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REACHING A HIGHER LEVEL OF INFORMATION SYSTEMS INTEGRATION: THE IMPACT OF INFORMATION TECHNOLOGY SUBSTITUTION STRATEGIES ON PROCESS EFFICIENCY

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Abstract

Firms frequently apply more than one information system for their processes and data exchange. This variety is often due to the existence of legacy systems and can cause large inefficiencies. At present, most consumer goods firms aim at replacing non-integrated information flows with electronic data interchange. In doing so, firms constantly increase their level of information systems (IS) integration. However, firms have to decide whether they replace non-integrated legacy systems incrementally or radically. The paper investigates this issue from a conceptual viewpoint that combines the information technology (IT) substitution perspective with the concept of levels of IS integration. An empirical case study investigates two alternative IT substitution approaches, i.e., an incremental and a complete IT substitution, in respect of their impacts on process efficiency improvement. The results indicate that the complete IT substitution achieves significantly larger efficiency gains due to the impact of IS integration levels.

Keywords: IT substitution, IS integration level, inter-organizational systems, electronic data interchange, case study.

1 Introduction

Information technology (IT) such as enterprise resource planning (ERP) systems and inter-organizational information systems (IOS) allow a seamless integration of data within and across organizations' boundaries. With growing requirements on an integrated flow of information in various business contexts, full integration of business data and supply chain processes increasingly become competitive factors (Kumar 2004) and are a key enabler of supply chain management practices.

However, in contrast to the past, contemporary IT environments in practice are characterized by many existing legacy systems (Bygstad et al. 2010) which are often not fully integrated. Companies hesitate to dispose of legacy systems as these systems were developed for core business processes and usually contain crucial data or essential algorithms (Bennett et al. 2006), thus providing value (Akyuz and Rehan 2009). Major changes are likely to cause large investments and substantial risks (Schneidewind and Ebert 1998). IS research identified a technology lock-in due to switching costs, path dependency, and excess inertia as major reasons for keeping legacy systems in use (Zhu et al. 2006). Although integration of legacy systems has been topical for decades, it is expected that they will further increase in value due to constantly developed new applications (Coyle 2000).

Thus a large number of firms use multiple applications particularly for inter-organizational processes (Gizanis et al. 2005). As Kim and Shunk (2004) point out, business processes such as procurement often cannot be carried out by one single information system (IS) only. Especially large companies can operate huge numbers of applications that were custom built long time ago (Cimino and Marcelloni 2011). A manufacturer investigated in a case study by Themistocleous et al. (2004) operated not less than 2,000 different legacy systems, hundred ERP applications, and 125 e-business modules. Therefore when supply chain integration is considered in an organization, the integration of legacy systems has to be taken into account (Akyuz and Rehan 2009). Already ten years ago, an empirical survey revealed that firms used more than five systems for order entry and more than four systems for order processing on average (Keltz and Kraus 2002). Given the dynamic development of Internet-based applications, it can be assumed that this number further increased since that survey was done.

A variety of IT applications increases complexity (Linthicum 2003) and therefore tends to raise the need for human system administrators (Lin et al. 2005). Moreover, the exchange of non-integrated information often occurs in a non-electronic manner, i.e., by telephone, fax, or e-mail (Anonymous 2004), particularly when it comes to inter-organizational information flows. For example, a recent study on the exchange of item master data reveals that a non-electronic exchange of business data is still common even among large companies (Madlberger 2011). But also when ERP systems are available, the lack of integration between applications is often bridged by manual data entry. Typical resulting problems are multiple re-entries of data, transfer of missing or incomplete information, and errors (Gizanis et al. 2005).

While academic research addressed the issue of enterprise application integration (EAI), electronic information flows, and ERP systems for a long time (see Liu et al. 2008 for a review), practice considerably lags behind the state of the art in academic research. Issues of migration from legacy systems to integrated IS are a major concern of many organizations. With growing variety of different systems, firms are increasingly faced with the decision whether to migrate incrementally or radically (Wright and Capps 2011, Ambrosini et al. 2009). Given the large number of possible migration paths, the decision between incremental and radical migration has to take the impact on process improvement into account.

