systems integration differentiates two types of integration: internal (integration among internal systems in an organization) and external (integration between systems external to an organization with the internal systems of the organization) (Hamilton 1999;Markus 2000;Themistocleous and Irani 2002). In this review we split the external integration into: interface and network integration. Interface integration refers to the adaptations an organization makes to its internal systems in order to allow them interoperate with systems external to the organization (i.e. the level of automation in the information transfer). On the other hand, network integration deals with the connection of systems that belong to different organizations (i.e. type of electronic connection, the existence of standards for processes and data at the network level). Network integration may be located beyond the organization's boundaries.
2. The *layer of integration*: ICT, data and process. Integration at the ICT concerns with the provision of a seamless mechanism for the transmission, processing and storage of information (Markus 2000). ICT layer integration can be achieved through ICT standards (i.e. TCP/IP), web services, message brokers, etc. Integration at the data layer concerns with the availability of common data definitions that enable different systems to process data in real-time, share and automate information exchanges (Goodhue et. al. 1992). Data layer integration can be accomplished through data standards (i.e. EDIFACT, ANSI), normalized data models, XML, etc. Integration at the process layer refers to the extent to which discrete business tasks conducted within or between organizations, are viewed, operated and managed as a unified business process (Markus 2000). The aim is to enhance automation and non-redundancy of business tasks (Hammer 2001), and allow real-time coordination and pragmatic integration (the message transmitted is not only understood by the receiver but also triggers some actions) (Österle et. al. 2001). Some mechanisms that enable process-layer integration are: process standards (i.e. CIDX, RosettaNet) and business process reengineering.

3. The *conceptualization of the ICT artefact*. In analyzing how the ICT artefact has been conceptualized we build on (Orlikowski and Iacovou 2001) who identified five general views: tool (or feature), proxy, ensemble (or functional), computational and nominal.
4. Additionally we also examine the definitions and operationalizations for the IOIS integration construct.

4 RESULTS

4.1 Analysis of methodological issues

Forty four papers (or 73%) were empirical. Within these empirical papers the research approaches that emerged from the analysis were: 22 (35%) case studies, 20 (32%) surveys, 2 (3%) action research, and 2 (3%) field experiments. Two papers (Clark 2001;Fawcett and Magnan 2002) combined case study and survey studies. Three of the case studies (Crook and Kumar 1998;McAdam and McCormarck 2001;Volkoff et. al. 2005) used grounded theory, and one of the survey studies (Daniel and White 2005) used the delphi method. Within the 17 (or 27%) non-empirical papers 15 (24%) were conceptual and 2 (3%) did a review (Al-Naeem et. al. 2004;Themistocleous and Irani 2001) of existing literature.

Positivism was the dominant epistemology with 53 papers (or 86%). Twenty six articles (42%) were theory grounded and 27 (44%) were descriptive. There were 8 (13%) interpretive studies and none adopted a critical perspective. Table 2 shows the breakdown of papers by research approach and epistemology.

	Case study	Survey	Conceptual	Action research	Review	Field experiment
theoretically grounded	6	13	4	1	0	2
descriptive	8	7	11	1	2	0
interpretativist	8	0	0	0	0	0
critical	0	0	0	0	0	0

Table 2: Frequency of research approaches for each epistemology

Prior research has drawn on the following theoretical perspectives: transaction cost theory (12 times), resource-based theory (3), semiotics (2), information processing theory (7), organizational theory (2), IS implementation (1), inter-organizational relationship (3), resource-dependence theory (2), diffusion of innovations (4), institutional theory (1), roles-linkage model (1), communities of practice (1), business process reengineering (2), industrial organization (1), game theory (1) and technology-organization-environment framework (1).

The duration of the empirical studies has been: 30 (or 48%) papers used one-shot cross sectional data collection, 7 (11%) papers used cross-sectional over multiple periods, 8 (13%) were longitudinal studies and 1 (2%) was categorized as process trace. Table 3 shows the breakdown of papers by research approach and duration. All but two (Bergeron and Raymond 1997;Christiaanse and Venkatraman 2002) of the 20 survey studies, of the two action research studies and of the two field experiment studies used one-shot cross-sectional data collection or cross-sectional data collection over multiple periods. On the other hand, the case studies used a combination of one-shot cross-sectional, multiple cross-sectional, longitudinal and process traces studies.

