

The frugal, the radical, the adaptive and the stratjacket: configurations of ERP adopters in the European and US manufacturing sector

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Abstract¹

This paper builds upon existing studies on knowledge and learning to examine the mechanisms through which business organizations develop IT capabilities. More specifically, it has two specific objectives. First and foremost it aims at identifying configurations of IT adopters that exhibit common characteristics with respect to both their IT implementation strategies (particularly in relation to the intensity of their knowledge investments) and the environment in which the companies operate. Second, it aims at examining whether and under what circumstances some configurations exhibit superior results. Our underlying research hypothesis is that, as knowledge and learning investments are important determinants of operational effectiveness and as IT systems play a paramount role in enabling these activities, IT implementation strategies that entail knowledge development efforts should be also designed to spouse the specific requirements of the firm's operational environment.

The application of cluster analysis to a sample of 75 companies that adopted SAP R/3 between 1995 and 2000 uncovered four distinct configurations of ERP adopters. The results suggest that complex and turbulent environments provide greater challenges to ERP adopters than stable and simple ones, and also that these challenges can be effectively addressed by means of appropriate knowledge-intensive strategies that privilege articulation efforts. They also highlight that, whereas strategies based on limited knowledge investments are still effective in steady environments, where the relative stability of the underlying reference system renders repeated adjustments based on a trial and error strategy still possible, they become intrinsically hazardous when the competitive landscape shifts continuously and unpredictably.

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Introduction

As a direct consequence of the new centrality that knowledge, knowledge management and learning processes assume for many business organizations, information systems also play a new and more fundamental role. Not only do these systems accomplish a mere transactional function to support the execution of back office operations. They also become a key strategic tool that “provides cost-effective functionalities for building knowledge platforms through systematic acquisition, storage and dissemination of organizational knowledge (Purvis et al. 2001, p. 117). As this is recognized as a primary strategic resource for organizations and a source of competitive advantage (Prahalad and Hamel, 1990; Prahalad and Hamel, 1994; Kogut and Zander, 1994) this function becomes of paramount importance, especially in dynamic markets where the manipulation of knowledge resources is particularly critical (Grant, 1996; Kogut and Zander, 1995) and requires appropriate organizational architectures (Mendelson, 2000).

However, while companies invest significant amounts of resources to update and ameliorate their IT infrastructures, the returns of these investments remain uncertain (Brynjolfsson, 1993; Hitt and Brynjolfsson, 1996a; Hitt and Brynjolfsson, 1996b; Upton and McAfee, 1998; Strassmann, 1990). Both industry surveys and academic research provide ample evidence that the mere increase of a firm’s IT expenditures does not guarantee – by itself, the achievement of performance improvements. It is only when it is accompanied by the development of effective IT capabilities that the adoption of an IT innovation produces operational improvements and – possibly, sustained competitive advantage (Markus and Benjamin, 1996; Bharadwaj, 2000). However, while the importance of developing IT capabilities becomes increasingly more evident, it is still not clear how they can or should be generated, both from a practical and a theoretical standpoint.

Organizations that renovate or update their IT infrastructure are confronted with difficult choices that entail fundamental trade-offs and -- hence -- often hesitate among a variety of possible strategies, none of which has yet been proven to be generally superior. At the theoretical level, researchers have recently recognized the role of IT capabilities and have provided an attempt to portray their characteristics (Bharadwaj, 2000). However, they have often neglected to specify the mechanisms that permit their generation and, also, generally overlooked the question of whether different IT strategies display the same degree of effectiveness for firms that exhibit different operational and organizational needs.

