Inf Technol Manag (2012) 13:69–90
DOI 10.1007/s10799-012-0118-9

Impact of an ERP system's capabilities upon the realisation of its business value: a resource-based perspective

Sylvestre Uwizeyemungu · Louis Raymond

Published online: 8 April 2012

Abstract Using the resource-based view as a frame of reference, this study seeks to explore the potential link between the essential characteristics of an ERP system, defined as ERP capabilities, and its contribution to organisational performance. This contribution is conceptualised and measured through the value added by automational, informational and transformational effects of ERP capabilities upon the firm's operational and managerial processes. Empirical data were obtained for the study's purpose from three case studies of manufacturing firms, through 25 in-depth interviews of various managers, including the firm's CIO. In addition to proposing an instrument to characterise an ERP system "as installed" in terms of three capabilities (ERP integration, ERP flexibility, ERP transversality), the study confirms that these capabilities are crucial in determining the contribution of an ERP system to organisational performance. The study also highlights different ERP effects on organisational processes and their relative importance in providing business value. While exploratory in nature, this study derives interesting implications from the data analysis in the form of propositions that may serve as research hypotheses in future studies.

S. Uwizeyemungu
Institut de recherche sur les PME, Université du Québec à Trois-Rivières, Trois-Rivières, QC, Canada
e-mail: sylvestre.uwizeyemungu@uqtr.ca

L. Raymond (✉)
Département des sciences de la gestion, Université du Québec à Trois-Rivières, 3351, boul. des Forges C.P. 500, Trois-Rivières, QC G9A 5H7, Canada
e-mail: louis.raymond@uqtr.ca

Keywords ERP capability · ERP integration · ERP flexibility · ERP transversality · IT business value · Organisational performance

1 Introduction

One can find both in the academic and in the professional literature numerous studies on the impact of IT in general, and of ERP systems in particular. While there seems to be no doubt as to the positive impact of IT at the macroeconomic level, relationships and causal links are much less clear at a more microeconomic level (enterprise-level, organisational unit-level, process-level) [65]. At this last level however, even the mitigated results of IT impact studies clearly point the way to the further research that is needed. Now, the relevant issue is not whether IT contributes to the organisational performance of the firms that adopt and implement such technologies, but rather why certain firms benefit from these technologies whereas others do not (cf. [16]. In other words, it has become essential for researchers to identify the antecedents of *IT business value*.

In the specific case of ERP systems, it is obviously important to know why certain implementations are more successful than others [41]. Or more precisely, it is important to know under what conditions ERP systems contribute to organisational performance, given that "IT creates value under certain conditions" [62, p. 26]. In this perspective, one could for instance study the eventual links between the characteristics of the installed ERP system and the organisational performance that derives from it. With ERP systems, the range of possibilities as to the combination of modules, the configuration of system parameters and the reengineering of business processes is so wide that

it is possible for a given organisation to transform a resource that is more and more common and accessible to all, into an asset that is more or less unique and hard to imitate. This feature thus renders ERP systems particularly approachable from a "resource-based" perspective [47].

Using the resource-based view (RBV) as a frame of [6, 115] and three case studies, this research seeks to explore the potential link between the specific capabilities of an ERP system and the contribution of these capabilities to organisational performance. More specifically, this study pursues a threefold objective. First, it seeks to find out how ERP capabilities can be measured in the context of adopting organisations (ERP "as installed"). Second, it aims to determine the different effects of ERP on organisational processes and the relative importance of these effects. Third, it seeks to explore the potential causal links between different ERP capabilities and different ERP effects on one hand, and ERP capabilities and the realization of ERP potential (ERP "business value") on the other hand. Determining the essential ERP capabilities that are associated to an improved performance should provide guidance to firms in the choices that must be made throughout the ERP system implementation process.

2 Theoretical context

In this section, we introduce the notions of "IT resources" and "IT capabilities" from the resource-based view (RBV). We focus in particular on the relationship established in the IS literature between IT capabilities and competitive advantage on one hand, and between IT capabilities and organisational performance or "IT business value" on the other hand. Considering ERP capabilities as a subset of IT capabilities, we then position ERP in relation to the RBV to show that the characteristics of an ERP system make it an interesting and relevant object of study from this theoretical perspective. We thus analyze the passage from a "generic" ERP system, that is, a homogeneous and mobile resource, to the ERP system "as installed" that is appropriated by the firm so as to transform this system into a heterogeneous and immobile resource.

2.1 IT resources and IT capabilities from the resource-based view

The resource-based theory (generally referred to as the resource-based view—RBV), whose origins can be found in Penrose's [88] work, has grown in recognition since the nineties [115] and is extensively used in IS research. In this view, the firm's strategic success depends upon the combination of unique resources and competencies that it assembles internally. Thus, from the RBV's perspective, the contribution of IT to the attainment of a competitive advantage does not so much lie with information technologies as such, but much more with the firm's IT organisation and management processes [76]. If a firm can combine IT resources so as to create a unique IT capability, superior organisational performance should occur [11].

IT resources refer to a set of means, in human, material and immaterial terms, that an organisation endows itself with regard to IT, whereas the firm's *IT capability* can be defined as "its ability to mobilize and deploy IT-based resources in combination or co-present with other resources and capabilities" [11, p. 117]. The essential distinction to remember here is that "while resources can be easily duplicated, a unique set of capabilities mobilised by a firm cannot be easily duplicated and will result in sustained competitive advantages" [95, p. 128]. While a number of authors distinguish between IT resources and IT capabilities as above [60], in their literature review of the resource-based view in IS research, Wade and Hulland [112] as well as Piccoli and Ives [90] consider IT capabilities to be a subcategory of IT resources, as are *IT assets*. These last authors' definition of IT assets is similar to what others call IT resources, whereas they use this last term in a more generic manner (IT resources = IT assets + IT capabilities). As for Bhatt and Grover [12], IT capabilities cover IT infrastructure, IT business experience, and relationship infrastructure.

2.1.1 IT capabilities and competitive advantage

Prior to being adopted in information systems research and applied to IT, the concept of "capabilities" has been developed and applied in many other contexts. Leonard-Barton [68] examined the history of the concept and applied it to new product development projects. He defined "core" capabilities as "the knowledge set that distinguishes and provides a competitive advantage" (p. 113). Stalk et al. [101] applied the concept in the context of general corporate strategy, and advanced that as more and more firms adopt capabilities-based competition, the specific capabilities a firm chooses to build will matter in creating its competitive advantage. In particular, IT capabilities may be among such specific capabilities.

Now, a number of studies that have used the RBV to evaluate the impact of IT consider competitive advantage as the dependent variable. For instance, Lai et al. [64] measure competitive advantage in terms of cost advantage, service variety advantage and service quality advantage. Their study clearly indicates that "IT capability is a strong facilitator of both service variety advantage and service quality advantage"; it also finds that IT capability helps improve service quality. Other studies explicitly or implicitly use the RBV to evaluate the sustainability of

IT-enabled competitive advantage. From this perspective, Piccoli [89] asserts that IT resources and IT capabilities are among the drivers of response lag, that is, the time it takes competitors to respond in a way that erodes a firm's competitive advantage gained from an IT initiative. The summary result of these prior studies is that IT capabilities contribute to sustained competitive advantage by leveraging other organisational resources so that a firm is able (1) to offer a product/service valued by customers on criteria such as cost, quality and convenience, (2) to render this product/service very distinctive when compared to the competition's offer, and (3) to delay or to complicate imitation by other firms.

2.1.2 IT capabilities and organisational performance

In studies that have used the RBV to investigate information technology's impact, the notion of competitive advantage is often assimilated to the notion of organisational performance or IT business value. For instance, Bhatt and Grover [12] operationalise the competitive advantage construct through two dimensions that explicitly refer to the notion of performance: relative performance with respect to the competitors for the past 3 years, and performance for the past 3 years (profitability, financial performance and sales growth). Melville et al. [80] define IT business value "as the organisational performance impacts of information technology at both the intermediate process level and the organisation-wide level, and comprising both efficiency impacts and competitive impacts" (p. 287). The proximity of the two notions does not mean however that they are similar. It is now recognised that there is a difference between "creating value" and "creating differential value". Indeed, "IT-based value is not the same as IT-based competitive advantage" [62, p. 26]. In other words, IT can be beneficial to the firm in many ways without providing it with a competitive advantage. Competitive advantage can then be seen as one component within the broader notion of organisational performance.

2.2 ERP and the resource-based view

In reviewing previous research on the ERP-organisational performance relationship, three categories of studies emerge. The first category groups studies investigating whether ERP systems affect business performance in its different aspects (e.g. [48, 56, 70, 116]. In the second category, one finds studies on the technological, organizational and environmental antecedents or conditions under which an ERP system contributes to business performance (e.g. [2, 46, 52, 59, 96, 107]). The third category is composed of studies proposing models, frameworks or methods for measuring the contribution of an ERP system to organisational performance [22, 25, 26, 27, 51, 79, 110]. Hence the present study pertains to the second group, as it uses the RBV as a frame of reference to understand the extent to which different ERP capabilities contribute to organisational performance.

One finds in the literature a few studies that have looked at ERP from the resource-based perspective. Beard and Sumner [7] have used the RBV to ascertain whether an ERP system can provide an organisation with a sustained competitive advantage, whereas He [47] used this theoretical perspective to assess major ERP challenges and opportunities in China, and to identify obstacles to the attainment of a competitive advantage from ERP. And in Kalling's [58] study, the RBV was used to describe the processes that firms and managers go through in their quest to create and sustain a competitive advantage based on ERP. Whereas for Lengnick-Hall et al. [67], the claim that ERP is extremely useful in leveraging the firm's other resources and enhancing its competitiveness was seen to be an overstatement. In referring to the RBV, Laframboise and Reyes [63] found that the influence of ERP systems on competitive advantage and organisational performance is only indirect, that is, through interactions with other resources. Stratman [103] found that a firm's strategic focus influences, through its portfolio of competencies and available resources, the ERP implementation objectives and eventually the benefits realised from ERP. The installed ERP system is thus seen to reflect, to some extent, the strategic vision of the firm's management team.

2.2.1 Generic versus installed ERP system

The generic functionality that characterises ERP systems [93] supposes that they are designed to be used in diversified contexts (different processes, functions and industries). However, the configurability or customising of the system allows the firm to adapt it to its own usage context, in other words to self-appropriate it. Moreover, depending upon the choice made by the firm of either adapting the system or adapting its processes, it will end up with an implemented ERP system that may be quite different from the generic system it started with. It is this system that can be qualified as an implemented or "as installed" ERP as opposed to a pre-configured (for a given industry or type of enterprise) or generic ERP [61]. Thus, two firms that have acquired the same ERP product from the same supplier may wind up in the end with two very different systems. It thus becomes necessary to characterise an implemented ERP system, as the system's particular design and characteristics can determine its contribution to organisational performance. And in order to characterise an ERP system as installed, one can use the notions of IT resources and IT capabilities that originate in the resource-based view of the firm.