	Case study	Survey	Conceptual	Action research	Review	Field experiment
one-shot cross-sectional	13	16	0	1	0	2
cross-sectional over multiple time periods	3	3	0	1	0	0
longitudinal	6	2	0	0	0	0
process traces	1	0	0	0	0	0
NA	0	0	15	0	2	0

Table 3: Frequency of research approaches for the research duration

Finally, within the empirical papers the most common unit of analysis has been the firm (37 times), followed by the dyad (16 times), the business unit (8) and the network (5). On the other hand, 28 of the empirical have adopted a variance model and 16 have adopted a process model.

4.2 Analysis of concept

Fifteen papers (or 24%) provided some definition for integration. However, these papers used diverse terms for integration: systems integration, electronic integration, EDI integration, data integration, B2B application integration. Integration has been defined from several perspectives (see Table 4): 1) as process, 2) as use, 3) as strategy, 4) as structure, 5) as degree, 6) as a set of tools, or 7) as automation.

Perspective	Definition
Process	· EDI integration "is the process during which a firm alters its business practices and applications so that they interface with its EDI applications." (Iacovou et. al. 1995):468 · Systems integration "is the creation of tighter linkages between different computer-based information systems and databases" (Markus 2000):10
Use	· Data integration is "the use of common field definitions and codes across different parts of the organization" (Goodhue et. al. 1992)
Strategy	· Electronic integration are "the strategic choices made by a firm to exploit ICT to transform business processes and relationships, and business networks" (Kambil and Short 1994).
Structure	· Systems integration is "the structural coherence of a set of applications and databases. Structural coherence can be achieved through the adoption of common data, process and technology definitions." (Hamilton 1999):70 · Electronic integration is a "form of vertical quasi-integration achieved through the deployment of proprietary information systems between relevant actors in the adjacent stages of the value-chain" (Zaheer and Venkatraman 1994):549.
Degree	· Information systems integration is "the extent to which a firm integrates its various IT systems to provide visibility to customer and supplier data and to allow online information sharing and transaction execution across the value chain. It is achieved by resolving data type and semantics differences among multiple databases and integrating various hardware platforms, communication technologies and applications to works seamlessly" (Barua et. al. 2004):593 · Information systems integration is "the extent to which data and applications through different communication networks can be shared and accessed for organizational use." (Bhatt 2000):1333 · EDI integration is "extent to which data could be directly entered into internal applications without additional preprocessing." (Lee and Lim 2003) · "The degree to which a focal firm has established information systems for the consistent and high-velocity transfer of supply chain-related information within and across its boundaries" (Rai et. al. 2006).
Set of tools	· B2B Application Integration are "the mechanisms and approaches to allow partner organizations…to share information in support of common business events. In short, B2B application integration is the controlled sharing of data and business processes among any connected applications and data sources, intra- or inter-company." (Linthicum 2001):10, also

	used by (Themistocleous and Irani 2001;Themistocleous and Irani 2002).
Automation	• External systems integration refers to the "IT-mediated transactions between independent business entities" (Markus et. al. 2003)

Table 4: Integration perspectives

A common feature of the definitions above is that they deal with the three layers of integration (ICT, data and process) proposed in the coding section. Fifty four papers deal with integration at the process layer, 42 at the data layer, 42 at the ICT layer, and 29 consider the three layers simultaneously.
Analysis of former literature reveals three scenarios for IOIS integration at the data layer:

1) The creation of a unique shared repository for data, which will avoid data redundancy, and the problems of asynchronous data exchange between different systems (Volkoff et. al. 2005). This is similar to the global schema approach (March et. al. 2000).
2) Data are standardized, but they are stored in several repositories. As different systems may have the same data there may be data-redundancy. This scenario fits into the federated schema approach (Sheth and Larson 1990).
3) Data are not standardized, and they are stored in several repositories. Data are transformed (syntactically) and synchronized from one application to another. Each system has its own data schema. This scenario also fits into the federated schema approach (Sheth and Larson 1990).

Similarly, prior literature uses two forms of IOIS integration at the process layer:

1) Communication among business tasks that compromise the inter-organizational business process and among agents who operate and/or manage the business tasks (Becker et. al. 2003;Kobayashi et. al. 2003;McAdam and McCormarck 2001).
2) Coordination of the business tasks spanning several organizations, or the creation of tighter coordination among discrete business activities conducted by different organizations, so that a unified business process is formed (Kemppainen and Vepsäläinen 2003;Markus 2000;Sikora and Shaw 1998).