This generalized lack of knowledge about the mechanisms that subsume the development of IT competences is also due to the fact that most of the existing studies on IT implementation have often limited their analysis to the mere technical domain (Jiang et al., 2001), without addressing the more complex issues of how alternative IT strategies may affect the knowledge-integration function that these systems perform or their contribution to the distribution of cognitive activities in the firm (Boland et al., 1994). On the other hand, scholars who have examined the question of how learning and knowledge integration may contribute to the generation of organizational capabilities and competitive advantage (Zollo and Winter, 2001; Inkpen and Dinur, 1998), have seldom applied this perspective to the IT area. As a consequence, firms confronted with the challenge of an IT implementation often lack solid theoretical grounds to design and deploy effective strategies in this domain.

The lack of specific knowledge in this area is important and deserves further investigation. In a different work (Masini, 2003) we have established that complex information systems exert a structural impact on the operational antecedents of dynamic capabilities. However, we have also argued that this impact can be attenuated or amplified by means of appropriate implementation strategies. Consistently with this perspective, we suggest that to examine whether they are truly “appropriate”, these strategies should be analyzed with respect to their influence on the knowledge integration mechanisms that subsume the generation of organizational capabilities.

There is indeed ample evidence that the design and the implementation of IT infrastructures affect the key mechanisms that underlie the development of organizational competences. However, while it is evident that IT implementations do affect the knowledge integration process behind the development of effective capabilities, it is less clear whether the different types of learning investments that can be undertaken during this activity are equally effective for the achievement of this objective.

The discussion above suggests that the application of a knowledge-based perspective to analyze the development of IT capabilities highlights several important questions, such as: what type of capability-building mechanisms and learning investments do companies privilege in relation to the implementation of complex information technologies that require knowledge integration efforts? Also, can any relationship be unveiled between the type of capability building mechanisms adopted and the environment (both external and internal) in which the firm operates? Do different mechanisms display different degrees of effectiveness, either in general or in relation to the operational environment and the organizational architecture of the firm?

Following the renewed interest for organizational gestalts (Miller 87 and 90, Meyer et al. 1993; Bensaou and Venkatraman, 1995; Atuahene-Gima and Ko, 2001) we adopt a configurational approach to shed some light on the above questions. Within this perspective, the above questions reduce themselves to a more general one, which consists in understanding whether IT adopters organize themselves according to “internally consistent combinations of strategy, organizational architecture and technology that provide superior performance in a given environment” (Tidd and Hull, 2002), p. 7) and whether these configurations display a different degree of effectiveness in different competitive settings. Our underlying research hypothesis is that, as knowledge and learning investments are important determinants of operational effectiveness and as IT systems play a paramount role in enabling these activities, IT implementation strategies that entail knowledge development efforts should be also designed to spouse the specific requirements of the firm’s operational environment.

We decided to examine the research questions highlighted above by focusing on Enterprise Systems, for several important reasons. First and foremost, these technologies are the perfect archetype of a complex information system that requires intensive knowledge integration efforts. Second, it is evident that a large number of enterprise projects still do not match expectations and that there is no easy and generally applicable way to guarantee the development of effective IT capabilities in this domain. Third, the magnitude of the investments associated with these systems renders the cost of a potential failure almost prohibitive and reinforces the urge to deepen our understanding of these phenomena. Finally, the very large diffusion that enterprise systems have experienced in the last few years facilitates the collection of reliable data and it is a guarantee for the robustness of this research.

The remainder of this paper is organized as follows. In section 2 we develop a conceptual model of fit between ERP needs and ERP capabilities, which is based on the fundamental premise that an ERP implementation must match the characteristics of the adopter’s operational environment. In section 3 we describe the analytical approach that we used to uncover configurations of ERP adopters in a sample of European and US firms that have implemented SAP R/3. In section 4 and 5 we assess respectively the descriptive and the predictive validity of the proposed taxonomy. Finally in section 6 we conclude and discuss avenues for further research.

A conceptual model of fit between ERP needs and ERP capabilities

To address the research questions discussed above we develop a stylized conceptual model that considers the capabilities developed by the adopters of complex information systems throughout the software implementation process vis à vis the characteristics of the external environment where the firms operate. The model extends the one proposed by (Bensaou and Venkatraman, 1995) and it is anchored to a main theoretical perspective.