2.2.2 An ERP system as a homogeneous and mobile resource

In 2003, Carr published a provocative article in the Harvard Business Review under the title "IT doesn't matter", advancing that IT has become a simple commodity such as electricity. Being presently accessible to all firms, IT would not have any strategic value as the only significant advantage to be obtained from such a widely-used technology would be a cost advantage [19]. For this author, even the attempts at customisation of IT are doomed to fail, as the benefits obtained would be rapidly overshadowed by the costs of operation and of isolation (lack of inter-connectedness and lack of inter-operativeness). Also, IT applications are easily replicable, leading to a rapid economic obsolescence of made-to-measure applications.

The observations formulated by Carr [19] seem to apply well to ERP systems. An ERP system is a software package available from a supplier. Any firm, albeit with sufficient financial means, can implement such a system. In theory, the firm could not even count on an ingenious application of the technology to distinguish itself because even its use is standardised and incorporated into the infrastructure: by adopting an ERP system with the "best practices" that are embedded in it, the firm is seen to equal the leading enterprises in its sector or industry. Moreover, customisation of ERP appears to be very risky [87], and requires very special capabilities [72]. As customisation is also very time-consuming and costly, and deprives the firm of upgrades to the standard product, it is not surprising that many propose a "vanilla" approach to ERP implementation [86].

In the RBV, three conditions are required for a resource to be at the source of a sustained competitive advantage [76, 82]: (1) the resource must be valued by customers, which provides an advantage to the firm; (2) it must be heterogeneously distributed, which then provides a competitive advantage, and (3) the resource must be immobile, or more precisely, imperfectly mobile for this advantage to be sustainable. The resource's immobility implies that firms without this resource will have difficulty or incur disadvantages in developing, acquiring or using it. Imperfect mobility (versatility) means that the firm which disposes of the resource can use it for itself in other markets.

At first glance, an ERP system does not seem to satisfy the conditions of heterogeneity and immobility. Under these conditions, if one refers to the resource-based model of competitive advantage developed by Mata et al. [76], an ERP system would only offer a position of competitive parity to the firm that adopts it. In this line of thought, Beard and Sumner [7] concluded following a literature review on ERP that due to the "common systems" approach used for the implementation of most ERP systems, these systems do not offer a sustainable competitive advantage and that in the best of cases, they can only offer a temporary advantage.

2.2.3 Appropriation of a generic ERP system

Does a standardised offer place all firms on an equal footing with regard to the exploitation of ERP systems? Following the RBV, firms can start from more or less homogeneous bases, and sufficiently differentiate themselves *ex post* to the point where they cannot imitate one another [115]. With regard to IT, "even if companies share infrastructure and common application, they will not necessarily end up with identical systems or use them in similar ways" [45, p. 14]. The RBV thus suggests searching for the source of a sustained competitive advantage not in the information technologies themselves but rather in the firm's IT organisation and management processes [76].

But would the adoption of "best practices" smooth things out in this regard? The appearance of such practices is considered by industry leaders and proactive firms as a signal for the competition to establish new standards [102]. Moreover, the value of IT will derive much more from the strategic alignment of these technologies with other organisational factors [9], especially in the case of ERP [104]. Hence IT can be used to enhance other resources of the firm in order to provide a unique offer to customers [58].

The preceding considerations allow the firm adopting an ERP system to fulfil the heterogeneity condition. We now turn to the immobility condition. This last condition is fulfilled when the firm that has developed a resource/capability is advantaged either by the role of history, by causal ambiguity, or by social complexity [76]. In the first case, the firm has benefited from particular circumstances that will not be renewed for competitors, or the development can be done only over a long period of time. In the second case, either the development of resources and capabilities is not sufficiently clear (tacit attributes, invisible assets), or it derives from a large number of "small"—rather than a few "big"—decisions and/or actions which complicates the task of eventual imitators. In the third case, the more socially complex are the resources/capabilities, the more difficult they are to imitate or to acquire.

Managerial IT skills can provide the firm with a sustainable competitive advantage to the extent that these skills reflect the organisation's particular evolution, are part of taken-for-granted organisational routines, and are based on socially complex relationships within the IT function and between this function and other organisational functions, and between the firm and its customers and suppliers [76]. In the specific case of ERP, the more a firm has developed its managerial IT skills, the more its installed ERP system will be distinctive and will be hard for

competitors to copy. Such a firm will thus have succeeded in transforming a resource that was initially generic, hence homogeneous and mobile, into a heterogeneous and immobile resource.

2.3 Research model

As found in the literature, ERP impact evaluation models can be regrouped under four categories: causal models, contingency models, process models, and scorecard models. Causal models (e.g. [2, 48, 49, 56, 98]), also known as variance models, attempt to establish a cause-effect relationship between ERP investments, ERP characteristics or aspects of the ERP implementation process on one hand, and organizational performance on the other hand. In contingency models (e.g. [42, 59, 70, 91]), it is assumed that the impact of ERP on organizational performance depends not on ERP as such but rather on the alignment or "fit" of ERP with other dimensions of the organization such as its strategy, structure, and business processes. Process models (e.g. [116]) conceptualize the contribution of ERP to performance through a temporal series of interlinked effects. This process is then one of converting the potential value of ERP into realized value for the enterprise [30]. Scorecard models highlight the multiple dimensions of performance, and their use to evaluate the impacts of ERP systems (e.g. [20, 22, 79, 111]) seems well-indicated, given that these systems are deemed to affect the organization in many different ways.

Prior studies based on the RBV have generally sought to identify a direct causal link between IT resources and capabilities on one hand, and organisational performance on the other hand [11, 60, 95], thus favouring the use of causal models. In this study, we rather put forward a process model, that is, rather than directly linking ERP capabilities to performance, an intermediate step will be taken, surmising that it is through their automational, informational and transformational effects upon operational and managerial processes [84] that ERP capabilities provide added value to the firm (ERP business value).

As for ERP business value, one will speak here of "ERP potential realised" instead of organisational performance because organisational performance is affected by a multitude of factors other than ERP systems. Hence a variation in performance cannot be solely attributed to an ERP system. But as such systems are indeed adopted by firms for their potential impact upon organisational performance, one could evaluate the extent to which an ERP system has provided business value, and if it was possible to estimate this potential on one hand and to ascertain the level of realisation of this potential on the other hand. As presented in Fig. 1, the research model echoes the preceding considerations by relating the firm's ERP capabilities to its ERP potential realised through automational, informational and transformational effects on its business processes.

2.3.1 ERP capabilities

In order to determine which measures would be relevant for ERP capabilities, previous studies of three types were considered: (1) studies that applied DeLone and McLean's model to ERP systems, (2) studies using the RBV to determine IT capabilities, and (3) studies highlighting the distinctive characteristics of ERP systems when compared to other IT systems.

DeLone and McLean's [33, 34] model of IS success has been extensively used to assess IT effectiveness. It has been also well used to assess ERP value or to investigate ERP success [10, 24, 53, 108, 114, 119]. The system quality dimension of the model refers to the technical level and thus "focus on the desired characteristics of the information system itself which produces the information" [33, p. 62]. It is thus the one that corresponds to IT capabilities. DeLone and McLean [33] had identified 18 measures of system quality from prior IS empirical studies, but all the studies that followed and applied these authors' model to ERP success assessment selected only a few measures deemed appropriate to ERP systems. Ifinedo and Nahar [53] used 11 measures (including eight from DeLone and McLean's model: data accuracy, ease of use, ease of learning, realization of user requirements, system flexibility, system reliability, integration of systems, and system efficiency). The studies done by Tsai et al. [108] and Zhang et al. [119] each applied five measures (data accuracy, data currency, database contents, system accuracy and response time for the first, and ease of use, usefulness of system features and functions, system flexibility, system reliability and response time for the second), while Chien and Tsaur [24] retained three measures (data currency or up-to-date

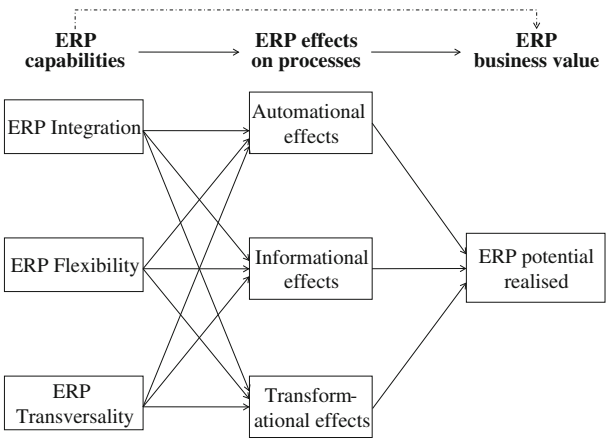

Fig. 1 Research model

information, system accuracy, and response time). It is worth noting that later on, presenting a ten-year update of their model, DeLone and McLean [34] themselves retained only five measures of system quality for measuring e-commerce system success (adaptability, availability, reliability, response time, and usability).

The previous studies that applied the RBV denoted the importance of the IT capability concept, and some of these attempted to operationalise this concept [12, 60, 65, 105, 118]. Santhanam and Hartono [95, p. 125] have indicated that "it is critical to develop theoretically derived multi-dimensional measures of IT capability in order to continue to apply the RBV approach to assess the impact of IT investments on firm performance". Some of the previous studies used the rankings of IT-leader firms published by Information Week as a proxy for IT capability [11, 95, 113] while others have developed alternative measures. For instance, Bhatt and Grover [12] conceptualise IT capabilities under three dimensions: IT infrastructure, IT business experience and relationship infrastructure. Langdon [65] has excluded the human element, studying two dimensions of IS "architecture" capabilities, namely IS integration and IS flexibility. Karimi et al. [60] define ERP capabilities in terms of ERP functional, organisational and geographical scope, comparable to the notion of vertical, horizontal and interorganisational integration used in the present study. For Zhang and Tansuhaj [118], there are four dimensions that include both IT capabilities and IT resources, namely IT architecture, IT infrastructure, IT human resources and IT relationship resources, whereas for Tallon [105], IT capabilities are classified into two dimensions, namely managerial IT capabilities and technical IT capabilities.

Of the previously cited studies, only Karimi et al. [60] have specifically referred to ERP capabilities. There exist, however, certain characteristics that distinguish ERP systems from other conventional information systems. In analyzing the increasingly voluminous ERP literature, we found at least nine characteristics that were regrouped in three main categories, in regards to their nature [109]: technical, organisational and informational characteristics. The technical category regroups characteristics that refer to the capabilities or facilities for applications development offered by ERP in comparison to traditional IT. This includes flexibility [46, 69, 93] and openness [69, 93]. The organisational category refers to the system's deployment in the firm, and includes: integration [5, 8, 31, 39, 55, 71], completeness (generic function) and homogenization [15, 32, 93], transversality or cross-functionality [18, 38], characteristic that corresponds to the process-oriented view [40, 77], and adoption of best practices [28, 75, 99]. The informational category regroups characteristics that relate to the quality and usefulness of the information provided by ERP, namely real-time information [32, 85] and simulation of actual business processes [93]. In an attempt to identify among these characteristics those that are most significant and common, we analyzed them in light of their definitions in the ERP literature, keeping some on the basis of their discriminating power and discarding others found to be redundant or less important. This discussion led us to limit essential characteristics to three, namely ERP integration, ERP flexibility and ERP transversality, under the assumption that these are the minimal requirements for a system to be qualified as an ERP. The ERP capabilities retained are measured with 22 dimensions (3 for integration, 10 for flexibility, and 9 for transversality). The operational definitions of these dimensions of the ERP capability construct are presented in "Appendix 1". If one compares the 18 measures of system quality in DeLone and McLean's model against the 22 dimensions of the ERP capability construct we propose as a result of the above-mentioned analysis, one would notice some similar or closely-related measures (such as data accuracy/data transparency, system efficiency/efficiency, system sophistication/robustness, system flexibility/variety dimension, realization of user requirements/customer focus, etc.) and some that are rather unique to ERP systems (standardization, holistic view, vertical–horizontal—interorganisational integration, etc.).