This decision may be supported by considering the impact of the IT substitution strategy. IS researchers developed the conceptualization of IS integration levels that reflect the varying degrees of internal and inter-organizational integration of an organization's different IS. The goal of the research presented in this paper is to use IS integration levels as a basis for a comparison of an incremental IT substitution of a legacy system with a complete and thus more radical replacement. The main focus on the research therefore lies on the different impacts of both approaches on performance. For this purpose, the procurement process of a large consumer goods retailer is analyzed empirically. The observed processes are supported by three kinds of IS: a non-integrated legacy system, a fully-integrated ERP system, and a semi-automated procedure as an intermediate step. There are two IT substitution strategies in place: an incremental change with two steps (from the manual to the semi-automated and from the semi-automated to the automated process) and a radical substitution in one single step (immediate replacement of the legacy system by a switch from the manual process to the automated process). The results indicate that there are significant differences between the incremental and the radical change in terms of process efficiency and achievement of benefits.

The paper is organized as follows: Section two provides a review of IT substitution strategies. Section three discusses the application context of the study, i.e., procurement based on electronic data interchange (EDI) from the viewpoint of levels of IS integration. Section four presents the case study with the investigated procurement processes and the analysis results. The findings are discussed in section five. Section six provides conclusions and implications of the research.

2 IT substitution strategies

IS literature discusses incremental and radical changes as approaches of IT substitution. Within the wider context of management, these approaches reflect continuous change on the one hand and punctuated change on the other (Hinton 2002). Changes in business processes and in the IT per se are two different issues although they are usually closely linked to each other (Galliers 1994).

Incremental changes are widely used in IS development as they allow accounting for the social context of the change (Orlikowski 1993). Gradual changes enable a constant adaptation to environmental developments. In the absence of radical changes in an organization's environment, incremental changes are usually sufficient (Ambrosini et al. 2009). However, during longer periods of incremental changes that do not contribute to substantial improvement, more radical changes may become necessary (Wright and Capps 2011). IS research explains this on the basis of the biological science theory of punctuated equilibrium where periods of stability are alternating with periods of radical change (Eldredge and Gould 1972). Thus incremental changes are not the opposite, but rather a supplement or even promoter of radical changes (Lyytinen and Newman 2008).

The radical approach has large relevance in the context of business process reengineering (BPR). This strategy usually involves a comprehensive substitution of IT together with a simultaneous alteration of business processes. BPR was introduced to a larger audience by Hammer (1990) who called for the use of IT to reorganize processes instead of only automating them. While BPR assumes a radical change that spans across business functions and comprises changes in organizational design, culture, and IT, in practice BPR rather is implemented in a more modest way due to organizational limitations (Stoddard et al. 1996). BPR requires a strategic approach that includes an appropriate mindset, a sense of urgency without too hasty changes, directed efforts in multiple directions, and a systematic redesign (Mohanty and Deshmukh 2001).

Depending on individual organizational and technological backgrounds, each approach has its strengths and weaknesses. Advantages of an incremental IT substitution are reduced risk due to the opportunity to learn and experiment as well as a stepwise technological integration. Furthermore, an incremental approach accounts better for organizational issues (Bygstad et al. 2010). However, incremental changes are often limited to automation of processes that stay unchanged, but may not be optimal. To allow for more far-reaching process change, the more radical approaches, such as BPR become necessary (Hammer 1990). Often only radical changes can enable organizations to achieve substantial benefits like productivity increase or staff reduction (Teng et al. 1996). The large impact on the process organization requires organizations to conduct radical approaches of process reengineering and IT substitution with caution (Mohanty and Deshmukh 2001).

