Publication III

Jouni Kauremaa, Mikko Kärkkäinen, and Timo Ala-Risku. 2009. Customer initiated interorganizational information systems: The operational impacts and obstacles for small and medium sized suppliers. International Journal of Production Economics, volume 119, number 2, pages 228-239. doi:10.1016/j.ijpe.2009.02.007.

Int. J. Production Economics 119 (2009) 228–239

Contents lists available at ScienceDirect

Int. J. Production Economics

journal homepage: www.elsevier.com/locate/ijpe

# Customer initiated interorganizational information systems: The operational impacts and obstacles for small and medium sized suppliers

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ARTICLE INFO

*Article history:*
Received 22 September 2006
Accepted 13 February 2009
Available online 11 March 2009

*Keywords:*
Interorganizational information systems
Small and medium sized enterprises (SMEs)
Supply chain integration
System-to-human integration
System-to-system integration

ABSTRACT

Small and medium sized enterprises (SMEs) have typically remained outside integrated supply networks enabled by interorganizational information systems (IOISs). This paper investigates, by means of a case study, the operational impacts and implementation obstacles of customer initiated IOISs for SME suppliers. In particular, the paper compares the effectiveness of system-to-system and system-to-human integration. As a result we find that interorganizational system-to-human integration can provide operational benefits for non-initiating SMEs, but not as much as system-to-system integration. In addition, system-to-system integration appears elusive where resources are scarce and backend system capabilities limited.



## 1. Introduction

In the present day business landscape, companies should not be considered as independent entities, but as parts of multi-company, multi-echelon networks, that is supply chains, delivering goods and services to the end customer (Lambert and Cooper, 2000; Christopher, 2005). Supply chain management (SCM) perspective argues that controlling these multi-company networks integrally can provide significant benefits (Cooper et al., 1997; Burgess, 1998; de Leeuw et al., 1999; Mason-Jones and Towill, 1999; Magretta, 1998; Norek and Pohlen, 2001; Chen and Paulraj, 2004; Halldorsson et al., 2007; van der Vaart and van Donk, 2008). The use of interorganizational information systems (IOISs) is considered imperative for successful SCM and has been associated with significant supply chain efficiency improvements (Lee and Billington, 1992; Mukhopadhyay et al., 1995; Gunasekaran and Ngai, 2004; Barua et al., 2004; Boone and Ganeshan, 2007).

However, prior research has overlooked a key *modus operandi* in IOIS use: whether the data exchange is fully automated (system-to-system integration) or whether some parts of the data exchange are assisted by human operators (system-to-human integration). There is a need to conduct focused evaluations contrasting these two means and to study their individual effectiveness. From the viewpoint of the non-initiator, the question becomes whether system-to-human integration provides benefits in transaction processing, or whether it is only an additional cost of customer service.

The question on non-initiator benefits from system-to-human integration is particularly relevant for supply networks with small and medium sized enterprises (SMEs), as they have typically remained outside these advanced and integrated IOIS enabled supply networks (Stefansson, 2002; Levy et al., 2002; Patterson et al., 2003; Harland et al., 2007). This is because the IOIS solutions enabling efficient SCM are expensive and intricate to install and the available off-the-shelf solutions demand sophisticated internal systems (Stefansson, 2002). Thus, SMEs often do not have the necessary resources for their implementation, and as they usually operate with lean

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doi:10.1016/j.ijpe.2009.02.007

systems they cannot wholly benefit from efficiency improvements in most cases (Eagan et al., 2003; Morrell and Ezingeard, 2002; Stefansson, 2002). The lack of investment can be detrimental to SMEs' competitiveness. For example, Closs and Savitskie (2003) state that a firm's success strongly depends on effective information sharing, and Kemppainen and Vepsäläinen (2003) regard inter-enterprise systems as prerequisites for success in the next decade. Consequently, by holding back investment in IOISs, SMEs face the risk of permanently falling behind in developing supply network management.

This paper reports a single case study evaluating the magnitude of operational impacts from the use of system-to-human and system-to-system-based IOISs for non-initiating SME-suppliers. The study is conducted on a supplier-facing IOIS of a consumer durables retailing company or CDRC (a pseudonym) operating in Northern Europe. As common in many current IOISs (Laukkanen et al., 2007), CDRC's suppliers have the alternative to either fully integrate message exchange with CDRC or to remain a system-to-human user. In our study we evaluate the impacts and effectiveness of the system from the perspective of CDRC's key suppliers, all SMEs.

The paper proceeds as follows. First, in Sections 2.1–2.3, we review extant literature and develop the research questions this paper addresses (Section 2.4). Next, Section 3 describes methods and data used. Results are presented in Section 4 and discussed in Section 5. Research implications and further research needs are addressed in Section 6.

## 2. Literature review

### 2.1. System-to-human and system-to-system integration of IOISs

IOISs can be divided into two broad categories in terms of level of automated information processing (i.e. IOIS depth; Massetti and Zmud, 1996). In *system-to-system integration*, data exchange between the internal information systems of the transacting organizations is fully automated: no human intervention is needed. Electronic data interchange (EDI) in its idealized form is the classic example (see e.g. Emmelhainz, 1990). In *system-to-human integration*, on the other hand, data exchange is semi-automated: data from the internal information system of one transacting party is delivered in an electronic format to the other transacting party, who further processes this information manually. A current prominent example is the web portal, where Internet technologies have provided a means to extend electronic integration in supply chains to processes and partners which were previously inaccessible due to high costs of system-to-system integration.