2.3.2 *ERP effects*

In the IS literature, the effects (or benefits) of IT have been implicitly or explicitly classified by their degree of tangibility [43], the organisational level at which they are felt [14, 54, 83, 97], or by the nature itself of such effects [84].

In this study, Mooney et al.'s [84, p. 21] classification and definitions were adopted. This classification originates from Zuboff's [120] well-recognised "automate/informate" definition of the role of IT. Now, this classification is generic for all IT and can thus be applied to IT subsets, and notably to ERP systems. Moreover, in their study of ERP capability building and business outcomes, Karimi et al. [60] have used this same classification. One can also establish a correspondence between Mooney et al.'s [84] classification and other classifications based on the organisational level of IT effects [14, 54, 83]: the automational effects essentially correspond to the transactional (or operational) benefits, the informational effects to the tactical (or intermediate) benefits, and the transformational effects to the strategic (or business-level) benefits. For Mooney et al. [84, p. 12], "automational effects refer to the efficiency perspective of value deriving from the role of IT as a capital asset being substituted for labor". As for informational effects, they "emerge primarily from the capacity of IT to collect, store, process, and disseminate information". Finally, transformational effects "refer to the

value deriving from the ability of IT to facilitate and support process innovation and transformation".

2.3.3 Realisation of ERP potential

If one refers to process models of IT business value such as Soh and Markus' [100] model for instance, the use of IT assets produces IT effects that in turn affect organisational performance. It thus becomes important, from a prescriptive point of view, to link the ERP effects identified to operational (local) and organisational (global) performance indicators (PIs). The PIs considered here will be the ones that are actually and habitually used by managers, rather than generic PIs chosen a priori by the researchers that would have less significance for managers. This being said, to determine the ERP potential realised, a three-step process would be necessary: (1) find a way to measure the impact of the firm's ERP capabilities on organisational performance under actual usage conditions, (2) find a way to measure what should be the impact of the firm's ERP capabilities upon organisational performance under ideal usage conditions, that is, the implementation and usage conditions that would allow the ERP system to achieve its full potential, and (3) by comparing the two preceding measures, the first one as a numerator and the second as a denominator, the degree of realisation of ERP potential would be obtained.

3 Research method: positivist multiple case study

The present research is designed as a positivist multiple case study, this method being suitable for exploration and hypothesis generation [35]. We studied three cases, and following Yin's [117, pp. 78–81] prescriptions, a first case, namely the pilot case, was studied in depth and insights gained from this first case were used to better structure the two subsequent cases. Case studies in general are appropriate to the analysis of a contemporary phenomenon within its actual context, notably when the demarcation between the phenomenon and its context cannot be clearly established (Yin, *op. cit.*, p. 13). This is most often the case for the study of organisational IS effectiveness in general [1], and of ERP system effectiveness in particular.

3.1 Choice of the cases

The theoretical sampling procedure [37, 117, pp. 46–53] rests upon the two principles of literal replication and theoretical replication. Literal replication aims for similarity or homogeneity of the cases with regard to the object of study so that the sample satisfies the theoretical representativeness criterion [50, p. 82]. Theoretical replication aims for variety in the cases with regard to certain elements of their organisational context so that divergence in the results may be analyzed.

With regard to similarity, three criteria guided the selection of the cases: (a) the firm should be in manufacturing, (b) it must have been using an ERP system for at least 2 years, and (c) it must have been using the system in at least two of its core business processes, including the "deliver products and services" process as defined in the process classification of the American Productivity and Quality Center [3, 4].

As ERP adoption began in manufacturing, it would seem that the systems developed for this sector would be more mature than those proposed for the service and public sectors. Consequently, cases in the manufacturing sector generally provide richer data, and thus increase the potential for discovery [50, p. 82]. The two-year minimum length of use criterion allowed us to exclude organisations that did not have sufficient hindsight with regard to their system, or those that were still at the project stage. Recent studies have in fact concluded that there is a period of approximately 2 years between the time of ERP adoption and the realisation of benefits from the system [116]. As for the third criterion, it seemed important that the ERP system occupy a key role in the management of the studied firms, i.e., that it be related to the production process critical in manufacturing. The use of the ERP system was not to be confined to one process however, and its use in another key process increases the opportunity to observe the system's integration effects [8].

The first three business enterprises contacted that conformed to the preceding criteria and were willing to participate in the research were chosen. They are named Alpha (pilot case), Beta and Gamma in this study, that is, fictitious names used to preserve their anonymity as wished by these enterprises. As observed in Tables 1 and 2, while they satisfy the similarity criterion as defined previously, the selected cases also satisfy the variety criterion for certain contextual elements. Indeed, the three cases differ in terms of organisational characteristics (e.g., company size, strategic challenges) and of their ERP implementation (e.g., ERP system, ERP investment, implementation process). This variety is necessary to allow for a fruitful cross-case analysis.

3.2 Data collection and analysis

Data collection, mainly through semi-structured interviews, was made over a period of 20 months. There were 13 interviews with 9 individuals at Alpha (pilot case) for a total of 12 h, 6 interviews with 3 individuals at Beta for a total of 8 h, and 6 interviews with 4 individuals at Gamma for a total of 7.5 h. The interviews aimed essentially at

Table 1 Comparison of the organisational characteristics of the three cases

Organisational characteristic	Alpha	Beta	Gamma
Organisational size number of employees	300–350	60	600
Annual sales	54 M $ (CAD)	10.5 M $ (CAD)	280-300 M $ (CAD)
Sector of activity (products)	Door windows, PVC doors	Furniture (chairs and tables)	Lumber, floor-boards, plywood, embossed panels
Market	Multinationals specialised in construction Canadian market and export to USA	Furniture wholesalers (large prime contractors) Canadian market	Multinationals specialised in construction Canadian market and export to USA
Main challenges of the production system	Optimisation of the supply system	Optimisation of the supply system	Optimisation of production planning and control process
Major strategic challenges	Competition from multinational firms Competition from emerging countries Exchange rate	Raw materials waste Competition from emerging countries	Declining prices Raw materials supply Attraction and retention of HR
Main strategic orientations	Differentiation Continuous improvement	Differentiation Continuous improvement	Market diversification Rationalisation Modernisation

collecting data in a systematic manner on the effects of ERP in the three firms and on the impacts of these effects upon the firms' performance indicators.

For those individuals who were interviewed twice, the second interview was always held after analyzing the data obtained from the first interview. For the others, cross-verifications were done and when apparent contradictions emerged, further clarification was obtained either by telephone or email. Moreover, Alpha provided us with rich documentation on the decision process that led to the adoption of the ERP system, and on the system/supplier adoption and selection process. As the production process is at the core of this study, a guided tour of the plant in each case allowed us to better understand the explanations provided on this process, and especially the use made of the ERP system within it.

To analyze the collected data, document summary forms, interview recordings and interview notes were used, as well as notes taken during the guided tours of the plans. The transcriptions of the recorded interviews (and other data in electronic form) were processed with the Atlas.ti qualitative data analysis software, whose development follows the principles of grounded theory-based research. Open coding of the data was used, with predefined codes based on the literature and corresponding to the principal categories included in the evaluation model. The coding system was refined however during the analysis, allowing for a further breakdown of these categories, notably with regard to ERP effects. The three cases were first analyzed individually, before proceeding to a cross-case analysis.

Given the lack of valid pre-existing instruments to measure the essential characteristics of an installed ERP system, "indigenous" scales were developed for the purposes of this study [60, p. 233]. This was done on the basis of the various characterisations, dimensions and definitions of integration, flexibility and transversality found in the work of Duncan [36], Byrd and Turner [17], Forsberg et al. [40] and Golden and Powell [44], thus insuring the content validity of the measurement instrument. Following its development, this instrument was further refined by pretesting it in a large manufacturing firm[1] that had been using an ERP system since 1997.

3.3 Methodological rigour of the positivist multiple case study

In addition to the content validity of the measurement instrument, the methodological quality of the positivist multiple case study may also be judged in terms of construct validity, internal validity, external validity, and reliability [117, p.34]. Following the guidelines from the literature, construct validity was met essentially by establishing a chain of evidence, and by having key respondents review and confirm the results of the data analysis. This validation of the results by the informants along with the triangulation of collection methods and sources strengthen internal validity. External validity was increased in three ways, that is, by a rich description of each case, by confronting results to existing theories, and by the use of a

[1] The firm in question is not one of the three cases studied.

Table 2 Cross-case comparison of ERP systems installed

ERP implementation	Alpha	Beta	Gamma
Year of ERP adoption ("go-live")	2004	2000	1997
Previous ERP experience	Yes (with FDM since 1995)	No	No
ERP system adopted	Oracle	Orchestra for SMEs	ScoopSoft
ERP system provider	Oracle Corporation	Concepts Industriels 2000	Bell solutions d'Affaires
Initial ERP investment	2 M $ (CAD)	75 000 $ (CAD)	250 000 $ (CAD)
Project manager	VP finance	CEO	IT manager
Project team	9–13 members	6 members	Undetermined
External intervention in the implementation process	Consultant (project study and selection)	ERP system provider (implementation and *post*-implementation)	ERP system provider (implementation)
	ERP system provider (implementation)		Consultants (business intelligence)
Implantation duration (1st implementation)	2 years	6 months	1 year
Basis for ERP system selection	Preliminary study	Proposal from the ERP system provider	ERP system implemented by competitors
Number of sites	One site	Two sites	Multi-site (8)
Implementation strategy	"Big bang"	By stages (by module and by site)	By stages (by module)
Main modules	Accounting	Accounting (general ledger, payroll, cost accounting)	Accounting
	Financial reports	Production planning and scheduling (for tables only)	Reports
	Manufacturing process management	Bar-coding	Production management
	Logistics (purchasing MRP, shipping)	MRP	Transportation and logistics
	Bar-coding	Sales forecasting (not yet used)	Inventory management ("y-board")
	Inventory management		Project management
	SCM		Sales (incl. customer portal)
	Sales management and marketing		Business intelligence
Elements kept from the legacy system	Business intelligence (Cognos)	None	Not applicable
	Intranet portal		
Other systems adopted	None	None	Business intelligence (BI) system

generic approach in the three cases. Reliability refers to "the extent to which an instrument produces consistent or error-free results" [13, p. 5]. As it is frequently recommended for case studies [35, 81, 117], to ensure reliability, an interview guide, a case documentation, and a data analysis protocol were elaborated.