3 Levels of IS integration

Integrated, IOS-supported procurement started with bilateral electronic data interchange (EDI) based on proprietary systems. Later, bilateral EDI was replaced with EDIFACT, a set of standardized business documents that can be exchanged via value-added networks. More recent IOS use the Internet and the XML format (Soliman and Janz 2004), b2b marketplaces (Christiaanse 2005), or ERP modules for electronic procurement (Loh et al. 2006). A comparison between the academic discourse and the IOS use in practice shows that practice considerably lags behind research. Despite the advancements on Internet-based IOS, EDI is still state of the art in many industries. In the European fast-moving consumer goods (FMCG) sector EDI-based procurement with the EDIFACT format ORDERS is widely used particularly by large corporations. For example, the top 15 retailers in the United Kingdom place 87% of their orders via EDIFACT (GS1-UK 2010). A similar trend can be observed in other European countries such as France, Germany, and Austria (GS1-Austria 2011). Strong reasons for consumer goods companies to prefer EDI are network effects and the technology lock-in (Zhu et al. 2006).

Independent from the underlying technology, the implementation of IOS in organizations can be structured by different levels of IS integration. In organizations IS are not only a technological issue, but also have a strong organizational impact. Thus the discussion of levels of IS integration should include both the technological and the organizational viewpoint. The impact of the technological perspective is largely based on the enabling function of IS on process and organizational improvements (Kumar 2004). Thus technological IS integration is often a prerequisite for organizational IS integration. Plomp and Batenburg (2010) juxtapose the levels of technological IS integration with organizational IS integration based on an extensive literature research.

From the technology viewpoint, the starting point is the absence of any integrated IS. While intra-organizational IS integration can take place at that level (Wang et al. 2004), inter-organizational IS integration starts with bilateral e-business integration. A further level is IS-supported multilateral collaboration based on common standards. If all organizations in a supply chain are linked electronically, the highest IS integration level is achieved (Plomp and Batenburg 2010). Lummus and Duclos (1995) distinguish three levels: The transaction level is characterized by a limited number of electronic transactions with few trading partners. At the linked level, a firm's EDI system is connected with the manufacturing planning system. At the integrated level, which is the highest, EDI transactions between trading partners are integrated with other applications of both involved firms. Zmud and Massetti (1996) provide a finer distinction into four dimensions of IOS integration: volume (proportion of electronic documents), diversity (number of different electronic types of business documents), breath (proportion of trading partners that are linked electronically), and depth (degree of electronic integration of business processes).

Besides the technological viewpoint, IS researchers distinguish levels of IS integration along the organizational dimension. A structured overview is provided by Wang et al. (2004). The prerequisite of any IS integration is the electronic support of essential functions, i.e., electronic documentation. Starting from this first level, IS integration proceeds further to the integration of single departments and operation processes at level two, cross-departmental integration involving multiple processes at level three, and enterprise integration at level four. The further step to level five involves the inter-organizational integration in the form of b2b integration in the supply chain and represents the shift from intra-organizational to inter-organizational integration. Plomp and Batenburg (2010) make a finer distinction of inter-organizational IS integration and collaboration levels and distinguish between bilateral collaboration, multilateral collaboration, and extended chain collaboration. The latter involves collaboration between different supply chains. The model proposed by Schoenfeld (2008) stays between the previous two approaches as its considers siloed companies with no integration at the first level, followed by companies with an internal integration at the second level. At level three, inter-organizational integration starts with bilateral integration, followed by level four with multilateral integration. The highest level of integration again comprises the entire supply chain. Gottschalk (2009) links both dimensions by proposing technical computer interoperability on the basic level, followed by four organizational interoperability levels. Level two describes the process interoperability that supports an alignment of tasks that span across organizations. At level three, knowledge interoperability provides the basis for inter-organizational relationships that depend on knowledge sharing and knowledge transfer. Level four establishes the linkage to value creation and includes the interoperability of key activities in the value chain. Finally, the fifth interoperability level extends IS integration to the strategic perspective as it represents collaborative sharing of goals.