The general theoretical foundation of our analysis is the widely accepted view that - for purposes of effectiveness, firms should generate capabilities or deploy resources in accordance to the requirements of the environment in which they operate (Lawrence and Lorsch, 1967; Thompson, 1967; Burns and Stalker, 1961). When analyzed through the information-processing view of the firm, (March and Simon, 1958; Cyert and March, 1963; Tushman and Nadler, 1978), the “structure-environment” perspective takes the simple and elegant formulation proposed by Daft and Lengel (1986). Organizations are seen as networks of information processors who assimilate information from the external environment, match it with knowledge accumulated internally and act on it by means of their capabilities, which - to be effective, must fit the specific information processing needs of the firm.

This formulation is also the point of departure of our analysis. We extend the original Daft and Lengel’s framework into a more comprehensive model², which takes into account both the equipment (i.e. IT) and the organizational nature of the technology (Corbett, 1992). The central tenet of our approach is that in the case of complex information systems whose role goes beyond that of a pure transactional instrument it is not sufficient to limit the assessment of “needs” to the mere information-processing domain. Besides performing a basic *information processing function* (i.e. ensuring a timely, accurate and consistent flow of information and data across the different layers of the organization) these technologies also ensure a *process integration and an organizational function*. They support business processes by helping the firm integrate and streamline its operations and standardize them across its many different units. They are also often used as a change agent to prompt process and organizational transformation that would be otherwise very difficult to accomplish.

Information processing requirements occur because firms must cope with various forms of uncertainty (Galbraith, 1973; Tushman and Nadler, 1978). Process integration needs originate from the fact that – by helping firms streamline processes across different units, and redefine the execution of tasks and responsibilities, enterprise systems change the way

² For a full characterization of the model see: Masini, 2003.

organizations operate (Davenport and Short, 1990; Child, 1987; Hammer, 1990). Finally, organizational requirements stem from the need to design and implement the IT infrastructure in a way that fits the organizational attributes of the adopter, with respect to the degree of task formalization (Goodhue and Thompson, 1995), to the level of access to information and data that is granted to different users, and with respect to the different cognitive styles that have become predominant in the organization (Benbasat and Taylor, 1978).

Accordingly, when filtered through this lens, the environment-fit perspective suggests that successful ERP adopters should develop capabilities that match simultaneously their information processing needs and, also, their process integration and organizational needs. We identify three fundamental capability-building mechanisms, related to IS projects. The first mechanism determines the nature of the knowledge developed and considers the “degree of knowledge articulation” (Zollo and Winter, 2001), i.e. the extent to which the firm spends time and resources to develop a deeper understanding of the phenomena that determine the effectiveness of its business processes. The second mechanism considers the knowledge sourcing process, i.e. the extent to which the adopter relies on external consultants to manage and execute the implementation of the software (as opposed to managing the process in-house with its own resources). The third mechanism involves the process through which knowledge and competences embedded in the new business processes are finally diffused and integrated in the organization via the direct involvement of end-users.

As capabilities are generated by means of deliberate instruments (knowledge integration and learning investments), the contingency argument we advocate suggests that these instruments should also be adequately matched to the idiosyncratic requirements of the firm’s internal and external operational environment. Differences in “fit” between the needs and the capability-generating mechanisms -- more than the choice of a particular configuration strategy “per se”-- should possibly explain the differences in operational performances observed across adopters.