4 Results

4.1 Presentation of the cases studied

A comparative description of the global organisational context of the three firms studied is presented in Table 1. The pilot case is a medium-sized enterprise (Alpha with 300–350 employees and a turnover of 54 million $ CAD), one is a small enterprise (Beta with 60 employees and a turnover of 10.5 million), and another is a large enterprise (Gamma with 600 employees and a turnover of approximately 300 million). It is important here to take the firm's size into account. Indeed, different studies have shown the moderating role of the organization's size on the IT-performance relationship [57, 66, 73, 94].

A comparison of the three cases with regard to the implementation of the ERP system is presented in Table 2. These aspects provide the necessary context to the evaluation of ERP effects and their links to operational and organisational performance.

4.2 Characterisation of the ERP systems as installed

4.2.1 Integration of the installed ERP systems

Integration was measured by the importance of information, data and document exchanges that are made through the ERP system between hierarchical levels (vertical integration), between units (horizontal integration), and between the organisation and its business partners (interorganisational integration). A 0–5 scale was used, where 0 means there is no exchange via the system, and 1–5 mean very weak (0–20 %) to very strong (80–100 %) exchanges.

The level of vertical integration at Alpha is weak, that is, 2.3 on a 0–5 scale. Horizontal integration is also weak at 0.4, which means that the ERP system has not provided 'functional interconnection' [93]. Interorganisational integration is strong however (3.8), this being explained essentially by Alpha's membership in a network with strong ties.

Beta's vertical and horizontal integration levels are relatively weak at 2.3 and 2.7 respectively. Whereas there is no interorganisational integration whatsoever. The firm has experimented with a transactional Web site, notably for order entry but encountered customer resistance as the latter preferred using their own ordering systems. And Beta has established no links with its suppliers through the ERP system.

Gamma's ERP system has a very weak level of vertical integration (1.7), whereas horizontal integration is weak (2.0) and interorganisational integration is almost nonexistent (0.8). There is however a strong level of horizontal integration between certain functions, notable between production and finance (4.0), production and sales (4.0), and finance and sales (4.0). In fact, only the HRM function has no interconnection with other functions through the ERP system.

The preceding data on ERP integration are summarised in Table 3 for comparison purposes. One first sees that vertical integration is similar for Alpha and Beta whereas it is weaker for Gamma. Secondly, Beta shows a higher level of horizontal integration than Alpha and Gamma. And Alpha presents a quite higher level of interorganisational integration than the other two firms. Finally, the global integration levels are 2.3 for Alpha, 1.7 for Beta and 1.5 for Gamma.

Table 3 Comparison of the integration of the installed ERP systems

	Alpha	Beta	Gamma
Vertical integration level (0–5)	2.3	2.3	1.7
Horizontal integration level (0–5)	0.7	2.7	2
Interorganisational integration level (0–5)	3.8	0	0.8
ERP system integration level (0–5)	2.3	1.7	1.5

4.2.2 Flexibility of the installed ERP systems

The flexibility of an ERP system is evaluated on four dimensions through ten measures: the temporal dimension (efficiency and sensitiveness), variety (versatility and robustness), modularity (applications functionality and data transparency) and the human dimension (technology management, business skills, managerial knowledge and technical knowledge). These dimensions and measures were developed on the basis of previous work done by Byrd and Turner [17] and by Golden and Powell [44]. The global measure in each firm corresponds on a 5-point scale to $\Sigma m_i/10$, where m_i represents one of ten scales on which flexibility is evaluated. This measure of ERP flexibility is equal 4.2 at Alpha, 3.9 at Beta and 3.9 at Gamma. All three firms are thus quite similar in this regard.

4.2.3 Transversality of the installed ERP systems

The transversality of an ERP system was evaluated through 5-point Likert scales on which the respondent indicated his or her level of agreement (1: totally disagree, 5: totally agree). These scales were formulated in order to account for the "process" orientation of an ERP system, using prior work on this orientation done by Forsberg et al. [40] and by McCormack and Johnson [78]. Note that in Gamma's case, transversality is measured in two ways, that is, by including, or not, a business intelligence (BI) system that is linked to the ERP system.[2] The global measure of transversality for each firm corresponds on a 5-point scale to $\Sigma m_i/9$, where m_i represents one of nine scales on which transversality is evaluated.

The level of transversality of Alpha's ERP system is equal to 3.2, whereas it is 4.0 at Beta and 3.6 at Gamma. In the last case, the level of transversality drops down to 2.4 if one excludes the BI system. One can surmise that as the ERP-SCM conjunction is more beneficial than an ERP system alone [116], the ERP-BI conjunction would have the same effect in that it would enhance the firm's process orientation.

4.3 ERP effects and performance indicators

It is important to note at the outset that in the three cases, very few of the ERP effects studied could be taken for the

[2] The conjunction of both systems in Gamma's case is based on their mutual dependence, the BI system needing the ERP system to provide it with input data, whereas the ERP system needs the BI system to provide meaning to its information output.

usual indicators of operational or organisational performance. In other words, it is rare that an ERP effect is at the same time a performance indicator (PI) used by the firm to evaluate and control its activities. For example, in Alpha's case, managers indicate an ERP effect to be the "standardisation of information", whereas this effect does not constitute one of Alpha's usual performance indicators (PIs). Hence it is necessary to relate such effects to the indicators affected by them in one form or another. Appendix 2 exemplifies this relation for Alpha. The measure developed here takes into account the importance of the PI (a_i) (from 1 = unimportant to 5 = very important), and the extent to which a variation in the PI is attributable to the ERP effect (b_i) (none [0], weak [1], average [2], strong [3], with a minus sign if the variation is negative).

The ERP effects were identified through the interviews; managers responsible for the various sub-processes were asked to describe the changes brought about by the ERP system. Respondents were then asked to estimate the impact of each of the ERP effects identified on each of the performance indicators they use to evaluate and control their activities. Thus, one (a_i*b_i) product is obtained for each (ERP effect—PI) couple. The global score is obtained by summing the (a_i*b_i) products. As there are 43 (ERP effect—PI) couples for Alpha, 27 for Beta and 68 for Gamma, one obtains the following scores: $\Sigma_{i=1,43}$ (a_i*b_i) = 287 for Alpha, $\Sigma_{i=1,27}$ (a_i*b_i) = 165 for Beta, and $\Sigma_{i=1,68}$ (a_i*b_i) = 729 for Gamma.

How should one interpret such results? Ideally, one would expect positive ERP effects to have a strong impact upon each PI to which it is associated: the value of B (ideal b), should be 3. For negative effects, one would ideally expect them to have no impact upon the PIs: the value of B should be 0. By maintaining the a_i values unchanged and by replacing all b_i values by B_i (3 = strong variation for positive effects, 0 = no variation for negative effects), one will obtain what could be called the "system's impact potential" that will serve as a basis for comparison.

In a general formula, one will obtain for a given enterprise a score of $\Sigma_{i=1,n}$ (a_i*b_i) that will be compared to the maximum score possible for this same enterprise, that is $\Sigma_{i=1,n}$ (a_i*B_i) where i = numeric order of the (ERP effect—PI) couple; n = total number of (ERP effect—PI) couples; a_i = importance of the PI (1: unimportant, 2, 3, 4, 5: very important); b_i = variation in the PI attributed to the ERP effect (0: none, 1, 2, 3: strong, with a *minus* sign if the variation is negative); B_i = ideal b_i; if $b_i \geq 0$, $B_i = 3$; if $b_i < 0$, $B_i = 0$.

The calculation of summation $\Sigma_{i=1,n}$ (a_i*B_i) results in a total of 435 for Alpha, 252 for Beta, and 903 for Gamma. One thus obtains a global score of 287/435 for Alpha, 165/252 for Beta and 729/903 for Gamma.

Table 4 Measures of the realisation of an ERP system's potential

		Alpha	Beta	Gamma
(1)	$\Sigma(a_i*b_i)$	287	165	729
(2)	$\Sigma(a_i*B_i)$	435	252	903
(3)	Raw score [(1)/(2)]	287/435	165/252	729/903
(4)	Normalised score [on 5]	3.3	3.3	4.0

To facilitate interpretation, one can transpose the preceding scores to a usual comparison scale by changing the denominator to a more meaningful number such as 5, 10 or 100. Here the scores were transposed to a 5-point scale, naming each level of contribution of the ERP system to organisational performance as follows: very weak [1], weak [2], average [3], important [4], and very important [5]. Table 4 presents the results obtained by applying the procedure outlined above in the three cases studied. Thus Alpha's global score is calculated as: 5*(287/435) = 3.3, an average realisation of its ERP system potential. For Beta, this score will be 5*(165/252) = 3.3, a potential realisation equivalent to Alpha's. For Gamma, it is 5*(729/903) = 4.0, an important potential realisation.

5 Results analysis and propositions

In the following analysis, we will compare the results obtained in the three cases (cross-case analysis). Given the exploratory nature of this study, this analysis will allow us to draw some implications that will be presented in the form of propositions that may serve as research hypotheses in future studies with data from a broad sample of firms.

5.1 Analysis of the relative importance of ERP effects

Very few negative ERP effects were found in the three cases studied. Negative aspects of the ERP project were more related to the adoption costs and implementation difficulties than to the actual impact of the system. This can be illustrated by the following quote from the production director: "The ERP system's implementation phase was really, really turbulent… Late deliveries were at a frequency never seen previously. We believed the worst could happen. But, little by little, with use, we managed to solve problems we thought were insurmountable". The preceding considerations lead to a first research proposition.

Proposition 1 *Once the implementation of an ERP system is achieved, the positive effects of the system outweigh its negative effects.*

We also denote the predominance of informational effects of ERP in all three cases. This predominance is seen

Table 5 Relative importance of ERP effects

Case (size)	ERP effects		
	Automational (%)	Informational (%)	Transformational (%)
Alpha (medium-sized enterprise)	14	81	5
Beta (small enterprise)	4	64	32
Gamma (large enterprise)	3	88	9

not only in the total number of such effects, versus automational or transformational effects (24 for the three cases, versus 12 and 8 respectively), but also in their relative weight in the calculation of the ERP system's impact on organisational performance, as indicated in Table 5.

Using the ratio of the sum of the (a_i*b_i) products for each type of effect over the total effect, informational effects are seen to account for 81 % (232/287) of ERP effects at Alpha, 64 % (105/165) at Beta, and 88 % (642/729) at Gamma. More than the automation or the transformation of business processes, it seems that the impact of the ERP system is felt through the availability and exploitation of information. This is in line with Mabert et al.'s [73, p. 240] finding that "companies reported increased efficiencies in budgeting, financial controls and financial close cycles as a result of the information availability from their ERP system". The following citations taken from the interviews also provide such an impression:

> "… in fact, ERP systems are only tools that help us to obtain measurements and to process these measurements in order to render them more significant" (Alpha's CEO).
> "What makes the system great is its great processing capability, as it takes many parameters into account when suggesting purchase orders" (Alpha's purchasing manager).