To reach an advanced level of IS integration, IS that support procurement must be capable of two application areas: processing of internal information, which is usually done by ERP systems, and inter-organizational information transfer by IOS. Standard ERP systems, e.g., SAP, Oracle, or MS Dynamics NAV include procurement and purchasing as modules in their packages. They allow the application of EDI by creating EDI-able documents (e.g. iDocs by SAP). Hence, standard ERP systems are at present a strong enabler for an electronic flow of information in inter-organizational transactions (Tatsiopoulos 2004). It is therefore likely that firms aim at achieving advanced IS integration levels for most of their inter-organizational processes with ERP systems.

4 Case study

In order to structure the different levels of IS integration in a natural environment we conducted an empirical analysis. Given the nature of the research question, we chose a case study approach due to the following reasons: The main objective is the analysis on understanding what IT substitution strategies look like in practice (descriptive question) and how they differ in their contribution to process improvement. A case study is an appropriate research approach for establishing the real-world context to provide answers to these questions. Furthermore the study focuses on a contemporary issue (Yin 2009, Yin 2012).

The case study is conducted on a large FMCG retailer in the German-speaking area. The retailer stocks an assortment of almost 50,000 product items and is supplied by around 3,000 manufacturers. It adopted EDI in the 1990s and implemented a standard SAP ERP system several years ago. The ERP system generates EDIFACT messages that are exchanged via a value-added network. Besides the ERP system, the retailer uses a large number of legacy systems. Within order management, the firm uses individual software that is not integrated with the ERP system for the procurement of certain product categories. The retailer's goal is the replacement of the legacy system with the ERP system in the long run. At the time of the case study the retailer conducts two approaches of IT substitution at different distribution centers: an incremental change in two steps including a switch from the existing manual process to a semi-automated process followed by the replacement of the legacy system in the second phase. The second approach is a complete IT substitution in one single step.

4.1 Processes analyzed in the case study

The analyzed processes of the retailer's procurement task are the following:

- The manual ordering process with total use of the legacy system without electronic order transfer.
- The semi-automated ordering process with a mixed use of the ERP system and the legacy system.
- The automated ordering process with full process support by the ERP system.

The original process is a manual ordering process that is dominated by the legacy system. In this process the legacy system creates an inventory list that serves as a basis for calculating the quantities of items to be purchased. The purchaser accesses this list by printing it out. The list contains information about the demand in the stores and the inventory level. Based on these data, the purchaser calculates the order amounts, fills in the inventory list and sends it via fax to the suppliers. In the current IT infrastructure, this data cannot be entered into the ERP system, as it is not capable of managing the affected product categories. As the order information is recorded only on paper, it is necessary to manually re-enter the order data into the legacy system to obtain an electronic record needed for the receipt of the goods. Thus this process is neither integrated internally nor on an inter-organizational basis. The left hand side of Figure 1 shows the event-driven process chain of this manual process.

In the semi-automated process, the first part of the process, i.e. up to the calculation of the required quantities is identical with the manual process, thus the IT substitution is only incremental. At the following step, i.e., executing the order, a switch between the two systems takes place and data is manual keyed into the ERP system. Next, the ERP system generates an EDI message sent to the supplier. Simultaneously, the order is again transferred to the materials management system (see right hand side in Figure 1). Thus the inter-organizational information flow is fully integrated, while the internal one is only partly integrated.