Taking into account the vast amount of reported research around IOISs (Elgarah et al., 2005; Nurmilaakso, 2008), the limited weight of differences between different levels of IOIS depth is noticeable; there are relatively few studies addressing the differences in system-to-human and system-to-system links. Several exceptions exist, although they focus mainly on older, EDI-based technologies. Hart and Estrin (1991), for one, show through a case study in the semiconductor industry that higher order benefits from IOIS use are provided only after system-to-system integration, compared to system-to-human IOIS use where systems are used only as a substitute for conventional communication methods. Riggins and Mukhopadhyay (1994) and Mukhopadhyay and Kekre (2002), on the other hand, examine the use of EDI and demonstrate empirically how system-to-system integration of EDI to internal information systems provides fewer errors, faster processing times, and lower probability of delayed payments compared to system-to-human EDI. Truman (2000) finds an empirical relationship between a low number of administrative employees and interface integration—the extent to which EDI is integrated to internal information systems. More recently, Zhu and Kraemer (2005) use structural equation modeling to assess the determinants of e-business value. They find that both front end functionality—whether a company offers different services through its website—and back end integration—whether the company has integrated its databases with its supply chain partners—explain well the variation in perceived value of e-business initiatives. Taken together prior studies come short in explicitly examining Internet-enabled system-to-human systems, such as web portals, but focus on the different depths of traditional EDI usage. Moreover, a typical feature in prior research is the focus on the benefits for the initiator of the system (Subramani, 2004).

### 2.2. Adoption of IOISs

In general, factors explaining IOIS adoption—typically traditional EDI—have been studied extensively. Two basic features of business relationship associated with IOIS use are the volume of transactions (McLaren et al., 2002; Premkumar, 2000; Iskandar et al., 2001) and dependence on trading partner (Hart and Saunders, 1997). Beyond these basic factors, prior research has identified a range of issues such as asset specificity, trust, uncertainty, power exercised, interdependence, reciprocal investments, institutional factors, competitive intensity, perceived benefits, organizational readiness, and organization size (Grover, 1993; Iacovou et al., 1995; Premkumar et al., 1997; Hart and Saunders, 1997, 1998; Chwelos et al., 2001; Ramanathan and Rose, 2003; Teo et al., 2003; Ranganathan et al., 2004; Son et al., 2005; Zhu and Kraemer, 2005; Harland et al., 2007). However, prior literature has not evaluated differences in IOIS adoption between using system-to-system and system-to-human integration.

### 2.3. IOISs for SMEs

In general, the use of IOISs in inter-company communications by SMEs seems lagging (Stefansson, 2002; Harland et al., 2007). Prior literature has identified three distinct reasons for the low adoption rate: limited financial resources for implementation (Morrell and Ezingeard, 2002; Stefansson, 2002), lack of the sophisticated internal systems demanded in IOIS implementation (Morrell and Ezingeard, 2002; Stefansson, 2002), and limited resources

and IT expertise (Eagan et al., 2003; Iacovou et al., 1995; Morrell and Ezingeard, 2002; Stefansson, 2002; Patterson et al., 2003).

However, we do not know that well how the recent technological developments, both in system-to-system and system-to-human integration (web portals most notably) technologies, have changed the case for IOIS use at SMEs. The issue of low SME adoption is relevant since SMEs constitute the majority of the amount of companies and because the benefits of electronic communication grow with the share of trading partners included in the system (Massetti and Zmud, 1996; Agi et al., 2005). Thus the question remains: to what extent are web portals, where non-initiators do not need to automate data flow from and to their internal system, the long sought solution to the problem of reaching all wanted supply chain partners in the sphere of electronic communication, albeit semi-automated? A related question is whether technological developments (making potentially the development of both internal information systems and external information systems cheaper) have diminished the obstacles for system-to-system integration. There is then room for empirically evaluating the use, benefits, and adoption factors of both contemporary system-to-human and system-to-system integration among SMEs.

### 2.4. Research motivation

Shortcomings in the extant literature warrant a more detailed investigation of the impacts of customer initiated IOISs for small and medium sized suppliers. First, previous studies concentrate mainly on the perceptions of company representatives, and usually operational performance data is not collected to analyze the impacts of IOISs. Second, studies tend to either focus on a single technology with a single application or any Internet-capable technology. Examples of the former include EDI in purchases (Chwelos et al., 2001) or trade declarations (Kuan and Chau, 2001), and of the latter a mixture of web presence, e-mail, or other Internet technology (Poon and Swatman, 1999; Daniel, 2003; Hughes et al., 2003). Moreover, there is an absence of articles comparing different levels of IOIS depth and their effects on SMEs. Specifically, the increasing use of supplier portals as a method for supply chain integration has not been studied well so far, even though their potential benefits for SMEs have been acknowledged (Stefansson, 2002). Third, extant studies concentrate on the benefits for the initiators of the IOISs. This motivates the following research question:

**RQ.** How do system-to-human and system-to-system integration compare as means in supply chain integration from the perspective of non-initiating SME supplier?

## 3. Methods

### 3.1. Overall research design and case selection

To address the research question posed for the study, we chose a single case study design (Yin, 1994). Case study offers a good way to study rich phenomena embedded in contexts, and to address emerging research topics (Benbasat et al., 1987; Eisenhardt, 1989; Yin, 1994), such as web portal-based system-to-human integration. Our specific reason for selecting the particular research design for this study was also practical: we had access to an interesting case. CDRC (a pseudonym), a retailer of consumer durable goods, operating in Northern Europe with over 80 sales outlets, had introduced a supplier-facing IOIS in two phases (1996–1998 and 2003). The particular reason CDRC's system was of interest for the study was that the suppliers could integrate to CDRC either with direct system-to-system or system-to-human approaches. In particular, the second phase of CDRC's system, initiated in 2003, added a possibility for the suppliers to integrate with CDRC using a web portal interface.