Moreover, one notes that automation or transformation decisions are taken on the basis of information produced by the ERP system. For instance, optimisation of the manufacturing sequence (transformational effect) at Beta was decided on the basis of information provided by the system with regard to production defects found in various manufacturing steps (informational effect). As confirmed by Beta's plant manager:

> "With the information provided by the system, we quickly realised that when parts passed through the M-11 equipment (finishing sander) at step 3, we would wind up at the end of the process with parts that were scratched or dented because many manipulations on the equipments were needed and employees would knock the parts with their tools. By placing the sanding operation much later in the process, that is, at step 7, we were able to eliminate many production defects".

One also notes that the relative weight of informational effects are related to organisational size, that is, the bigger the organisation, the greater the relative importance of such effects. Is this due to chance, or due to many other potential factors, or would this mean that an ERP system affects a small enterprise differently than a large enterprise? One could surmise here that communication, coordination and control difficulties that increase with size could render the large enterprise more attuned to the benefits of ERP systems in this regard, that is, in terms of integration, flexibility and cross-functionality. This is what is suggested by the following remark made by Gamma's controller:

> "When we had two or three plants to monitor, things weren't so bad… but when we had eight, it wasn't the same… we had to put things in order. Implementing the [ERP] system really helped a lot."

One would also note that in Beta's case (the smallest firm), significantly more transformational effects (32 %) were observed than for Alpha (5 %) and Gamma (9 %). This may be due to chance, but one can also surmise that the implementation of an enterprise-wide system such as an ERP in a small structure would require relatively more transformations than in a bigger organization. This impression is reinforced by the results of Mabert et al.'s [73] study in which small firms are shown to customise their ERP system less than large firms. By adapting their processes to the ERP software, the former are subject to greater organizational transformations than the latter, as small firms can ill-afford the high costs of customisation in most cases.

The preceding considerations allow us to make three other propositions:

Proposition 2 *The ERP system's impact on organisational performance results more from using the business process information made available by the system than from the automation or transformation of these processes by the system.*

Proposition 3 *The relative weight of ERP informational effects in comparison to automational and transformational*

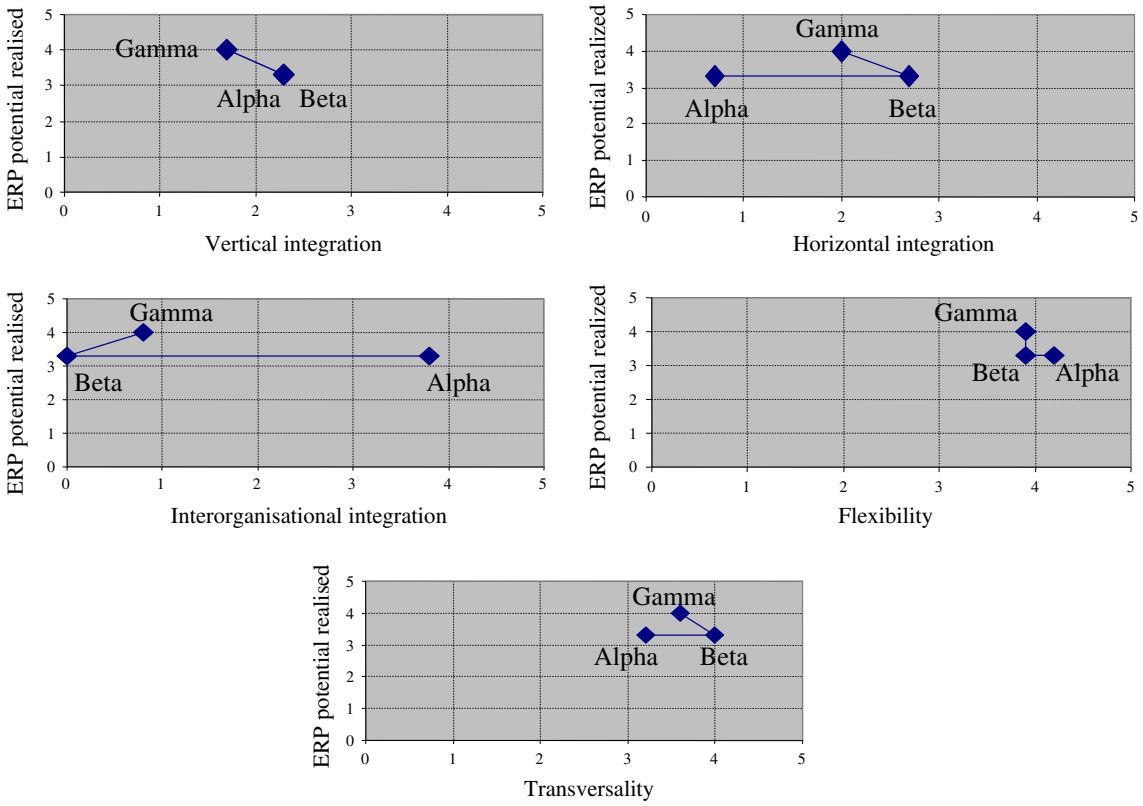

Fig. 2 ERP potential realised in relation to ERP capabilities

effects is directly proportional to the size of the firm, that is, the bigger the firm, the greater the relative importance of ERP informational effects.

Proposition 4 *ERP transformational effects will be more significant in small firms than in large ones.*

5.2 Impact of ERP's capabilities upon the realisation of its business value

The level of realisation of the ERP system's potential impact is 3.3 for Alpha and Beta and 4.0 for Gamma. Note at the outset that ERP business value is the same for Beta, a small firm, as it is for Alpha, a medium-sized firm. And this level is significantly higher than it is for Gamma, a large enterprise.

To the extent that interdependencies between ERP characteristics have been surmised, notably between flexibility and integration [14, 74], it has been proposed to examine the nature of these interdependencies, and to evaluate their impact upon the performance of an ERP system. We can now attempt to determine the levels at which the integration-flexibility-transversality of the ERP system provide a high level of realised business value, that is, the contribution of ERP to organisational performance. Figure 2 illustrates the correspondence between ERP capabilities and ERP business value.

One sees that Gamma, whose vertical ERP integration level is quite lower than Alpha's and Beta's, has realised a much higher proportion of its ERP potential, whereas Alpha and Beta, with similar ERP capabilities in terms of vertical integration, attain a similar level of ERP business value. One could tentatively conclude from this result that the contribution of an ERP system to organisational performance is inversely related to the level of vertical integration induced in the firm by the system. This conclusion is supported by two additional observations that can be made from further analysis of Fig. 2:

- The level of ERP potential that is realised by Alpha and Beta is equivalent even though these two firms are quite different in terms of ERP capabilities other than vertical integration. If one were to consider this last result only, one would think that horizontal integration, interorganisational integration, flexibility and transversality would not be determinant in explaining the attainment of ERP business value.
- While Beta and Gamma show equivalent levels of ERP flexibility, the latter achieves greater business value from its ERP system than the former. One could

suppose here that ERP flexibility is not a determining factor of ERP business value.

The preceding considerations lead us to the next proposition:

Proposition 5 *The contribution of an ERP system to organisational performance is inversely related to the level of vertical integration (subset of ERP integration capabilities) induced in the firm by the system.*

But a more complex explanation is possible, calling upon the optimal levels of integration, flexibility and transversality. Following Hitt et al. [49], there would be an optimal level of functional integration beyond which diseconomies of scale begin. This notion of an optimal level can also be applicable to the other forms of integration and to flexibility and transversality. One could thus surmise that ERP business value is best explained by the attainment of optimal integration, flexibility and transversality levels, given the organisational context, rather than by vertical integration alone. As shown in Fig. 3, one can attempt to identify an optimal configuration of the essential characteristics of an installed ERP system.

One notes that apart from vertical integration where it is surpassed both by Alpha and Beta, Gamma neither dominates nor is dominated simultaneously by the other firms on the four other ERP capabilities. This does note prevent Gamma however from obtaining more business value from its ERP system than the other two enterprises. The variation between Alpha and Beta's ERP capability scores are much greater than for Gamma. This would indicate that a relative equilibrium between levels of integration-flexibility-transversality enables the firm to realise more of its ERP system potential. This leads us to the following proposition:

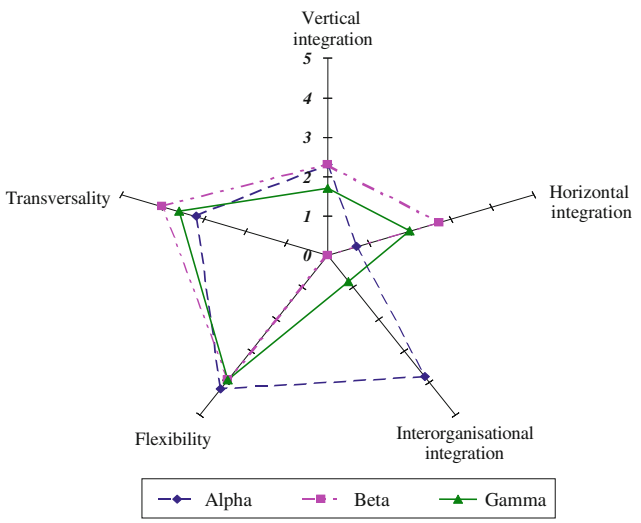

Fig. 3 Cross-case comparison of ERP capabilities

Proposition 6 *The ERP potential realised is greater for the firms that have developed all three ERP capabilities (integration—flexibility—transversality) more or less equally than for the firms that have highly developed only one or two capabilities at the expense of the others.*

Rather than only considering the business value of ERP as a whole, one can also subdivide it into three categories that correspond to the three different types of ERP effects. Thus, returning to Appendix 2, one can calculate for each firm the ERP automational potential realised, the informational potential realised and the transformational potential realised. To do so, one proceeds in the same manner as for the calculation of the global ERP potential realised (see Table 4), by considering for each category the $\Sigma(a_i{*}b_i)$ and $\Sigma(a_i{*}B_i)$ subtotals that correspond to it. As illustrated in Table 6, one can then ascertain in each firm how the three types of ERP capabilities, namely integration, flexibility and transversality, relate to the three types of ERP potential realised, namely automational, informational and transformational.

One first notes that the similarity between Alpha and Beta as their global ERP potential realised (at the 3.3 level) hides notable differences. Whereas Alpha's ERP business value is quite evenly distributed between the automational (2.3), the informational (3.6) and the transformational (2.8), it is less evenly distributed for Beta with a preponderance of the informational (3.8) and transformational (4.0.) at the expense of the automational (0.7). Alpha realises the most informational value from its ERP system whereas it is the transformational value that is most realised by Beta. For Gamma, the ERP informational potential is best realised (4.3), closely followed by transformational potential (4.2) at the expense of the automational potential (1.7).

In searching for an explanation to these differences, one can look to ERP capabilities, measured here by the levels of ERP integration, flexibility and transversality, as determinants of the type and extent of ERP value realised by the firm. Returning to Table 6, one can compare ERP capability levels to ERP value levels, noting immediately that in Alpha and Gamma's case the strongest ERP capability is flexibility and the ERP potential that is best realised is informational in nature. In Beta's case, it is transversality that is the strongest ERP capability, with an ERP potential that is best realised in transformational terms.