Apart from the ICT, data, and process layers, prior literature has used additional ones. Lee et al. (2003) propose behavioural integration, which deals with the "redistribution of roles and responsibilities among members which can destroy an organization if it is not properly managed". The authors argue that change management and transformation of an organization are difficult and sensitive issues in any integration project. Waring and Wainwright (2000) classify the definitions of integration into four areas: technical, systems, organizational and strategic. The authors acknowledge that focussing on the technical aspects of integration at the expense of human and organisational aspects may compromise success, particularly as the concept of integration is open to a range of interpretations. In a multi agent context Sikora and Shaw (1998) decompose integration into three layers: 1) integration of heterogeneous information systems, data bases, or application software, which fits with the data and ICT layers; 2) integration of different physical stages in business processes to improve the internal performance metrics, which fits with the process layer; and 3) a higher- layer dimension which is the integration of subsystems into a well-coordinated, networked system.

Forty six papers deal with interface integration, 43 with internal integration and 14 with network integration. Nevertheless 7 deal with the three simultaneously, and only 3 of these papers are empirical.

Most studies in the sample (35 or 56%) conceptualize the ICT artefact as a tool. The rest of studies adopt: 14 (23%) a proxy view, 7 (11%) an ensemble view, 2 (3%) a computational view and 4 (6%) a nominal view.

Some studies have treated integration as a dependent variable and have examined its antecedents, whereas others have studied the consequences of IOIS integration. Figure 1 depicts a list of antecedents and consequences of integration that appears in the literature.

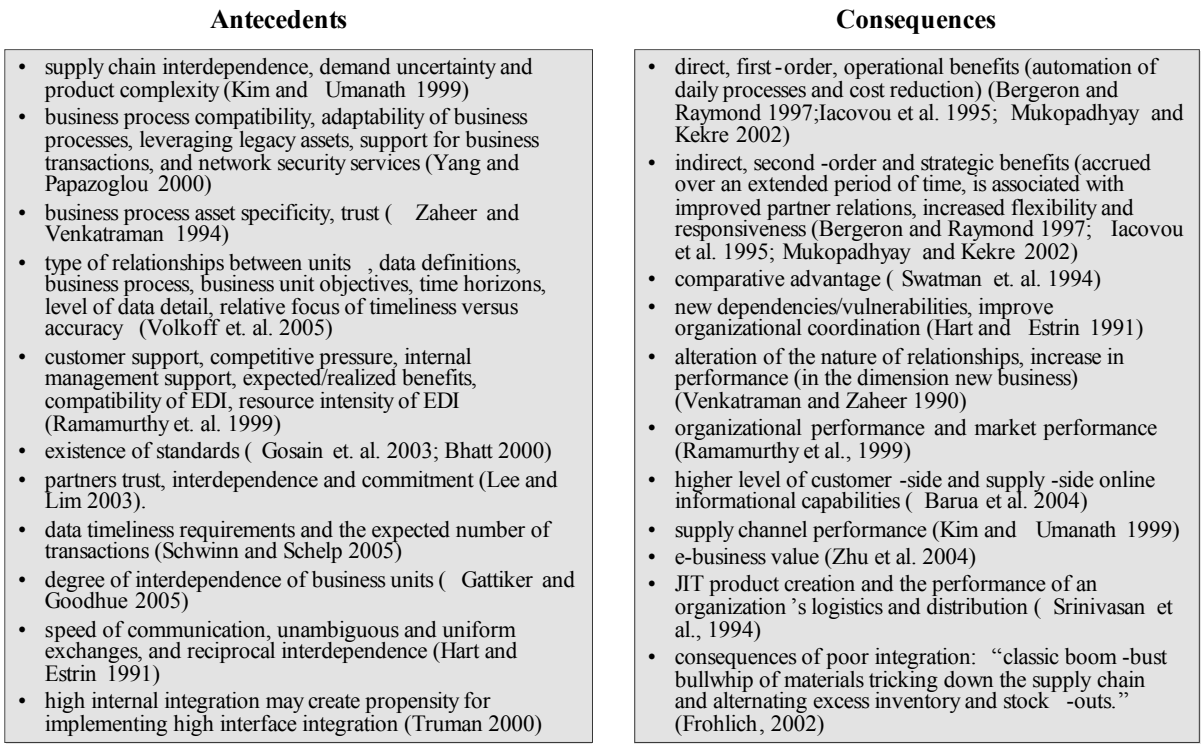


Figure 1: Antecedents and consequences of integration

Similar to the definition of systems integration (Table 4), we notice a lack of consensus on the measurement of the IOIS integration construct. Table 5 summarizes the diversity of measures for IOIS integration that the prior literature has used. There are two main group of measures: 1) those concerning the object of integration (the transaction, the data, the application, process or business function, and the partners), and 2) those referring to the degree of automation.