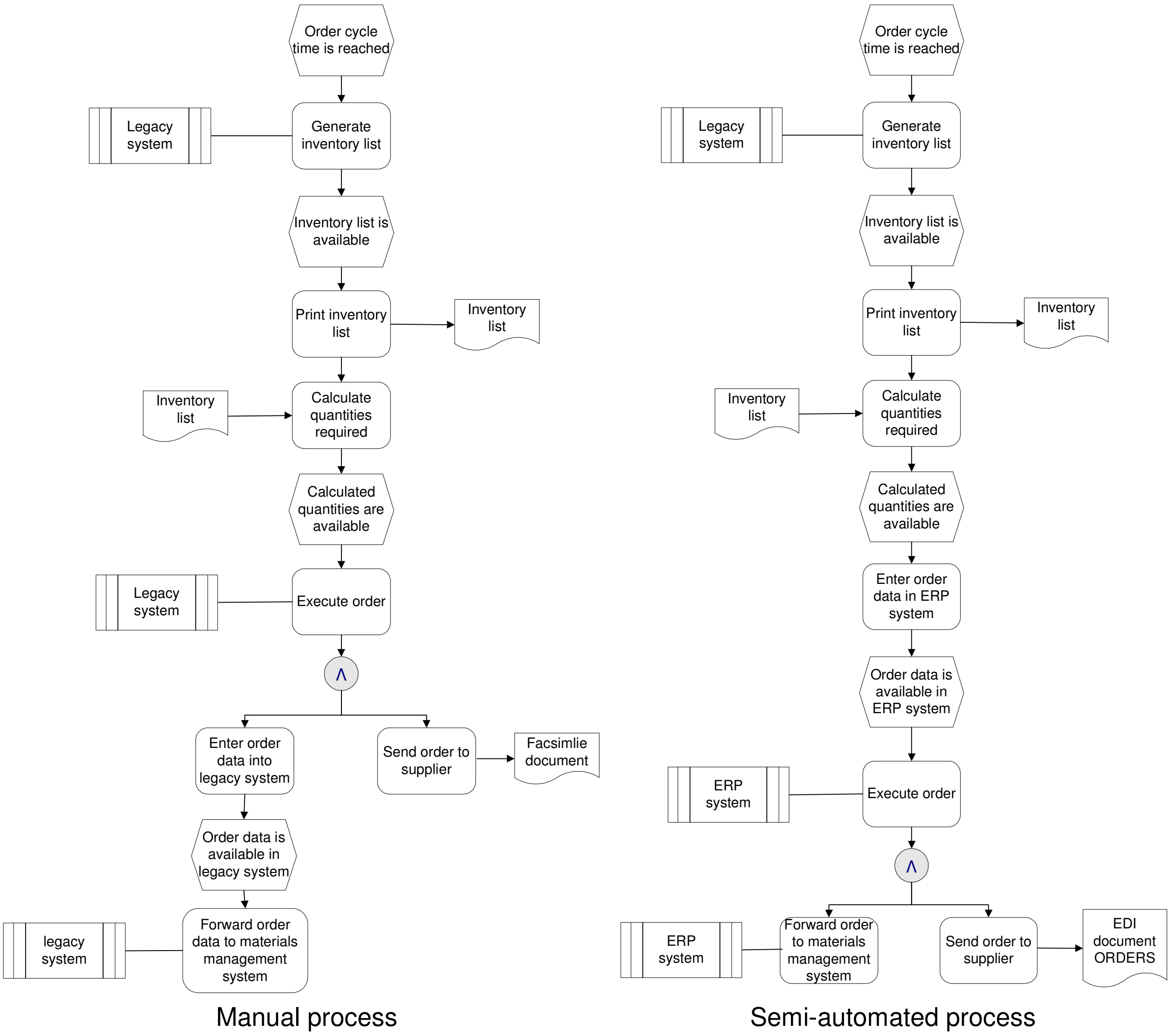

Figure 1. Event-Driven Process Chain of the Manual and the Semi-Automated Process

In the automated ordering process, the process is completely reengineered. The legacy system is fully replaced with the ERP system, thus this change represents a radical IT substitution. In this process, the order proposal is calculated by the ERP system. The purchaser checks the order proposal, either accepts or corrects it in the ERP system, and creates an EDI document that is directly transferred to the supplier. In addition, the order is internally transferred to the materials management system where it is required for the receipt of the goods (see Figure 2). The information flow is fully integrated internally as well as in the inter-organizational context. According to the company's IS strategy, the automated process is the ultimate IT substitution goal.