Methodology and analytical issues

Overall analytical approach

To address the above questions we analyzed a sample of ERP users in three main sectors (process industry, discrete manufacturing and consumer products). Our analytical approach had three main objectives, namely: i) to observe whether the application of the conceptual model above could identify some archetypical configurations of ERP adopters; ii) to assess

the statistical significance of the differences among configurations; iii) to examine whether the proposed classification could account for some of the performance differences observed across firms. To this end we followed the six-step approach developed in (Bensaou and Venkatraman, 1995). As first steps (1-2) we used the conceptual model of ERP implementation described in the previous paragraph to operationalize the variables suitable for cluster analysis. In steps 3 and 4 we followed the multi-tiered approach suggested by Hambrick (1983) to derive the configurations of fit between the ERP needs and the ERP capabilities. In step 5 we assessed the descriptive validity of the configurations that emerged from the analysis. This was achieved first by verifying whether the proposed clustering had any statistical discriminating power and then by analyzing the peculiar characteristics of each group with respect to the variables statistically significant. Finally, in step 6 we examined the predictive validity of the proposed configurations by checking whether the clustering structure uncovered by the above analysis could explain the performance differences across ERP adopters.

Operationalization of variables and data collection

The data necessary to perform the analysis were directly gathered by administering a questionnaire to a randomly selected sample of 560 companies that adopted SAP R/3 between 1996 and 2001 in Europe and North America. The questionnaire was administered to a general manager who supervised or sponsored the project or who was ultimately involved in performance evaluation. To guarantee that each completed questionnaire could be used in our analysis as a single and representative data point we asked respondents to complete the survey on behalf of the part of the organization that was under their direct responsibility and to report this information. For small companies the unit of analysis typically coincided with the entire firm whereas for larger groups responses mainly referred to the strategic business unit under the direct responsibility of the respondent. Further details on the data collection procedure can be found in Masini (2003).

We received a total of 82 answers with a total response rate of around 15%, which was comparable to that of other studies of this nature (Mabert, Soni et al. 1999) and judged acceptable given the time and effort required to complete the questionnaire. After eliminating responses with missing values the sample contained 75 usable answers. Descriptive statistics are reported in Table 1.

The application of the cluster analysis procedure sketched above and further described in (Masini 2003) generated a four clusters solution. The four clusters were composed

respectively of 31, 15, 15 and 14 firms. The application of a series of one-way comparisons among the four configurations for all the variables included in the original model confirmed the significance of our results and suggested that all the variables included in the model strongly discriminate among groups (at $p < 0.05$ with a Scheffe contrast). For reasons that will be evident from the discussion below, we proposed the following denominations for the four groups: i) the frugal ERP; ii) the radical BPR iii) the adaptive ERP; iv) the strait jacket.

Number of companies	82
Europe	53
<i>Outside Europe</i>	29
Project duration (months)	7.05 (13.62)
Number of employees affected	711 (2008)
Number of modules installed	7.03 (3.07)
Number of sites involved	7.95 (18.71)
Percentage of process supported	0.63 (0.26)

Table 1: Descriptive statistics (standard deviation in parentheses)

Configurations of fit

The frugal ERP

The configuration of “frugal ERP adopters” includes companies that operate in stable environments, where both technology and market changes occur at a slow pace and - more importantly, along predictable trajectories. Products display long life cycles, thereby creating limited pressure on engineers for continuously modifying and improving design specifications. By the same token, these companies organize their production system in a made-to-stock mode, which leaves ample margins for long term planning.

The internal operational environment displays a high degree of homogeneity. The firms ascribed to this group are typically small or medium size companies that operate locally. Furthermore, even when they are part of larger multi-site organizations, the individual business units exhibit similar characteristics: they are often located in the same region,

produce similar products or use the same distribution channels. In strategic parlance (Porter, 1986), they face both weak forces for local responsiveness (i.e. limited need to adapt to the idiosyncratic characteristics of profoundly different markets) and relatively weak forces for global integration, (i.e. they do not need to standardize their processes across a diversified network of units because they mainly operate at a local scale).