### 3.2. Data collection protocol

The case data were collected from three primary sources during May–November 2004 (see Table 1). First, we interviewed CDRC's representatives to study the objectives, history, current status, and perceived impacts of CDRC's supplier-facing IOIS from CDRC's perspective. In total, eight interview sessions were conducted with the following CDRC representatives: information systems manager (interviewed two times), development manager (interviewed two times), logistics director (interviewed one time), two product managers for different product groups (both interviewed one time), two salesclerks (both interviewed one time) and a person responsible for a recent study of supplier collaboration between CDRC and its key suppliers (interviewed one time). The interviews were semi-structured and recorded in field-note documents by the interviewer (see Appendix A for the interview protocol). Interview data was supplemented with data from CDRC's internal information system, in particular its purchasing system.

Second, five CDRC's suppliers, current users of either system-to-system or system-to-human approach with CDRC, were interviewed in order to understand supplier perspective of CDRC's supplier-facing IOIS. The five suppliers, all close to CDRC, were selected as they represented different product groups and operating models, issues deemed by CDRC's representatives as potentially influencing IOIS use. The interviews (one interview with each supplier), conducted in May–June 2004, were used to form an understanding of the opinions and impacts of IOIS use with CDRC (for interview protocol used, see Appendix A). Notes taken during the interviews

**Table 1**
Overview of data collected.

| | CDRC | Suppliers |
|---|---|---|
| Interview data | Eight interviews (with eight CDRC representatives) | Five interviews (with five different suppliers) |
| Questionnaire data | – | 24 suppliers |

were used to prepare a field-note document from each interview.

Finally, a survey to key 30 suppliers of CDRC was administered. These particular suppliers were regarded by CDRC as the main target population of the users of the IOIS. The survey instrument was developed based mainly on interviews (CDRC and supplier representatives) and was tested with one supplier. The supplier survey included measures of transaction volume (amount of sales) and dependency (share of sales) with CDRC, IOIS use with CDRC (no use, system-to-human use, and system-to-system use in seven pre-specified business processes with CDRC), perceived IOIS value (a 1–5 scale question on the perceived value of investments to CDRC's supplier-IOIS by the supplier), preferred way of communication with CDRC in specific processes, and clerical work content in specific processes with CDRC (estimates provided by the respondents on their weekly work content in order intake, order confirmation, and product availability update activities).

Following the test of the survey instrument with one supplier, the targeted 30 suppliers were contacted to ask for participation in the study. Six suppliers declined: two pleaded for limited amount of time, two regarded that the topic of the survey did not match well their business as a trade agency, one pleaded for confidentiality, and one was concerned about the continuity of business relationship with CDRC and thus regarded completing the questionnaire as an undue effort. The survey instrument was then delivered to the agreeing 24 suppliers. For each returned and filled questionnaire a telephone conversation was scheduled with the supplier. During each conversation, respondent's understanding of the questions was checked and, if needed, amendments to respondent's answers were made. The respondents were typically CEO's (46% of respondents) or sales/marketing managers (30% of the respondents) of the studied supplier companies. Basic data on the suppliers in the survey is exhibited in Appendix B, giving also the pseudonyms we use to refer to individual suppliers.

### 3.3. Data analysis procedures

We analyzed supplier perspective on CDRC's supplier-IOIS by analyzing our interview data on general perceptions, perceived impacts of current IOIS use with CDRC, and obstacles of system-to-system integration with CDRC. Specifically, we extracted mini-case descriptions on key points made. This analysis of interview data was complemented with analysis of our survey data on (1) estimates of current work content in clerical activities, (2) perceived payoff of investment to CDRC's supplier IOIS, and (3) perceived most preferred way of communication with CDRC in specific basic process. In analyzing the clerical work content of the suppliers in processes with CDRC, we developed a clerical work index measure. The index is based on respondents' estimations of weekly amount of work hours related to processes with CDRC. Estimation is annualized (assuming 52 weeks per year) and normalized (dividing it by sales volume to CDRC) to enable comparison between suppliers. Analysis focused on contrasting three groups of suppliers: the ones currently using system-to-system approaches at least in some processes with CDRC (termed "S2S users"), the ones using system-to-human but not system-to-system approaches in any processes with CDRC (termed "S2H users"), and the ones at the time of the study not using CDRC's supplier-IOIS (termed "nonadopters"). Further, interview results were analyzed again after survey results to better understand and to complement data from the survey.

As an external check to our analysis, a summary of our results was presented to and discussed with three key informants from CDRC (logistics director, development manager, and information systems manager). A preliminary summary was also sent out to the respondents in the supplier survey.

### 3.4. Assessment of reliability and validity of the study

Key criteria in evaluating the rigor of case study research are reliability, construct validity, internal validity, and external validity (Eisenhardt, 1989; Yin, 1994; Gibbert et al., 2008). Of these, internal validity is less relevant for this study as we aimed for a descriptive account of the effectiveness and impacts of CDRC's supplier IOIS, and not to build theoretical insight (i.e. an explanatory model).

To enhance the reliability of our study (the replicability of our study by external auditors and their coming to similar conclusions to ours) we have taken the following actions: (1) building a case study database including all our data and (2) explaining as fully as possible our study protocol (see above and Appendix A).