Measures	Measurement	Authors
Transaction		
Volume	・Total number of documents handled through EDI in relation to the total number of documents ・% of a firm's business directed to the focal firm through an IOIS (usually proprietary)	(Christiaanse and Venkatraman 2002;Massetti and Zmud 1996;Zaheer and Venkatraman 1994)
Intensity	・% of data exchange volume facilitated by each transaction type	(Krcmar et. al. 1995;Truman 2000) (Lee and Lim 2003)
Diversity	・Number of distinct transaction sets a company handles through EDI with its trading partners	(Lee and Lim 2003;Massetti and Zmud 1996;Premkumar and Ramamurthy 1995;Ramamurthy et. al. 1999)
Data		
Compatibility	・Ease with which data from different systems and organizational functions can be shared	(Goodhue et. al. 1992)
Accessibility	・Visibility of customer orders throughout the organization (interconnectedness) ・Single capture of information	(Hasselbring 2000) (Truman 2000)
Application, process or business function		
Integration of functions	・Variety of applications (or business functions) interconnected through EDI (or any other electronic link)	(Bergeron and Raymond 1997) (Iacovou et. al. 1995) (Massetti and Zmud 1996)
Partners		

Integration with partners	· Number or % of trading partners with whom the organization interacts through EDI (or any electronic link) · Direction of integration with partners: backward, forward	(Bergeron and Raymond 1997) (Fawcett and Magnan 2002) (Fearon and Philip 1999) (Iacovou et. al. 1995) (Massetti and Zmud 1996) (Premkumar and Ramamurthy 1995) (Tuunainen 1998) (Williams et. al. 1998)
Degree of automation		
Depth or Degree of integration	· Degree of electronic consolidation that has been established between business processes of two or more trading partners: 1) file-to-file, 2) application-to-application, and 3) coupled work environment. · % of internal data processing done through EDI in relation to manual processing · Degree of integration between the IOIS and the firm's internal systems: 1) loose vs. tight integration (dichotomous scale), 2) 7-point Likert-type scale	(Chatterjee et. al. 2002) (Fearon and Philip 1999) (Iacovou et. al. 1995) (Krcmar et. al. 1995) (Massetti and Zmud 1996) (Ramamurthy et. al. 1999) (Subramani 2004) (Swatman et. al. 1994) (Themistocleous and Irani 2002) (Truman 2000) (Tuunainen 1998) (Williams et. al. 1998) (Lee and Lim 2003) (Premkumar and Ramamurthy 1995)

Table 5 : Measures of IOIS integration

5 DISCUSSION

There are several points to draw from the analysis of the results in the previous section, which we propose as areas to uncover in future research:

1. We regard IOIS integration as a multidimensional concept whose relevant dimensions will vary across contexts. We propose IOIS integration involves four dimensions: 1) the scope (internal, interface and network); 2) the layer (process, data and technology); 3) the set of systems that constitute the IOIS (the features of these systems); and 4) the business network characteristics: topology (i.e. dyadic relationships, hub-spoke), the mode of interaction (i.e. equal or hierarchical interactions) and the interdependence between network members (i.e. pooled, sequential, reciprocal). We observe that most of the operationalizations in Table 5 use lean measures for IOIS integration that partially consider a maximum of two dimensions: the layer (or object) and the business network topology. Moreover, these measures are closer to IOIS usage (Massetti and Zmud 1996) than to integration. Likewise, the measures for the degree of automation are treated as dichotomous. Any study that attempts to operationalize IOIS integration should contextualize the measures; hence researchers should first choose the adequate dimensions according to the context, and secondly define appropriate measures for each dimension.
2. In this literature survey we observe a large number of papers that view integration as being materially determined. They consider that recent ICT developments (i.e. web services, XML) will promise the ability to easily integrate across traditional organizational boundaries, as they reduce the relationship-specific investments required (Christiaanse et. al. 2004) and make syntactical interoperability easy (Park and Ram 2004). Drawing on Iivari's (2003) three levels of abstraction in any information system or IOIS (organizational level, conceptual/infological and datalogical/technical level) we observe that the technical level of IOIS integration is relatively well covered by existing research, whereas few research has worked on the other two levels. The real challenge of integration does not only lay within the technical realm, but in the socio-technical realm (Waring and Wainwright 2000). This implies that examining the organizational and conceptual levels as well as adopting an ensemble view of the artefact may be suitable in the analysis of IOIS integration. In line with this perspective, theoretical lenses such as actor-network theory (Walsham 1997), which examine the interplay between the social and the technical by making no analytical distinction between them, seem adequate.