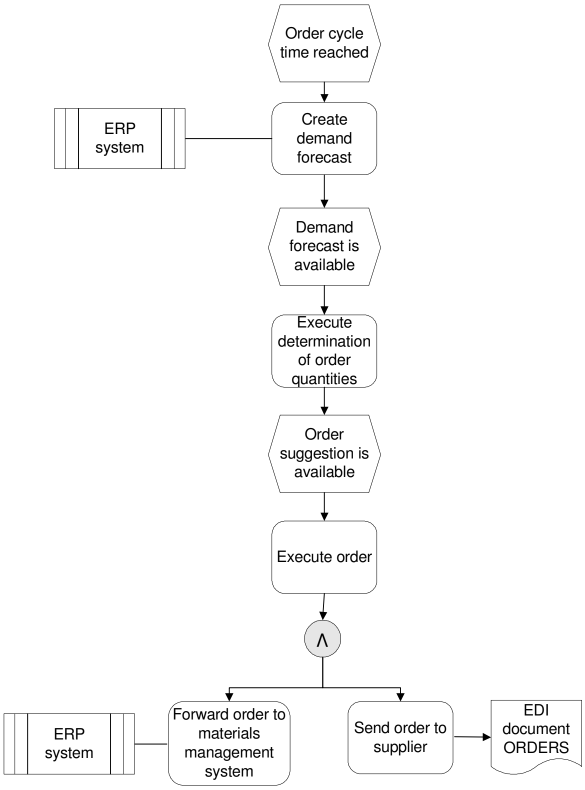

Figure 2. Event-Driven Process Chain of the Automated Process

These three processes were subject to empirical observation in order to analyze their efficiency. Efficiency measurement relates to direct benefits of IS that are characterized by their immediate impact (Mukhopadhyay and Kekre 2002). Examples of direct benefits are reductions of paperwork, reduced error rates, or shorter process duration. In contrast, indirect benefits of IS rather relate to strategically relevant improvements on an indirect basis (Mukhopadhyay and Kekre 2002), such as advanced levels of organizational integration or collaboration (Madlberger 2009). Another example of indirect IS benefits can be user satisfaction (Au et al. 2008). In line with the retail organization's IS strategy, the study puts a focus on efficiency of the IS support of the purchasing process. The applied efficiency measure is the time required for carrying out the ordering processes. This decision is made for several reasons. First, duration of processes is an important measure for the efficiency of a process (Khan 1984). Second, the duration of processes is an important basis for cost accounting, especially if activity-based costing (Cooper and Kaplan 1992) is applied. Activity-based costing can yield more accurate results than methods using direct costs and overheads. Third, the duration of the process is an efficiency criterion which can be measured very precisely and objectively. It can be directly related to personnel costs without major biases. Finally, efficiency was given most preference by the company's purchasing management and therefore was one of the key goals in the IT substitution strategy.

4.2 Analysis procedure

Prior to the process analysis, several meetings took place in which the conditions of the observations were determined. After the agreement on the analysis of all three process types in the firm, a workshop together with five managers was held in which the processes were discussed in detail and demonstrated online. On the basis on this input information, the observation instrument, a detailed questionnaire with the observation items, was developed. This draft was again presented to the firm's management and revised according to their comments. Prior to the process observation, a test observation took place. Based on these results, the observation instrument was again revised by making several refinements. The observations were carried out by trained graduate students who were instructed in detail prior to the analysis. For the process observation, groups of at least three students were sent to the firm in order to avoid information loss at parallel processes. The students had to record in detail the exact duration of the pre-defined processes as well as information related to the observed orders. To measure time exactly, the students were equipped with stop watches. Time was measured in seconds.

4.3 Results of the process analyses

In total, 574 transactions were analyzed. 25.3% of these transactions belong to the automated procedure, 59.3% to the semi-automated, and 15.4% to the manual procedure.