In order to enhance construct validity (to make sure that we have studied what we claimed to have), we have taken the following actions: (1) we have used multiple sources of evidence, by interviewing multiple people at CDRC, by interviewing multiple suppliers, and by supplementing both CDRC and supplier data collection by surveying having informants not included in the interviews; (2) we have aimed to explicitly ground each of our key findings empirically from multiple data sources; (3) we have presented preliminary results of our analyses to our key contact persons at CDRC and sent them to the studied suppliers.

The main concern related to this study is common to case study research in general and single case study research in particular: the issue of external validity (whether our findings hold beyond the studied context). Our study has the strength of rich description coming from a detailed in-depth study of one case from multiple angles. At the same time, the key potential idiosyncratic factors of the studied case are the technical and practical details of CDRC's supplier-IOIS, operating practices used by CDRC and its suppliers, and the context of small and medium sized suppliers. While comparison to prior works lends support to external validity of our study, our findings should be taken as tentative conjectures to be tested further in other contexts by further single case in-depth studies and also by different kinds of research approaches, most notably multiple-case studies better

enabling the identification of valid patterns and large sample statistical surveys, enabling the testing of hypotheses developed from explicitly stated ex ante propositions with operational content.

## 4. Case study results

### 4.1. Case background CDRC's supplier IOIS

CDRC, a retailer of consumer durable goods based primarily in one North European country, manages a retail outlet chain consisting of 82 stores (by fall, 2004), with two main types of stores. Previously vertically integrated, it has moved away from in-house manufacturing, with the exception of one wholly owned subsidiary. Its supply base includes around 400 suppliers. Approximately 30 suppliers, typically small and medium sized manufacturing enterprises, make up 80% of CDRC's purchases.

CDRC initiated its supplier-IOIS development in the late 1990s. During 1996–1998 a proprietary IOIS was introduced as an extension to CDRC's internal information system. Suppliers could either use the system manually or integrate the data flow to its internal system. A handful (under 10) of suppliers started to transact electronically, remaining either system-to-human users (using CDRC's system manually from a specific terminal) or making themselves a full system-to-system integration. In order to introduce more suppliers to the sphere of digital communication with CDRC, a new development phase was initiated in 2003: a supplier web portal was deployed. This system, delivered by a third party IT supplier, allowed a supplier using only a standard desktop computer and an internet browser to receive and confirm CDRC's orders, communicate with CDRC's retail outlets, send product availability data, and view inventory levels and sales figures of CDRC's retail outlets. For both IOIS types (the old system-to-system or system-to-human and the new system-to-human web-based), the supplier pays a fee to participate. The next planned step is to advance the new web-portal approach, based on XML-messaging, to also system-to-system integration, essentially replacing over time the old proprietary links of the first generation integrations (dating to late 1990s as explained above).

The key targets for the supplier-IOIS for CDRC have been to reduce manual work and telephone inquiries both at CDRC and at suppliers and to receive accurate information about product availability from the suppliers, especially from 10–15 closest suppliers with whom there are daily transactions and continuous cooperation. In general, it is regarded important by CDRC's retail outlets to be able to give accurate information about product availability to customers. Other targets for using the IOIS with suppliers have been to provide suppliers with reports on their performance (e.g. delivery accuracy) and also, potentially in the future to enable operating models where inventory ownership (at CDRC's stores or at other CDRC's inventory locations) is transferred to suppliers.

### 4.2. Supplier perspectives on operational impacts of CDRC's supplier IOIS

In total, the studied sample of CDRC's key suppliers included 10 nonadopters, nine system-to-human (S2H) users, and five system-to-system (S2S) users of CDRC's supplier-IOIS. These suppliers made up 67% of CDRC's purchases in 2003. From the studied suppliers eight had taken the IOIS into use in the last year.

The average value of sales and proportion of sales to CDRC grow with IOIS depth (see Table 2), indicating willingness to invest growing with CDRC's importance to total business. Data on clerical work are presented in Table 2 and Fig. 1. Table 2 gives clerical work index (amount of work in clerical tasks normalized with supplier sales to CDRC) for each of the three groups of suppliers (based on CDRC-IOIS usage) along with perceived payoff from the IOIS investment by the two CDRC-IOIS user groups.

The data displayed in Table 2 show how suppliers having implemented a system-to-system link with CDRC report on average considerably lower work content in clerical tasks and perceive higher profitability on their investments to the IOIS system with CDRC. The extent of potential to reduce clerical work is demonstrated by one of our interviewed suppliers, a user of system-to-system link.

**Table 2**
Data on sales, proportion of sales, clerical work content, and perceived payoff for IOIS investment in relation to CDRC (studied 24 suppliers).

| | Sales to CDRC ('000 euros) | | % of sales to CDRC | | Clerical work index A[a] | | Clerical work index B[b] | | Perceived IOIS payoff[c] | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Mean | *n* | Mean | *n* | Mean | *n* | Mean | *n* | Mean | *n* |
| Nonadopters | 1090 | 10 | 34.8 | 8 | 437 | 5 | 519 | 5 | | |
| S2H users | 2926 | 9 | 43.0 | 8 | 249[d] | 7 | 490 | 8 | 4.11 | 9 |
| S2S users | 5100 | 5 | 71.0 | 5 | 23 | 5 | 58 | 5 | 4.75 | 4 |

[a] Clerical work in order intake (hours in year per million euros of sales) relating to CDRC. Figure is based on respondents' estimations of weekly amount of work hours. Estimation is annualized (assuming 52 weeks per year) and normalized (dividing it by sales volume to CDRC) to enable comparison between suppliers.

[b] Clerical work in order intake, order confirmation, and sending product availability information (hours in year per million euros of sales) relating to CDRC. Figure is based on respondents' estimations of weekly amount of work hours. Estimation is annualized (assuming 52 weeks per year) and normalized (dividing it by sales volume to CDRC) to enable comparison between suppliers.