3. Integration is not a new phenomenon, especially within the organizational boundaries. Although existing literature on enterprise systems implementation and integration is a useful departure point for the examination of integration, IOIS integration has some particularities that cannot be fulfilled by prior literature. These particularities are: 1) firms are autonomous entities that do not operate on data and processes shared between them (Bussler 2003), 2) the number of actors (humans and non-humans) involved in inter-organizational context is larger than within organizations. In addition, the multiple interests and viewpoints of the stakeholders, the way these interests and viewpoints evolve, as well as how the stakeholders are interrelated (Pouloudi et. al. 2004) may shape the integration process; and 3) in inter-organizational contexts there is not always a higher authority that orchestrates the relationship (Markus 2000).
4. A great deal of prior literature is based on the assumption that IOIS integration deterministically implies organizational and inter-organizational results (Barua et. al. 2004;Bergeron and Raymond 1997;Mukopadhyay and Kekre 2002). In line with this assumption, some researchers conceptualize integration as a set of stages with increasing integration indicating more maturity, more control, and more efficiency (Angeles and Nath 2000;Clark 2001;Swatman et. al. 1994). Integration efforts, however, are prone to bring surprises to organizations as integration may indeed produce rather than curb disorder (Ellingsen and Monteiro 2005). Thus, there has been a call for an exploration of issues such as side effects (Jacucci et. al. 2003), disintegration, reverse integration and the unpacking of integrated systems (Lamb 2003).
5. Previous research has mainly conceptualized integration as an event, not an ongoing process, and therefore it has applied one-shot cross-sectional data collection (48%) and analysis. However, integration does not come quickly to information systems, which have been built up over years by layering new generations of technology or data models on top of old ones. IOIS integration is expected to be a cumulative process and to become path dependent in the sense that existing systems will influence the integration choices and paths (Hanseth 2002). Separate information systems become integrated over time into complex ensembles of heterogeneous IT artefacts, which are increasingly connected with and dependent upon one another (Hanseth and Lyytinen 2004). In line with this process view of IOIS integration, mutual adaptation theory (Leonard-Barton 1988;Orlikowski 1996) seems appropriate to inform integration research. Mutual adaptation theory can be used to examine the actions taken by different actors to appropriate the ICT features, modify their working procedures, their organizational structures or their communication patterns as a result of integration, and on the other hand, to examine how the artefact is altered.
6. Most of the prior research on integration focuses on transactional interactions within firms as well as between firms such as customers and suppliers in the value chain. There is a lack of papers, Lamb (2003) is an exception, that deals with integration of systems that are not transactional.
7. Finally, this literature survey confirms Kambil et al.'s observation (Kambil and Short 1994) that there is little empirical research at the network level (5 times).

The areas for future research we have proposed have consequences on the type of research methods and designs to be used for the analysis of IOIS integration. First, due to issues such as path dependency, doing research on IOIS integration entails adopting a process model, rather than a variance model (Markus and Robey 1988). Second, conceptualizing integration as a process leads to the collection of data using multiple timeframes. Finally, in the early stages of the research, qualitative data sets might be useful to frame the context (i.e. industry, stakeholders involved, type of inter-organizational relationship, type of IOIS) and obtain the salient characteristics of integration in that context. A qualitative research approach would enable inductive theory building. Furthermore, we advocate for contextual studies, and hence interpretive research would give access to the subjective understandings and meanings attributed by actors as well as provide contextual explanations for IOIS integration.

6 CONCLUSIONS

This paper shows that even though IOIS integration has been extensively used in the IS literature, the IOIS integration construct has received little conceptual scrutiny and has been marked by the diversity of conceptualizations. This diversity in IOIS integration research is manifested in the variety of terms and dimensions used, the variety of meanings (interfacing, adoption, implementation or use) attributed, the scarcity and disparity of dimensions considered and the variety of research methods adopted. This essay has attempted to show how: 1) different IS domains conceptualize integration; and 2) how systems integration literature has tackled the concept, both from a methodological point of view as well as from a conceptual perspective. We do not perceive the diversity of conceptualizations as a problem; we consider any conceptualization is context-specific. We regard IOIS integration as having four dimensions: scope, layer, set of systems, business network characteristics (topology, mode of interaction and interdependence). Any attempt to operationalize IOIS integration may select the appropriate dimensions for the context of the research and define measures for each dimension.

This study suffers from a few limitations. First, our selected sample could possibly have been expanded. Second, we could have been used additional dimensions for the analysis of the research methodology and the construct. Finally, a further literature review might consider the context of the empirical papers (type of IOIS, industry, country, etc). This paper contributes to the literature on integration by identifying methodological and conceptual aspects of this concept as well as by proposing areas for future research.

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[1] For lack of space we only give the references used in the introduction. The complete list of references is available upon request from the author