The following part-activities of the ordering process were measured:

- Number of product items on the inventory list
- Number of product items calculated
- Number of product items ordered
- Duration of calculation of order quantities
- Duration of order execution
- Duration of data entry into the legacy system (manual process only)

To account for different numbers of items per order, all activity durations were standardized, i.e., divided by the number of items. In the automated process, on average 25 items are ordered, in the semi-automated process 7 items, and in the manual process 16 items. Then, an analysis of variance (ANOVA) was run in order to test the mean differences for significance. To analyze differences between the time efficiency in greater detail, we conducted a post-hoc multiple comparison. As the variances of the groups turned out to be non-homogenous (Levene statistics was highly significant for each investigated item), a Tamhane-T2 test was run. This testing procedure does not require homogeneity of variances. Table 1 shows the average total duration of all process types and the results of the ANOVA analysis.

Efficiency measure	Manual Process	Semi-automated process	Fully automated process	F value	p value
Average number of ordered product items per order	15.84	7.16	24.97	6.977	**
Average duration of the order transfer per product item ordered	9.46	10.72	0.71	22.643	***
Average duration of the order transfer plus manual data entry in the legacy system per product item ordered	15.07	10.72	0.71	16.153	***
Average duration of calculation of the order quantity per product item ordered	20.37	23.27	7.35	5.358	**
Average duration of total ordering process per product item ordered	35.17	34.13	8.18	10.427	**
*** p < .001, ** p < .01, * p < .05, n.s. not significant					

Table 1. Means and ANOVA Results of Observed Process Durations

Table 2 displays all differences between the averages tested for significance by the Tamhane-T2 test. In this context, the differences between the manual and the semi-automated process types on the one hand and the semi-automated and the fully automated process types on the other hand are of particular interest. The differences between the "extreme forms" manual and automated process type are shown for completeness, however their significance is already represented by the ANOVA results.

	Process type	Compared process type	Mean Difference	p value
Average number of ordered product items per order	semi-automated semi-automated manual	manual automated automated	-8.675 -17.803 -9.128	n.s. ** n.s.
Average duration of the order transfer per product item ordered	semi-automated semi-automated manual	manual automated automated	1.261 -10.006 8.744	n.s. *** ***
Average duration of the order transfer plus manual data entry in the legacy system per product item ordered	semi-automated semi-automated manual	manual automated automated	-4.356 10.006 14.362	n.s. *** ***
Average duration of calculation of the order quantity per product item ordered	semi-automated semi-automated manual	manual automated automated	2.906 15.928 13.022	n.s. *** ***
Average duration of total ordering process per product item ordered	semi-automated semi-automated manual	manual automated automated	-1.041 25.945 26.986	n.s. *** ***
*** p < .001, ** p < .01, * p < .05, n.s. not significant				

Table 2. Results of Post-Hoc Multiple Comparison by Tamhane-T2 Test

On average, ordering an item takes 8.2 seconds in the automated process, whereas it takes 34.1 seconds in the semi-automated and 35.2 in the manual process. Hence the results confirm that the automated process type shows by far the lowest average activity duration with a difference of 26 seconds. On the other hand, the analysis reveals that there is no significant time difference between the semi-automated process and the manual process. As a consequence, the time efficiency gap between the automated and the semi-automated process is considerable, whereas it is negligible between the semi-automated and the manual process. Therefore, the manual entry of data in the semi-automated process offsets the advantage of the ERP system usage for ordering. In other words, as long as the legacy system is involved, the process duration is considerably delayed.

5 Discussion

The processes analyzed in the case study apply IOS that are situated at different levels of IS integration. The automated procurement system takes place at an advanced level of IS integration that allows medium or highest EDI depth by a fully integrated information flow between the retailer and its suppliers (Zmud and Massetti 1996). The semi-automated system is situated on two levels: while it is fully integrated and therefore at the second or third level of IS integration on the inter-organizational basis, it is only partly integrated and thus at the lowest level internally. The manual process run on the legacy system is non-integrated at all and therefore fully situated at the lowest level of IS integration.