[c] Mean perceived payoff of investments to IOIS with CDRC, measured with Likert 1–5 scale (1—not at all profitable, 5—very profitable).

[d] *n* of S2H users for "clerical work index A" is 7, since S2H user B reported work amount estimation only on total order intake plus order confirmation level.

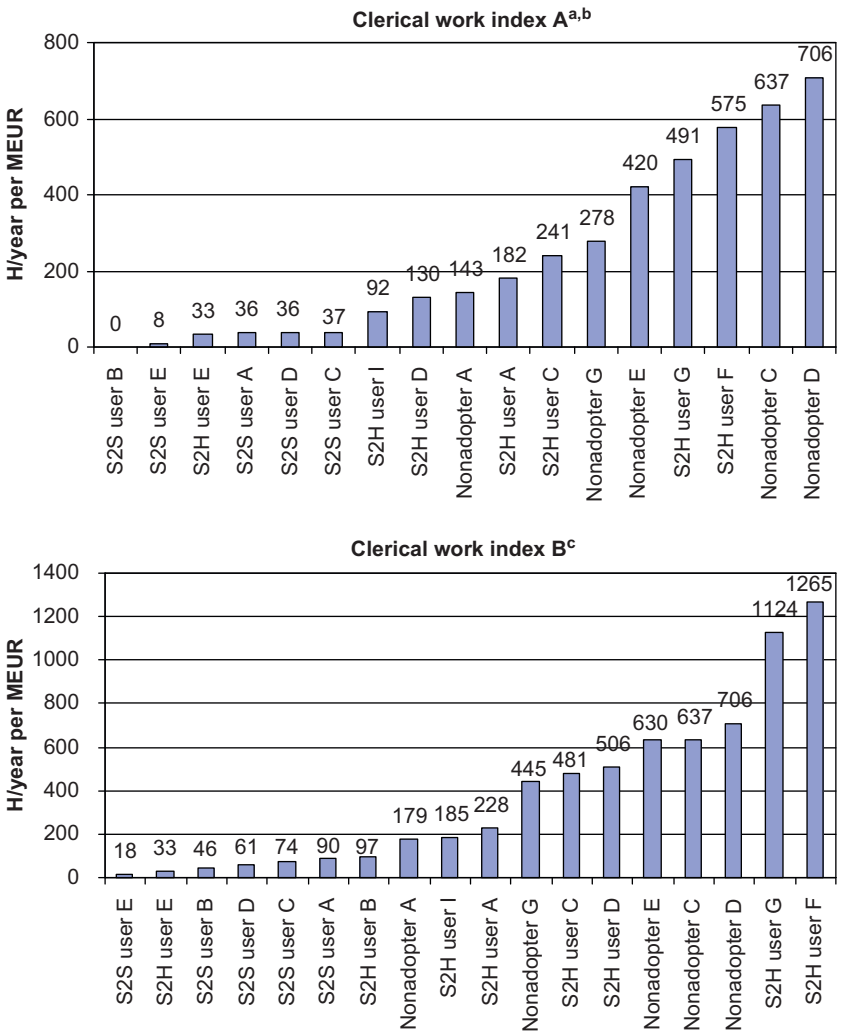


**Fig. 1.** Supplier-level clerical work indices. a—See note a of Table 2. b—See note d of Table 2. c—See note b of Table 2.

*S2S user D* reported that the system-to-system link it uses with CDRC has provided clear efficiency gains. Currently, one person does the clerical work that would have previously needed three persons and with current volumes at least five persons. The system provides correctness of order data and prohibits, among other things, misunderstandings common in telephone orders.

Also the system-to-human link has provided for the studied suppliers some productivity benefits, although more modest than for system-to-system users (reporting in the survey on average, 8–10 times higher clerical work content than the system-to-system users). Also interviews with suppliers indicated that much manual work is still present in system-to-human-based processes. Furthermore, CDRC has requested suppliers joining its supplier-IOIS to update product availability data through the web portal interface, an issue of potential de facto manual work increase for the suppliers. The following accounts from interviews demonstrate these points:

> For *S2H user A*, the CDRC's web-based system has speeded up work. The order handling work has been reduced by 40–50%, from previously spending 4–5 hours per day, to now spending some 2–3 hours per day.
>
> For *S2H user D*, phone calls have been reduced roughly by half through adopting CDRC's system. Previously much time was spent in handling the orders that came by fax. For example, it was typical after the weekend that the floor was covered with fax messages, and Mondays were spent until noon on the telephone trying to return calls to stores. At the same time, S2H user D has experienced an increase in manual work in certain processes, due to the new process of updating product availability data. S2H user D representatives do the update once or twice a week and it takes about 2–3 hours per update.

Another *S2H user* (*ext*), [interviewed, not responding to the survey pleading to time limitations] reported that the use of CDRC's web-portal in order intake and product availability data updates has reduced telephone communication by 90% (estimation). However, still much work is put into handling orders: with an average volume of 100 orders per day, S2H user (ext) has two people processing CDRC's orders (printing out orders from the web portal and entering them manually to internal information system), confirming the orders, and doing sales related activities. In addition, product availability data is updated once a week to CDRC's web-portal, taking about 2 hours per update.

The examples of these interviewed suppliers show how merely having the orders in electronic format without full integration with internal systems results in numerous positive impacts, including reduced handling of papers and amount of telephone calls. However, supplier-level data comparisons demonstrate that the differences between system-to-human users and nonadopters are less clear (Fig. 1). In ordered observations these groups blend in terms of clerical work, both when only order intake work is considered, but especially when the product availability data work—imposed by CDRC on the web users—is considered as well. Collectively, these findings point to the manual content still present in system-to-human-based interorganizational processes.