A similar analysis for all other ERP capability measures and for all types of ERP business value suggests a correspondence between (a) the level of ERP integration and the realisation of the system's automational potential, (b) the level of ERP flexibility and the realisation of the system's informational potential, and (c) the level of ERP transversality and the realisation of the system's transformational

Table 6 ERP potential realised and ERP capabilities

	Alpha	Beta	Gamma
ERP potential realized by type of effects			
- Automational potential realised	2.3	0.7	1.7
- Informational potential realised	3.6	3.8	4.3
- Transformational potential realised	2.8	4.0	4.2
ERP potential realised (global)	**3.3**	**3.3**	**4.0**
ERP capabilities			
- Integration	2.3	1.7	1.5
- Flexibility	4.2	3.9	3.9
- Transversality	3.2	4.0	3.6 (2.4)*

*For Gamma, the number in parentheses refers to the level of transversality realised when not accounting for the BI system

potential. Thus, when compared to the previous results obtained by a global analysis of the potential value of an ERP system (see Figs. 2,3), more significant results are obtained when this value is analyzed by type. We draw from this analysis a seventh proposition that is broken down into three sub-propositions:

Proposition 7 *The nature and magnitude of ERP value realised by the firm depend on the type of ERP capabilities that it has developed.*

Proposition 7.1 *To realise the ERP system's automational potential, the firm needs to develop ERP integration capabilities.*

Proposition 7.2 *To realise the ERP system's informational potential, the firm needs to develop ERP flexibility capabilities.*

Proposition 7.3 *To realise the ERP system's transformational potential, the firm needs to develop ERP transversality capabilities.*

5.3 Contributions

5.3.1 Contributions to theory

Santhanam and Hartono [95] have stated that in order to continue applying the RBV to IT impact research, it has become necessary to develop measures of IT capabilities. The present study has answered this call by contributing to the measurement of ERP capabilities. As noted by Lai et al. [64, p. 29], "there is no extant measure to explicitly measure IT capability in the literature". Previous studies in which IT capabilities were a central element have used indirect or "proxy" measures [11, 95, 113], that is, to identify firms with superior IT capability, they used the rankings of IT leaders provided by *InformationWeek*. This ranking was based on various items of data related to IT such as IT budgets, size of IT staff, and percentages of IT budget to various technologies. To measure the IT capability construct, Lai et al. [64] asked four questions designed to uncover the ability of firms to utilise IT-based resources to conduct business transactions in the supply chain; their measure is thus strongly contextualised. By proposing a generally-applicable, explicit and direct measure of ERP capability, the present study has contributed to the use of the RBV for the study of ERP.

This study is more oriented on theory-building than theory-testing. While exploratory in nature, it contributes to theory development by advancing concrete propositions with regards (1) to the nature and importance of different ERP effects on processes in different organisational settings, (2) to potential causal links between different ERP capabilities and various ERP effects, and (3) to potential causal links between ERP capabilities and the realization of ERP potential (ERP business value). These propositions may serve as initial hypotheses in future research.

This study provides another interesting contribution to the body of research on IT/ERP impacts in that it uses the realisation of the potential ERP effect on organisational performance to conceptualize and measure these impacts. As the ERP system is adopted and implemented by a business enterprise on the basis of its potential impact on operational and organisational performance, the present study proposes a method both for estimating such potential

and for measuring the extent to which this potential has been realised. Moreover, an empirical demonstration has been made of the need for finer analysis when one looks at ERP business value. Hence, this study suggests that it is essential to distinguish between automational, informational and transformational types of ERP impacts because global measures may hide more complex relationships with ERP capabilities and other determinants of ERP business value.

5.3.2 Contributions to practice

Managers at all levels can readily ascertain the ineffectiveness of their ERP system after its implementation, by observing for instance that expected benefits are not realised. But given the intrinsic complexity of an ERP system and the multitude of factors that can affect organisational performance, they will have difficulty in (a) isolating the role of ERP in relation to this ineffectiveness, and (b) pinpointing the specific problems linked to the installed ERP system. In this regard, the present study offers a double contribution. First, it illustrates the manner by which one can circumscribe the system's role by highlighting the extent of realisation of the potential ERP effects on the various operational and organisational performance indicators. Second, by linking ERP capabilities with ERP potential realised, the study provides managers with means of affecting ERP system design in order to increase its business value. In this line of thought, even though this study is exploratory in nature, its results suggest that specific ERP capabilities should be developed depending upon the type of effects one is looking for when implementing ERP. If one wants automational impacts from ERP, one should insure a high level of ERP integration; if one aims for informational impacts, it is ERP flexibility that should be developed whereas if one aims to transform the organisation through ERP, it is the system's transversality that should be reinforced.

6 Limitations and future research

This research is based on an in-depth case study of three manufacturing enterprises that successfully implemented their ERP systems. In this regard, it is thus exploratory in nature; yet, this study provides clear insights on the effect of an ERP system's capabilities upon its contribution to organisational performance. These insights, in the form of testable propositions, should however be validated by further empirical studies with a larger and more diversified sample of enterprises, including firms that have experienced troubled implementations.

The use of subjective measures to estimate the contribution of an ERP system to organisational performance constitutes another research limitation. Note however that subjective measures are pervasive in research on the value of IT [21, 92, 106]. While the legitimacy of their use is still an object of debate, it has been shown that these measures can constitute valid surrogates or proxies for objective measures of realised value [106]. In our case, the estimation of ERP impact on a business process was generally provided by a single individual, the one judged to be in the best position in the organisation to provide this information. The individual chosen was always the one responsible for the attainment of the objectives measured by the business process PIs. In the end, the measure obtained of the global impact of the ERP system on the organisational performance is, for each firm, an aggregate of the perceptions of many managers, each expressing himself or herself on the business process he or she best masters, that is, the process that is under his or her responsibility. As denoted by Ragowsky et al. [92, p. 180], "IT's impact on organisational performance can be understood by evaluating management's perceptions of IT use when viewed through the lens of primary activities". It remains however that views may differ between business process managers and the employees they supervise, the latter being the actual end-users of the ERP system. It should then be worthwhile in future studies to include the views of both process managers and employees.

One must add that the study was done 2 years after the system's start-up and that given the efforts made to implement and use it effectively, the respondents' responses may be subjected to a rationalisation phenomenon. Thus, future studies should include more participants to limit perceptual biases, whereas rationalisation could be ascertained by comparing the perceptual impact of ERP effects on certain performance indicators with the temporal evolution of these same indicators from the very beginning of ERP use.

One could also attempt to determine optimal levels of integration-flexibility- transversality, that is, levels that in a given context would allow the organisation to obtain the greatest business value from its ERP system. The organisational context could be defined in relation to relevant factors such as the degree of interdependence/differentiation of the various organisational units [41], the organisational structure that existed prior to implementing the ERP system (bureaucracy vs. adhocracy), environmental turbulence and uncertainty, and the mechanisms used to reduce complexity [5], as "different process environments tend to align advanced manufacturing technology investments in distinct profiles, which are associated with superior performance" [29, p. 521].

7 Concluding remarks

ERP systems offer very diverse possibilities and potentialities to the organisations that adopt them, even though these organisations may have acquired the same generic system from the same supplier. This feature of ERP systems gives relevance to the resource-based view as a conceptual foundation for the study of ERP, that is, to uncover how an intelligent combination of theoretically homogeneous and mobile ERP resources enables an organisation to distinguish itself from its competitors.

The design of an ERP system "as installed" finally reflects the choices that were made throughout the system implementation process, and to a certain extent, it reflects the "managerial IT skills" that are, following Mata et al. [76], the only ones susceptible of providing the firm with a competitive advantage from its use of IT. The present study has thus attempted to qualify this design in form of ERP capabilities and link these capabilities to ERP business value through the automational, informational and transformational effects of an ERP system. This approach can help us understand why and to what extent certain firms benefit from implementing an ERP system while others do not. It is hoped that this study, while exploratory in nature, can provide some guidance to organisations in the choices that must be made initially—"vanilla" or customisation—and throughout the ERP implementation process with regard to the system's level of integration, flexibility and transversality.

Appendix 1

See Table 7.

Table 7 Definition of the ERP capability construct

ERP capability construct		Operational definition
(%)	Vertical integration	Extent to which an ERP system allows interconnection (i.e. connectivity and compatibility) between hierarchical levels in the organisation. Connectivity: ability of any technology component to attach to any other components [17, 36]; Compatibility: ability to share any type of information across any technology component [17, 36]
	Horizontal integration	Extent to which an ERP system allows interconnection, i.e. connectivity and compatibility [17, 36] between various organisational functions or departments
	Interorganisational integration	Extent to which an ERP system allows the firm's interconnection, i.e. connectivity and compatibility [17, 36] with its main business partners
(%)	Temporal dimension:	Extent to which an ERP affect the time it takes the organisation to react to change
	Efficiency	Ability to maintain the same performance level while changes occur [44]
	Sensitiveness	Quickness with which the organisation adapts to change [44]
	Variety dimension:	Extent to which an ERP affect the variety of responses available to the organisation in order to face both foreseen and unforeseen changes
	Versatility	Range of activities relating to foreseen changes that can be accomplished by a system [44]
	Robustness	Range of activities relating to unforeseen changes that can be accomplished by a system [44]
	Modularity dimension:	The degree to which hardware/software/data can be separated and recombined to support new system development [23]
	Functionality of applications	Ability to add, modify and remove the modules of software applications with little or no widespread effect on the applications collectively [17]
	Data transparency	Free retrieval and flow of data between authorised personnel in an organisation or between organisations regardless of location [17]
	Human dimension:	The degree to which IT personnel possess relevant skills and experience to effectively perform IT activities [23]
	Technological management	The organisation's ability to deploy IT in the most effective manner in support of the business strategies [17]
	Business skills	Ability of IT personnel to understand the business processes they are to support and to apply the appropriate technical solution to a given business problem [17]
	Management knowledge	Importance of IT personnel having skills and knowledge to assume roles outside their area of training or original competencies [17]
	Technical knowledge	Set of measures of technical capabilities, such as programming, understanding software development processes, and knowledge of operating systems [17]

Table 7 continued

ERP capability construct		Operational definition
(%)	Common language	Extent to which ERP system allows a common language to be adopted by all the firm's units
	Customer focus	Extent to which ERP system allows the firm to focus activities on the customer's satisfaction
	Cooperation	Extent to which ERP system contributes to better cooperation between the various units of the firm
	Holistic view	Extent to which ERP system allows employees at all levels to develop a better overall view of the firm's operations
	Reduced costs	Extent to which ERP system contributes to a reduction in operating costs
	Reduced delays	Extent to which ERP system contributes to a reduction in operating delays
	Learning	Extent to which ERP system contributes to the improvement of the employees' learning capacity
	Standardisation	Extent to which ERP system contributes to the standardisation of practices within the firm
	Coordination	Extent to which ERP system contributes to a better coordination of the firm's various operations

Appendix 2

See Table 8.