The data in the case study shows that the efficiency gap between the semi-automated and the automated process type is significant and substantially larger than the gap between the manual and the semi-automated procedure which is minimal and non-significant. A firm that runs processes at different levels of IS integration has to ask itself not only at which levels it operates but also how large the differences between these levels are. An objective measurement is necessary for determining efficiency gaps between different IS integration levels. The time efficiency of related processes, as demonstrated above, proves to be a meaningful approach.

The findings highlight the relevance of priorities in IT substitution and the choice of the optimal IT substitution strategy. The data clearly stress the superiority of the complete substitution of IT over the incremental adaptation. It is achieved by reaching a higher level of IS integration which is only possible with complete substitution. As long as non-automated steps are involved in the process, they cannot be overcompensated by efficiency gains of the ERP system. Furthermore, the complete substitution allows a faster reduction of IS variety in the organization as the legacy system can be eliminated in one single step.

An important issue in IT substitution is costs of the change. As a survey conducted by Kremers and van Dissel (2000) shows, the two most critical issues concerning ERP migrations are time and costs. The financial hurdle is manifold: Radical changes require a substantial investment and sometimes the payback period of the investment in the legacy system is not yet completed when the new investment is done (Kremers and van Dissel 2000). In addition, the lifetime costs of the new system must be considered as well. However, in a situation of large variety of IS applications, the cost issue has to be considered differently. As soon as a new system that will replace a legacy system is in use, the investment has already been made and the lifetime costs are equivalent to sunk costs. Therefore only the costs caused by the switch between systems are relevant. Thus, also from the cost viewpoint, an incremental substitution does not yield any further benefits.

6 Conclusion and Implications

Particularly the use of IOS is characterized by a large variety of different, often parallel systems in one single organization. The inter-organizational business relationships further enhance this variety, as trading partners may impose the use of different IOS. In the light of the tendency towards smaller modules in ERP systems, realized through Web services and Service-Oriented Architectures and the emerging relevance of XML-EDI, which allows greater variety of document types, it can be expected that the variety of different applications will further increase. The question of different IS integration levels of multiple systems within one organization will therefore remain relevant in the next years.

The research at hand clearly demonstrates the need for reducing the variety of multiple IS by complete substitution of legacy systems rather than an incremental approach. Efficiency gaps between systems at different levels of IS integration can vary considerably, thus they are an important impact factor that should be considered in IT substitution decisions. The study contributes to research on IT substitution by demonstrating that, beyond the obvious superiority of automated processes over non-automated processes, the IT substitution paths are crucial. Especially when it comes to substitution of legacy systems, companies are recommended to pursue a more radical approach rather than a gradual elimination of legacy systems.

The results allow deriving several implications for the retailer as well as companies with a comparable background. Particularly in the FMCG industry, where profit margins are low, companies increasingly engage in inter-organizational collaboration (Madlberger 2009), thus reaching higher organizational levels of IS integration. Therefore more advanced technological levels of IS integration also allow for larger indirect benefits (Mukhopadhyay and Kekre 2002), e.g., by entering into cost-saving collaboration models (e.g., vendor-managed inventory). As IS often enable such practices, a radical IT substitution is also likely to yield greater indirect, strategic benefits. Therefore, despite larger difficulties in measurement, an inclusion of effectiveness measures would probably have resulted in even larger performance differences between the incremental and the radical IT substitution strategy.

Like any research, this study has several limitations. Case studies are an appropriate method for gaining insights into an issue in an exploratory way. In order to generalize findings and to provide more explanatory results, it is necessary to do quantitative investigations. For complexity reasons, the case study only focused on ordering. Other inter-organizational processes, e.g. the financial flow, customer relationship management or information sharing should be addressed as well. Another limitation is the investigation of the cost and benefit perspective. In the case study, only one efficiency measurement, i.e. time, was applied for evaluating the different process types. To provide a stronger argument, further measures need to be included in an empirical observation. Finally, it is necessary to identify firm-specific conditions that may affect the appropriateness of the used IOS applications.

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