### 4.3. Supplier perspectives on the use of CDRC's supplier-IOIS

In general, reflecting the findings above, the studied suppliers found system-to-system system integration the most preferred way of communication with CDRC (see Table 3) in order intake, order confirmation, and product availability update processes. This is especially true for current system-to-human and system-to-system users; nonadopters appear to prefer manual communication roughly equally well. We note in particular how system-to-human users would prefer system-to-system communication, a fact plausibly reflecting the work content in the system-to-human process, especially in product availability updates (see e.g. how all six system-to-human users responding to this item stated that system-to-system integration was their preferred way to send product availability information to CDRC).

But even though system-to-system integration might be a preferred mode of communication, especially for suppliers with high share of sales to CDRC (as the interviewed suppliers and many respondents in the supplier-level survey), our data also shows that system-to-system data exchange remains elusive in several instances. This is highlighted by the interviewed suppliers as follows:

For *S2H user A*, the key obstacle for system-to-system integration with CRDC is a matter of costs. In order to integrate, S2H user A's internal information system would have to be renewed.

*S2H user B*'s experience is that creating system-to-system links is laborious and slow. The company initiated an integration project some 1.5–2 years ago that was still not complete at the time of the study. The integration work has been done intermittently. One reason for the slow progress of the work has been that the effort is coordinated by its parent company in [another North European country] and the work involves a third party IT supplier.

*S2H user D* reported that the key obstacles for system-to-system integration with CDRC are different item codes between the two companies. In addition, some update to internal information systems might be needed.

*S2S user D*, planning further system-to-system integrations beyond current processes (taking orders, sending product availability data), notes that the key obstacle is incompatibility of information systems. To overcome this, S2S user D has built a separate telecommunications module to its internal information system. Thus the key cost from system-to-system integration is developing different kids of integration tools.

The issue of limited back end system capabilities, raised by S2H user A, is a serious concern, and appears to be a key reason why there is not more system-to-system integration among CDRC's key suppliers. Further evidence on this topic is shown in Table 4, exhibiting data from the supplier survey. These data show that the overall perceived readiness of the studied suppliers in system-to-system integration is low. As an illustration, half of the nonadopters could not state whether integration was possible, and only one to three out of eight could integrate some of the messages. The key difference between each studied group of suppliers is that users (S2H and S2S) know better whether they can integrate or not. A further point suggesting low system-to-system capabilities by the studied suppliers is that the majority of the five studied suppliers currently integrated in system-to-system mode found it hard to extend the integration beyond order and product availability messages.

Finally, another key factor, pointing to the direction of CDRC itself, emerges on why CDRC's supplier-IOIS is not used more among its suppliers. This is exhibited by the following supplier reports:

*S2H user D* reported dissatisfaction in the way the system was introduced to it. CDRC just notified them that the company would be included in the system starting next week, without proper training given. Moreover, every update to the system has had flaws. For example, the product availability data S2H user D provides was erroneously displayed to the sales clerks at the retail outlets. CDRC has, however, fixed the problems as they have occurred.

*S2S user* (*ext*) reported that the key obstacle for moving to system-to-system integration comes from CDRC. From S2S user (ext)'s perspective CDRC's development work on the next phase of CDRC's supplier-IOIS, extending the web portal to enable system-to-system integration, has been slow. According to the

**Table 3**
Most preferred way of information exchange with CDRC[a].

| | Most preferred way of information exchange with CDRC … | | | *n* |
|---|---|---|---|---|
| | Manual (%) | S2H (%) | S2S (%) | |
| … in order intake | | | | |
| Nonadopters | 40 | 10 | 50 | 10 |
| S2H users | 0 | 11 | 89 | 9 |
| S2S users[b] | 0 | 20 | 80 | 5 |
| All | 17 | 13 | 71 | 24 |
| … in order confirmations | | | | |
| Nonadopters | 44 | 11 | 44 | 9 |
| S2H users | 0 | 22 | 78 | 9 |
| S2S users[b] | 0 | 20 | 80 | 5 |
| All | 17 | 17 | 65 | 23 |
| … in sending product availability information | | | | |
| Nonadopters | 50 | 17 | 33 | 6 |
| S2H users | 0 | 0 | 100 | 6 |
| S2S users[b] | 0 | 20 | 80 | 5 |
| All | 18 | 12 | 71 | 17 |

[a] Share of respondents in each studied group of suppliers indicating manual, system-to-human, and system-to-system communication as the most preferred way.

[b] We were not able to confirm in the post-questionnaire interview why one current system-to-system user (S2S user A) indicated system-to-human use as the most preferred way of communication. The likely explanation is that its current system-to-system approach is most preferred (a system-to-system link dating back to 1992, being an FTP-based link implemented prior to CDRC's supplier-IOIS program initiated in 1996), and the system-to-system approach offered by CDRC was seen as inferior to CDRC's system-to-human approach (which could perhaps be still used through the existing FTP system-to-system link).