In accordance to the principle of “requisite complexity” (Thompson, 1967), these firms respond to the above environmental requirements by deploying resources and by structuring their processes in a way that privileges efficiency and stability over responsiveness and continuous adaptation. Altogether, these attributes – both internal and external to the firm, generate limited requirements for “adaptive” ERP capabilities. On the one hand, the relative simplicity of the products manufactured and the homogeneity of the distribution process does not necessitate a particularly sophisticated information system that can handle large amounts of data and update them in a timely fashion. Similarly, a stable environment does not demand the organization to continuously reorganize its resource allocation scheme and to revise the configuration of its business processes to respond to unpredictable changes.

The IT capabilities developed by these organizations fully reflect the rather simple needs highlighted above and emphasize cost minimization. Well aware that an improvement of process performance would not offset the detrimental effect that an increase of their manufacturing and distribution costs will probably entail, these firms choose an implementation model that privileges cost reduction and minimization of complexity, even if this implies renouncing to potential process advantages. The ERP strategy followed emphasizes speed of implementation and project simplicity. To do so, adopters deliberately decide to limit their business process reengineering efforts and the accompanying knowledge investments that these efforts would entail.

Hence, this particular configuration somehow reflects a fit between limited ERP needs (both in terms of information processes requirements and of process optimization needs) and limited (or non-specialized) ERP capabilities. Accordingly, we name this configuration the *frugal* ERP, to reflect the fact that it correctly emphasizes cost reduction and rapid implementation over a more radical investment that would probably be inappropriate for the relatively basic environmental requirements.

The radical BPR

The environmental characteristics of this configuration closely resemble those of frugal ERP adopters. ERP adopters that follow a radical BPR approach are also small and medium

size organizations that operate locally, in well-consolidated industries distinguished by technological stability and limited market turbulence. Efficiency and cost minimization are key priorities in the design and operation of business processes as opposed to responsiveness and prompt adaptation. Companies in this configuration display structured organizations too, where the execution of tasks is regulated by well-consolidated operational routines that exploit the knowledge accumulated and refined over time.

However, in spite of the relative similarity of their ERP needs, these firms follow a completely different implementation strategy, and undertake significant investments to reconfigure business processes and streamline operations before migrating to the new system. Judging that the potential advantages engendered by a radical BPR effort will largely offset the additional cost that this very same effort may entail, they do not privilege a “low-cost, few-benefits” implementation strategy but heavily invest in the project throughout its development with the objective to realize a radical turnaround of their organization.

Not surprisingly in such a strategy the role of consultants is important. However - and in sharp contrast to the straitjacket case, external consultants work in close collaboration with the internal experts and with future end users. Needless to say, such a radical endeavor requires the active participation of end users, who contribute both to the preliminary assessment of business needs and, also, to the design, structuration and pre-test of the new process templates.

The adaptive ERP

The “adaptive” ERP configuration reflects a fit between complex ERP needs and the development of extended competences during the implementation of the software. Adaptive ERP organizations compete in high-clockspeed industries, where products have short life cycle, where technology evolves rapidly and where new and more successful business models developed by new market players continuously challenge those of the incumbent organizations. The degree of product and environmental complexity is also considerably higher than in the previous two cases. in their supply chain strategy. Firms ascribed to this group are mainly representatives of large, multi-site organizations with an extremely diversified presence on the territory, often established in many different countries or even in different regions. In turn, this diversified presence implies very different needs in terms of products and processes, which have to be adapted to the requirements of the local markets.

Under these circumstances, the ability to respond to a broad range of different and often unpredictable situations while maintaining process efficiency is vital. Well aware of the

challenging environment in which they operate, of the flexible *modus operandi* that they have developed to respond to these challenges, and, also, of the potential risks that a mismanaged ERP adoption may entail, these companies choose an implementation strategy that facilitates the generation of adaptive capabilities. Although initially mainly guided in their choice by technical reasons (such as the need to replace old legacy systems) adaptive ERP adopters do not consider the software as a mere IT system but, rather, as a catalyst for change and plan their implementation accordingly. This - which is executed by “planning centrally, analyzing specifically and deploying locally”, requires large knowledge investments and it aims at minimizing the structural rigidities of the software while preserving the local autonomy of the individual business units.