Table 8 ERP effects and their impact on Alpha's performance indicators

ERP effects		Performance indicator (PI)					
		PI affected	*i*	*a*	*b*	*a*b*	*a*B*
Automational effects	Productivity of organisational processes	Productivity ratios	1	3	2	6	9
		Labour improvements	2	4	2	8	12
		Personnel rotation	3	3	1	3	9
	Better management of warehousing space	Mean wait time of customers	4	3	3	9	9
		Shipping delays	5	3	2	6	9
	Connectivity with customers	Productivity ratios	6	3	3	9	9
		Order entry	7	3	1	3	9
		% of products returned by customers	8	4	2	8	12
	Integration of resources	Productivity	9	3	1	3	9
	Increase in the risks linked to integration (-)	Productivity ratios	10	3	−1	−3	0
		Inventory levels	11	4	−3	−12	0
Sub-total for automational effects						40	87
Informational effects	Improvement of production scheduling	Late deliveries	12	5	3	15	15
		Shipping delays	13	3	2	6	9
		Raw materials yield	14	3	2	6	9
		Inventory turnover	15	3	2	6	9
		Production cycle time versus standard	16	5	2	10	15
	Richness of information extracted from the data	Raw materials yield	17	3	2	6	9
		Inventory levels	18	4	2	8	12
		Obsolescence of raw materials	19	2	1	2	6
		Inventory turnover	20	3	2	6	9
	Precision and accuracy of data	Inventory levels	21	4	3	12	12
		Obsolescence of raw materials	22	2	3	6	6
		Inventory turnover	23	3	3	9	9
		% of products returned by customers	24	3	3	9	9
		% of production rejects	25	4	3	12	12
		Late deliveries	26	5	3	15	15

Table 8 continued

ERP effects		Performance indicator (PI)					
		PI affected	*i*	*a*	*b*	*a*b*	*a*B*
	Visualisation of information at the workstations	% of production rejects	27	4	3	12	12
		Number of work accidents	28	5	2	10	15
		Labour improvements	29	4	3	12	12
		Machine stoppages	30	4	2	8	12
		Machine throughput	31	4	2	8	12
	Simultaneous diffusion of information	Implication of employees	32	5	3	15	15
	Standardisation of information	% of production rejects	33	4	2	8	12
	Improvement in decisions	-% of products returned by customers	34	3	2	6	9
		Productivity ratios	35	3	1	3	9
		Machine stoppages	36	4	1	4	12
		Raw materials yield	37	3	0	0	9
		Production cycle time versus standard	38	5	0	0	15
		Inventory turnover	39	3	2	6	9
		Inventory levels	40	4	3	12	12
Sub-total for informational effects						232	321
Transformational effects	Development of products with customers	Order entry	41	3	1	3	9
		Number of new products launched	42	3	2	6	9
	Flexibility in pricing	Order entry	43	3	2	6	9
Sub-total for transformational effects						15	27
Total						287	435

i numerical order of the (ERP effect—PI) couple

a importance of the PI: from unimportant [1] to very important [5]

b degree of the PI's variation induced by the ERP effect: none [0], weak [1], medium [2], strong [3] (with a minus sign if variation is negative)

B ideal *b*

References

1. Alter S (1999) The siamese twin problem: a central issue ignored by "Dimensions of information system effectiveness". Commun Assoc Inf Syst 2(article 20: letters to the editor): 40–55
2. Anderson M, Banker RD, Menon NM, Romero JA (2011) Implementing enterprise resource planning systems: organizational performance and the duration of the implementation. Inf Technol Manage 12(3):197–212
3. APQC (1992) Process classification framework. Apqc.org, 1–16. https://storesonline.com/members/711336/uploaded/APQCPCF.pdf
4. APQC (2006) Process classification framework [electronic version]. apqc.org, 1–16. http://www.apqc.org/portal/apqc/ksn/APQC_PCF.pdf?paf_gear_id=contentgearhomeandpaf_dm=fullandpageselect=contentitemanddocid=121388
5. Barki H, Pinsonneault A (2005) A model of organizational integration, implementation effort, and performance. Organ Sci 16(2):165–179
6. Barney JB (2001) Resource-based theories of competitive advantage: a ten-year retrospective on the resource-based view. J Manage 27(6):643–650
7. Beard JW, Sumner M (2004) Seeking strategic advantage in the post-net era: viewing ERP systems from the resource-based perspective. J Strat Inf Syst 13(2):129–150
8. Beretta S (2002) Unleashing the integration potential of ERP systems: the role of process-based performance measurement systems. Bus Process Manage J 8(3):254–277
9. Bergeron F, Raymond L, Rivard S (2000) Fit in strategic information technology management research: an empirical comparison of perspectives. Omega 29(2):125–142
10. Bernroider EWN (2008) IT governance for enterprise resource planning supported by the DeLone-McLean model of information systems success. Inf Manage 45(5):257–269
11. Bharadwaj AS (2000) A resource-based perspective on information technology capability and firm performance: an empirical investigation. MIS Q 24(1):169–196
12. Bhatt GD, Grover V (2005) Types of information technology capabilities and their role in competitive advantage: an empirical study. J Manage Inf Syst 22(2):253–277
13. Boudreau M-C, Gefen D, Straub DW (2001) Validation in information systems research: a state-of-the-art assessment. MIS Q 25(1):1–16
14. Brandyberry A, Rai A, White GP (1999) Intermediate performance impacts of advanced manufacturing technology systems: an empirical investigation. Decis Sci 30(4):993–1020
15. Brown JP (2001) Is ERP a silver bullet? APICS Perform Adv 10:1–2 (downloaded from www.apics.org/magazine/past_issues/2001_01/erp_silver/full.asp)
16. Brynjolfsson E, Hitt LM (1998) Beyond the productivity paradox. Commun ACM 41(8):49–55

17. Byrd TA, Turner DE (2000) Measuring the flexibility of information technology infrastructure: exploratory analysis of a construct. J Manage Inf Syst 17(1):167–208
18. Carbonel M (2001) Dérives organisationnelles dans les projets ERP : les cas de Guerbet et Gaumont. Syst Inf Manage 6(1): 71–85
19. Carr NG (2003) IT doesn't matter. Harv Bus Rev 81(5):41–49
20. Chand D, Hachey G, Hunton J, Owhoso V, Vasudevan S (2005) A balanced scorecard based framework for assessing the strategic impacts of ERP systems. Comput Ind 56(6):558–572
21. Chang HH (2000) Technical and management perceptions of enterprise information system importance, implementation and benefits. Inf Syst J 16(3):263–292
22. Chang S-I, Yen DC, Ng CS-P, Chang IC, Yu S-Y (2011) An ERP system performance assessment model development based on the balanced scorecard approach. Inf Syst Frontiers 13(3): 429–450
23. Chanopas A, Krairit D, Khang DB (2006) Managing information technology infrastructure: a new flexibility framework. Manage Res News 29(10):632–651
24. Chien S-W, Tsaur S-M (2007) Investigating the success of ERP systems: case studies in three Taiwanese high-tech industries. Comput Ind 58(8/9):783–793
25. Ching-Chien Y, Ping-Ho T, Chun-Chung W (2006) A study of the factors impacting ERP system performance-from the users' perspectives. J Am Acad Bus Camb 8(2):161–166
26. Ching-Chow Y, Yeh T-M (2007) The use of fuzzy measures in a performance-evaluation model for ERP implementation among Taiwanese semiconductor manufacturers. Int J Prod Res 45(20): 4735–4752
27. Chun-Chin W, Kuo-Liang L (2008) An ERP performance measurement framework using a fuzzy integral approach. J Manuf Technol Manage 19(5):607–626
28. Clemmons S, Simon SJ (2001) Control and coordination in global ERP configuration. Bus Process Manage J 7(3):205–215
29. Das A, Narasimhan R (2001) Process-technology fit and its implications for manufacturing performance. J Oper Manage 19(5):521–540
30. Davern MJ, Kauffman RJ (2000) Discovering potential and realizing value from information technology investments. J Manage Inf Syst 16(4):121–143
31. Dechow N, Mouritsen J (2005) Enterprise resource planning systems, management control and the quest for integration. Acc Organ Soc 30(7/8):691–733
32. Deloitte Consulting (1999) ERP's second wave: maximizing the value of ERP-enabled processes. Deloitte Consulting, Atlanta
33. DeLone WH, McLean ER (1992) Information systems success: the quest for the dependent variable. Inf Syst Res 3(1):60–95
34. DeLone WH, McLean ER (2003) The DeLone and McLean model of information systems success: a ten-year update. J Manage Inf Syst 19(4):9–30
35. Dubé L, Paré G (2003) Rigor in information systems positivist case research: current practices, trends, and recommendations. MIS Q 27(4):597–635
36. Duncan NB (1995) Capturing flexibility of information technology infrastructure: a study of resource characteristics and their measure. J Manage Inf Syst 12(2):37–57
37. Eisenhardt KM (1989) Building theories from case study research. Acad Manage Rev 14(4):532–551
38. El-Amrani R, Rowe F, Geffroy-Maronnat B (2006) The effects of enterprise resource planning implementation strategy on cross-functionality. Inf Syst J 16(1):79–104
39. Elbanna AR (2007) Implementing an integrated system in a socially dis-integrated enterprise. Inf Technol People 20(2):121–139
40. Forsberg T, Nilsson L, Antoni M (1999) Process orientation: the Swedish experience. Total Qual Manage 10(4/5):540–547
41. Gattiker TF, Goodhue DL (2004) Understanding the local-level costs and benefits of ERP through organizational information processing theory. Inf Manage 41(4):431–443
42. Gattiker TF, Goodhue DL (2005) What happens after ERP implementation: understanding the impact of interdependence and differentiation on plant-level outcomes. MIS Quarterly 29(3):559–585
43. Giaglis GM, Mylonopoulos N, Doukidis GI (1999) The ISSUE methodology for quantifying benefits from information systems. Logist Inf Manage 12(1/2):50–62
44. Golden W, Powell P (2000) Towards a definition of flexibility: In search of the Holy Grail? Omega 28(4):373–384
45. Gurbaxani V (2003) Does IT matter? An HBR debate. Letter from Vijay Gurbaxani. Harv Bus Rev. 14 June downloaded from http://harvardbusinessonline.hbsp.harvard.edu/b02/en/files/misc/Web_Letters.pdf
46. Gutiérrez LG, Torres JT (2007) Relation between manufacturing practices, flexibility and the performance in ERP system firms. Bus Rev Camb 8(1):315–318
47. He X (2004) The ERP challenge in China: a resource-based perspective. Inf Syst J 14(2):153–167
48. Hendricks KB, Singhal VR, Stratman JK (2007) The impact of enterprise systems on corporate performance: a study of ERP, SCM, and CRM system implementations. J Oper Manage 25(1): 65–82
49. Hitt LM, Wu DJ, Zhou X (2002) Investment in enterprise resource planning: business impact and productivity measures. J Manage Inf Syst 19(1):71–98
50. Hlady-Rispal M (2002) La méthode des cas. Application à la recherche en gestion. De Boeck Université, Brussels
51. Ho C (2007) Measuring system performance of an ERP-based supply chain. Int J Prod Res 45(6):1255–1277
52. Hwang Y, Grant D (2011) Understanding the influence of integration on ERP performance. Inf Technol Manage 12(3): 229–240
53. Ifinedo P, Nahar N (2006) Quality, impact and success of ERP systems: a study involving some firms in the Nordic-Baltic region. J Inf Technol Impact 6(1):19–46
54. Irani Z (2002) Information systems evaluation: navigating through the problem domain. Inf Manage 40(1):11–24
55. Izza S (2009) Integration of industrial information systems: from syntactic to semantic integration approaches. Enterp Inf Syst 3(1):1–57
56. Jalal A (2011) Enterprise resource planning: an empirical study of its impact on job performance. Int J Bus Inf 6(1):77–90
57. Jin B (2006) Performance implications of information technology implementation in an apparel supply chain. Supply Chain Manage 11(4):309–316
58. Kalling T (2003) ERP systems and the strategic management processes that lead to competitive advantage. Inf Resour Manage J 16(4):46–67
59. Kang S, Park J-H, Yang H-D (2008) ERP alignment for positive business performance: evidence from Korea's ERP market. J Comput Inf Syst 48(4):25–38
60. Karimi J, Somers TM, Bhattacherjee A (2007) The role of information systems resources in ERP capability building and business process outcome. J Manage Inf Syst 24(2):221–260
61. Klaus H, Rosemann M, Gable GG (2000) What is ERP? Inf Syst Frontiers 2(2):141–162
62. Kohli R, Grover V (2008) Business value of IT: an essay on expanding research directions to keep up with the times. J Assoc Inf Syst 9(1):23–39
63. Laframboise K, Reyes F (2005) Gaining competitive advantage from integrating enterprise resource planning and total quality management. J Supply Chain Manage 41(3):49–64