**Table 4**
Perceived readiness for system-to-system integration with CDRC in four specific information exchange processes.

| | Possible to integrate (%) | Not possible to integrate (%) | Do not know (%) |
|---|---|---|---|
| *Nonadopters* ($n = 8$) | | | |
| Receive orders | 38 | 13 | 50 |
| Send product availability information[a] | 13 | 38 | 50 |
| Send advance shipping notification | 25 | 25 | 50 |
| Send delivery time change notification | 25 | 25 | 50 |
| *S2H users* ($n = 7$) | | | |
| Receive orders | 43 | 43 | 14 |
| Send product availability information[a] | 71 | 14 | 14 |
| Send advance shipping notification | 43 | 43 | 14 |
| Send delivery time change notification | 43 | 29 | 29 |
| *S2S users* ($n = 5$) | | | |
| Receive orders | 100 | 0 | 0 |
| Send product availability information[a] | 80 | 20 | 0 |
| Send advance shipping notification | 20 | 80 | 0 |
| Send delivery time change notification | 40 | 60 | 0 |

[a] On a daily or a weekly level.

interviewed S2S user (ext) respondent there are no obstacles to system-to-system integration from its own part.

We conclude our analysis of obstacles to using CDRC's supplier-IOIS by highlighting two key reasons: (1) limited resources and in particular, limited back end system capabilities; (2) actions and inactions idiosyncratic to CDRC. It appears that CDRC could have done a better job of introducing the supplier-IOIS to its suppliers.

## 5. Discussion

Our case study of CDRC's supplier-IOIS points to interesting directions. For one, system-to-human integration can indeed also benefit non-initiators, but only system-to-system integration provides fuller productivity benefits in manual transaction processing. However, we also note how system-to-system integration remains elusive, in particular through limits imposed by internal information systems, an issue particularly pressing for small and medium sized organizations, typically equipped

with ad hoc systems and limited resources (Stefansson, 2002; Harland et al., 2007). We summarize two key findings from our case study of CDRC's supplier-IOIS as follows.

**Finding 1.** Interorganizational system-to-human integration can provide operational benefits for non-initiating SMEs, but not as much as system-to-system integration.

This study shows that the current blend of system-to-human and system-to-system communication has indeed operationally benefited CDRC's suppliers. At the same time, we found that the depth of integration still makes a great deal of difference. In particular, in our study the system-to-system users exhibited on average one tenth of the manual work content and perceived higher benefits from their IOIS investments than the studied system-to-human users. This is perhaps reflected in the fact that the majority of the studied suppliers currently using system-to-human approaches would prefer system-to-system integration in basic interorganizational information exchange processes. We thus provide further empirical evidence with a rich in-depth case study that only system-to-system integration is the true source of dyad-level productivity gains. Taken together, these findings are in line with prior works on EDI and IOIS depth (Hart and Estrin, 1991; Mukhopadhyay and Kekre, 2002; Truman, 2000).

In general, an important contribution from our study comes from the systematic evaluation of the non-initiator impacts of system-to-human integration. Our study provides empirical evidence that web-based system-to-human integration approaches can provide productivity gains in manual work, even though not as much as in system-to-system integration. Thus supplier web portals, based on this study, appear clearly better than nothing in terms of productivity gains for the non-initiators, and using them in parallel with system-to-system approaches, as observed by Laukkanen et al. (2007), also appears reasonable at the supply chain level.

At the same time, our study provides grounds to explicitly measure IOIS depth in evaluating the effectiveness of interorganizational e-business systems: it certainly matters whether a system-to-system or system-to-human link is used, both in terms of operational impacts and obstacles for use. This measuring should be done at both ends of dyads.

**Finding 2.** System-to-system integration remains elusive where resources are scarce and backend system capabilities are limited.

Integration of IT systems has been identified as an important prerequisite of supply chain performance (Vickery et al., 2003; Rai et al., 2006) and advanced supply chain capabilities, such as flexibility and agility (Swafford et al., 2008). Prior work has, however, neglected a key *modus operandi* of interorganizational IT integration: the extent of automation between the trading partners. Our study has found evidence that even if full system-to-system integration is preferred at both ends of a dyad, capability to integrate might operate as an effective obstacle. Thus the intentions by CDRC and its closest suppliers to increase the use of system-to-system integration might prove challenging task as system-to-system integration is costly and demands backend system capability, both issues particularly noteworthy in the context of SMEs, as our findings further show. Before back end capability is built, system-to-system integration makes less sense. Furthermore, low financial and personnel resources seem to operate as effective obstacles towards integration, indicating that system-to-system integration still remains too costly for instances where flawless interorganizational processes are needed. Based on our work, previous findings on challenges for IOIS use for SMEs still seem valid (Eagan et al., 2003; Iacovou et al., 1995; Morrell and Ezingeard, 2002; Stefansson, 2002; Patterson et al., 2003; Harland et al., 2007). Thus reaching "100% EDI connected suppliers" (Agi et al., 2005) still remains hard to achieve. Using system-to-human and system-to-system links together can be one way to address this issue, although dyad-level efficiency gains are more modest in the semi-automated way.

## 6. Conclusion

This study has examined the operational impacts and the factors affecting the adoption and depth of IOIS use of customer initiated IOISs for small and medium sized suppliers. We have shown through a case study with multiple data collection strategies that SME suppliers can benefit on the operational level from customer initiated IOISs, but low internal information system readiness inhibits wider adoption. We conclude with remarks on managerial implications and further studies.

The findings of this study have significant managerial implications for network leaders with small and medium sized suppliers. The study indicates how low readiness of internal information systems can inhibit SMEs to engage in IOIS use with the initiating customer. It is then reasonable to believe that network leaders could provide issues such as technical assistance to alleviate the negative impact of their suppliers' low resources and internal information system readiness on IOIS adoption. Therefore, an active role by the network leader would in fact support diffusion among SME suppliers by downplaying the factors inhibiting adoption. However, it should also be noted that employing system-to-human integration approaches is one way to overcome the barriers to electronic commerce, but only a partial solution if full efficiency benefits are the objective.

For further research this study indicates that it is important to explicitly address IOIS depth in IOIS studies since IOIS depth seems to explain variation in IOIS performance outcome measures. Moreover, the limited resources and capabilities of SME suppliers towards system-to-system integration make this a prominent issue, especially in studies concerning SMEs. Therefore further work should include a richer conceptualization of the IOIS construct to increase validity, as examining overall level constructs such as the use of e-business technologies (e.g. Sanders, 2007; Matopoulos et al., 2007)

is likely to lead to overly simplified conceptualizations of IOIS use.

Another key question raised by this study are situational aspects related to the use of either system-to-system or system-to-human integration. As Welker et al. (2008) show, business conditions indeed matter for information sharing mechanisms within the supply chain. Both in-depth case evaluations and larger sample statistical studies would be valuable in probing in what instances a lean system-to-human link would do and where full system-to-system integration would be needed.

## Acknowledgments

We acknowledge National Technology Agency of Finland (TEKES) and CDRC for funding this study. All the support from representatives of CDRC during the study is gratefully recognized. We are also obliged to the 24 supplier companies of CDRC taking the time to participate in this study. The first author wishes to thank Emil Aaltosen säätiö, Jenny ja Antti Wihurin rahasto, Tekniikan edistämissäätiö (TES), and Kaupallisten ja teknillisten tieteiden tukisäätiö (KAUTE) for financial support.

## Appendix A. Interview protocols

Interview protocol for CDRC interviews

1. Background information on CDRC
   - Structure of the supply chain
   - Internal information systems
2. Critical information related to managing the supply chain
   - Current and preferred state of information sent to/received from suppliers
3. Information systems with suppliers
   - Role of information systems in supplier collaboration
   - Description of the history and current state of CDRC's supplier-IOIS
   - Impacts of CDRC's supplier-IOIS

Interview protocol for supplier interviews

1. Background information on the supplier
2. Relationship with CDRC
3. Critical information systems related to managing the supply chain
   - Current and preferred state of information sent to/received from CDRC
4. Assessment of CDRC's supplier-IOIS
   - Description of current use
   - Received benefits
   - Costs or impediments
   - Perceptions on opportunities, obstacles, and further development
5. IOIS use with other customers

*Notes*: (1) Each theme (numbered) or subtheme (bulleted) item included specific ex ante prepared guiding questions, which are omitted here for space considerations; (2) interview guides for individual interview sessions were customized based on informant expertise; (3) interviews also covered other themes (not directly related to data analyses as reported here).

## Appendix B. Survey respondents

| Pseudonym | Indexed sales[a] | System-to-human use | | | | System-to-system use | | | | Clerical work index A[b] | Clerical work index B[c] |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Order | Order confirmation | Prod. availability | ASN | Order | Order confirmation | Prod. availability | ASN | | |
| S2S user A | 6700 | | | | | x | | | x | 36 | 90 |
| S2S user B | 1600 | | | | | x | | x | | 0 | 46 |
| S2S user C | 700 | | | | | x | | | | 37 | 74 |
| S2S user D | 600 | | | | | x | | x | | 36 | 61 |
| S2S user E[d] | 500 | x | x | | | x | | x | | 8 | 18 |
| S2H user A | 2500 | x | x | | | | | | | 182 | 228 |
| S2H user B | 2100 | x | x | | | | | | | N/A | 97 |
| S2H user C | 800 | x | x | x | | | | | | 241 | 481 |
| S2H user D | 500 | x | x | x | | | | | | 130 | 506 |
| S2H user E | 500 | x | | | | | | | | 33 | 33 |
| S2H user F | 400 | x | x | | | | | | | 575 | 1265 |
| S2H user G | 200 | x | | x | | | | | | 491 | 1124 |
| S2H user H | 200 | x | x | | | | | | | N/A | N/A |
| S2H user I | N/A | x | x | | | | | | | 92 | 185 |
| Nonadopter A | 1300 | | | | | | | | | 143 | 179 |
| Nonadopter B | 700 | | | | | | | | | N/A | N/A |
| Nonadopter C | 500 | | | | | | | | | 637 | 637 |
| Nonadopter D | 400 | | | | | | | | | 706 | 706 |
| Nonadopter E | 400 | | | | | | | | | 420 | 630 |
| Nonadopter F | 300 | | | | | | | | | N/A | N/A |
| Nonadopter G | 200 | | | | | | | | | 278 | 445 |
| Nonadopter H | 100 | | | | | | | | | N/A | N/A |
| Nonadopter I | N/A | | | | | | | | | N/A | N/A |
| Nonadopter J | N/A | | | | | | | | | N/A | N/A |

[a] 2003 sales revenue of the supplier, indexed to smallest sales revenue in the sample (smallest sales revenue = 100), rounded to nearest hundred.

[b] Clerical work in order intake (hours in year per million euros of sales) relating to CDRC. Figure is based on respondents' estimations of weekly amount of work hours. Estimation is annualized (assuming 52 weeks per year) and normalized (dividing it by sales volume to CDRC) to enable comparison between suppliers.

[c] Clerical work in order intake, order confirmation, and sending product availability information (hours in year per million euros of sales) relating to CDRC. Figure is based on respondents' estimations of weekly amount of work hours. Estimation is annualized (assuming 52 weeks per year) and normalized (dividing it by sales volume to CDRC) to enable comparison between suppliers.

[d] This supplier uses both system-to-system and system-to-human integration with CDRC (depending on CDRC's store types). Since its sales volume related to system-to-system processes is roughly four times that of system-to-human processes, this supplier is categorized as system-to-system user in the analyses.

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