64. Lai F, Li D, Wang Q, Zhao X (2008) The information technology capability of third-party logistics providers: a resource-based view and empirical evidence from China. J Supply Chain Manage 44(3):22–38
65. Langdon CS (2006) Designing information systems capabilities to create business value: a theoretical conceptualization of the role of flexibility and integration. J Database Manage 17(3): 1–18
66. Lee J, Bose U (2002) Operational linkage between diverse dimensions of information technology investments and multi-faceted aspects of a firm's economic performance. J Inf Technol 17(3):119–131
67. Lengnick-Hall C, Lengnick-Hall M, Abdinnour-Helm S (2004) The role of social and intellectual capital in achieving competitive advantage through enterprise resource planning (ERP) systems. J Eng Technol Manage 21(4):307–330
68. Leonard-Barton D (1992) Core capabilities and core rigidities: a paradox in new product development. Strat Manage J 13(Special issue):111–125
69. Lequeux JL (2002) Manager avec les ERP. Progiciels de gestion intégrés et Internet, 2nd edn. Éditions d'Organisation, Paris
70. Li-Ling H, Chen M (2004) Impacts of ERP systems on the integrated-interaction performance of manufacturing and marketing. Ind Manage + Data Syst 104(1):42–55
71. Light B, Wagner E (2006) Integration in ERP environments: rhetoric, realities and organisational possibilities. New Technol Work Employ 21(3):215–228
72. Luo W, Strong DM (2004) A framework for evaluating ERP implementation choices. IEEE Trans Eng Manage 51(3): 322–332
73. Mabert VA, Soni A, Venkataramanan MA (2003) The impact of organization size on enterprise resource planning (ERP) implementations in the US manufacturing sector. Omega 31(3): 235–246
74. Markus, M. L. (2001). Paradigm shifts—E-business and business/systems integration. Commun Assoc Inf Syst 4(article 10)
75. Martin I, Cheung Y (2005) Business process re-engineering pays after enterprise resource planning. Bus Process Manage J 11(2): 185–197
76. Mata FJ, Fuerst WL, Barney M (1995) Information technology and sustained competitive advantage: a resource-based analysis. MIS Q 19(4):487–505
77. McCormack K (2001) Business process orientation: do you have it? Qual Prog 34(1):51–58
78. McCormack K, Johnson B (2001) Business process orientation, supply chain management, and the e-corporation. IIE Solut 35(10): 33–37
79. Mei-Yeh F, Lin F (2006) Measuring the performance of ERP system—from the balanced scorecard perspectives. J Am Acad Bus Camb 10(1), 256-256-263
80. Melville N, Kraemer K, Gurbaxani V (2004) Information technology and organizational performance: an integrative model of IT business value. MIS Q 28(2):283–322
81. Miles MB, Huberman AM (2003) Analyse des données qualitatives, 2nd edn. De Boeck, Paris
82. Mills J, Platts K, Bourne M (2003) Applying resource-based theory: methods, outcomes and utility for managers. Int J Oper Prod Manage 23(2):148–166
83. Mirani R, Lederer AL (1998) An instrument for assessing the organizational benefits of IS projects. Decis Sci 29(4):803–838
84. Mooney JG, Gurbaxani V, Kraemer KL (1995) A process oriented framework for assessing the business value of information technology. Proceedings of the sixteenth international conference on information systems, Amsterdam, 10–13 Dec, pp 17–27
85. Österle H, Fleisch E, Alt R (2001) Business networking: shaping collaboration between enterprises, 2nd revised and extended ed. Springer, New York
86. Parr A, Shanks G (2000) A model of ERP project implementation. J Inf Technol 15(4):289–303
87. Parthasarathy S, Anbazhagan N (2007) Evaluating ERP implementation choices using AHP. Int J Enterp Inf Syst 3(3):52–65
88. Penrose E (1959) The theory of the growth of the firm. Oxford University Press, New York
89. Piccoli G (2008) Information technology in hotel management. Cornell Hosp Q 49(3):282–296
90. Piccoli G, Ives B (2005) IT-dependent strategic initiatives and sustained competitive advantage: a review and synthesis of the literature. MIS Q 29(4):747–776
91. Ragowsky A, Adams DA (2005) Assessing the value provided by ERP applications through organizational activities. Commun Assoc Inf Syst 16:381–406
92. Ragowsky A, Stern M, Adams D (2000) Relating benefits from using IS to an organization's operating characteristics: interpreting results from two countries. J Manage Inf Syst 16(4): 175–194
93. Rowe F (1999) Cohérence, intégration informationnelle et changement: Esquisse d'un programme de recherche à partir des progiciels intégrés de gestion. Syst Inf Manage 4(4):3–20
94. Rowe F, El-Amrani R, Bodan M, Marciniak R, Geffroy-Maronnat B (2005) Does ERP provide a cross-functional view of the firm? Challenging conventional wisdom for SMEs and large French firms. Proceedings of the twenty-sixth international conference on information systems, 11–14 Dec, Las Vegas, Nevada
95. Santhanam R, Hartono E (2003) Issues in linking information technology capability to firm performance. MIS Q 27(1): 125–153
96. Shad SA, Chen E, Azeem FMF (2011) Performance enhancement factors of ERP projects in a telecom public sector organization of Pakistan: an exploratory study. Interdiscip J Contemp Res Bus 2(11):95–109
97. Shang S, Seddon PB (2000) A comprehensive framework for classifying the benefits of ERP systems. Proceedings of the Americas conference on information systems, 10–13 Aug, Long Beach, CA
98. Shin I (2006) Adoption of enterprise application software and firm performance. Small Bus Econ 26(3):241–256
99. Smyth RW (2001) Challenges to successful ERP use (research in progress). Proceedings of the 9th European conference on information systems, Bled, Slovenia, 27–29 June, pp 1227–1231
100. Soh C, Markus ML (1995) How IT creates business value: a process theory synthesis. Proceedings of the sixteenth international conference on information systems, Amsterdam, 10–13 Dec, pp 29–41
101. Stalk G, Evans P, Shulman LE (1992) Competing on capabilities: the new rules of corporate strategy. Harv Bus Rev 70(2): 57–69
102. Strassmann PA (2003) Does IT matter? An HBR debate. Letter from Paul A. Strassmann. Harv Bus Rev. 7–9 June, downloaded from http://harvardbusinessonline.hbsp.harvard.edu/b02/en/files/misc/Web_Letters.pdf
103. Stratman J (2007) Realizing benefits from enterprise resource planning: does strategic focus matter? Prod Oper Manage 16(2): 203–216
104. Sumner MR (2009) How alignment strategies influence ERP project success. Enterp Inf Syst 3(4):425–448
105. Tallon PP (2008) Inside the adaptative enterprise: an information technology capabilities perspective on business agility. Inf Technol Manage 9(1):21–36
106. Tallon PP, Kraemer KL, Gurbaxani V (2000) Executives' perceptions of the business value of information technology: a process-oriented approach. J Manage Inf Syst 16(4):145–173
107. Tsai M-T, Li EY, Lee K-W, Tung W-H (2011) Beyond ERP implementation: the moderating effect of knowledge

management on business performance. Total Qual Manage Bus Excell 22(2):131–144
108. Tsai W-H, Yi-Wen F, Li-Wen C, Ching-Chien Y (2007) The relationship between implementation variables and performance improvement of ERP systems. Int J Technol Manage 38(4): 350–373
109. Uwizeyemungu S, Raymond L (2005) Essential characteristics of an ERP system: conceptualization and operationalization. J Inf Organ Sci 29(2):69–81
110. Uwizeyemungu S, Raymond L (2010) Linking the effects of ERP to organizational performance: development and initial validation of an evaluation method. Inf Syst Manage 27(1):25–41
111. Velcu O (2007) Exploring the effects of ERP systems on organizational performance. Ind Manage + Data Syst 107(9): 1316–1334
112. Wade M, Hulland J (2004) The resource-based view and information systems research: review, extension and suggestions for future research. MIS Q 28(1):107–142
113. Wang L, Alam P (2007) Information technology capability: firm valuation, earnings uncertainty, and forecast accuracy. J Inf Syst 21(2):27–48
114. Wei KS, Loong ACY, Leong Y-M, Ooi K-B (2009) Measuring ERP system success: a respecification of the Delone and McLean's IS success model. Symposium on progress in information & communication technology, 7–8 Dec, Kuala Lumpur, Malaysia
115. Wernerfelt B (1995) The resource-based view of the firm: ten years after. Strat Manage J 16(3):171–174
116. Wieder B, Booth P, Matolcsy ZP, Ossimitz M-L (2006) The impact of ERP systems on firm and business process performance. J Enterp Inf Manage 19(1/2):13–29
117. Yin RK (2003) Case study research. Design and methods, 3 edn. Sage Publications Inc, Thousand Oaks, CA
118. Zhang M, Tansuhaj P (2007) Organizational culture, information technology capability, and performance: the case of born global firms. Multinatl Bus Rev 15(3):43–77
119. Zhang Z, Lee MKO, Huang P, Zhang L, Huang X (2005) A framework of ERP systems implementation success in China: an empirical study. Int J Prod Econ 98(1):56–80
120. Zuboff S (1985) Automate/informate: the two faces of intelligent technology. Organ Dyn 14(2):5–18