In line with this approach, the implementation occurs in a participative manner, following the principles of fair processes. Although longer, more costly and probably riskier, this strategy ultimately facilitates the development of a solid process knowledge repository at the local level, which is the necessary condition for adaptation to occur.

The “strait jacket”

Similarly to the “adaptive ERP” case, this configuration also includes companies that exhibit complex ERP needs, both in terms of information processing and process optimization requirements. These characteristics generate pressure to prioritize responsiveness over efficiency in the production and distribution systems, which are both designed to cope with sudden demand variations and to respond to the requirements of local markets, even at the risk of incurring higher costs. Furthermore, as production is mostly organized in a made-to-order fashion, schedules are subject to frequent modifications, which introduce an additional element of instability in the firm’s business landscape. According to Ghoshal and Noria (1990)’s taxonomy, these characteristics resemble those of a multinational environment, where the forces for local responsiveness are extremely strong and overcome those for global integration.

However, in spite of these relatively complex IT needs, which suggest that the development of adaptive ERP capabilities would probably be more appropriate, companies in the strait jacket cluster follow a radically different implementation strategy. Concerned by the challenges generated by their operational environment, these firms perceive the ERP implementation as the ultimate solution to their IT problems. They also consider it as a unique opportunity to replace a multitude of legacy systems with a simpler integrated solution. As a

matter of fact, adoption decisions in this configuration are mainly driven by “local optimization” purposes rather than by business process re-engineering needs. The ERP implementation is therefore perceived as an instrument to ameliorate specific operational areas rather than as an opportunity to streamline process across the entire organization.

However, concerned by the enormous costs and duration of typical ERP projects and probably misguided by the numerous horror stories on implementation failures, these companies decide to simplify the software configuration and minimize the complexity of the system by “planning centrally, developing centrally and imposing locally”. In order to minimize cost, the common procedures are designed and developed in a general competence center by a restricted group of internal IT experts, then implemented locally with very limited participation from the future end users, who have virtually no possibility to provide feedback, nor to influence the process.

Hence, the “strait jacket” configuration reflects a lack of fit between complex information processing needs (high environmental instability) and a diversified environment (many sites with often different requirements) and the development of simple ERP capabilities, resulting from a centralized - yet superficial and inexpensive, implementation strategy.

Predictive validity

To assess the criterion-related validity (Ketchen and Shook, 1996) of our results we examined whether the proposed grouping provided additional insights to explain the performance differences across organizations, in addition to what the individual variables used to derive the taxonomy could generate. To this end we assessed performance differences among groups along four distinct dimensions: i) changes in information quality ii) operational improvements; iii) degree of acceptance iv) degree of goal achievement⁵.

Table 2 displays the results of a pairwise comparison among the four clusters with respect to the four performance measures retained (only performance differences statistically significant at the 5% level are reported). The results of this comparison suggest that non-negligible performance differences exist across groups. The “strait jacket” clearly emerges as the low-performance relationship, for all the indicators considered. Although somewhat less sharp, some differences are also visible among the three high performance configurations, with the radical and the adaptive ERP being generally superior to the frugal one, at least in

some areas. The adaptive and the radical configurations consistently display higher information quality improvements than the other two clusters. The group of radical ERP adopters is also superior with respect to the degree to which employees accept the system and with respect to the magnitude of their operational improvements. Conversely, it exhibits lower degrees of goal achievement with respect to the adaptive and the frugal configurations.

In relation to our initial stylized model, the frugal configuration reflects therefore a fit between relatively simple ERP needs and the development of equally simple capabilities. Not surprisingly companies in this group report high level of goal achievement (because objectives that aim at cost-reduction such as the integration and standardization of procedures were among the primary goals). However they also achieve limited operational improvements, because achieving the latter would have required significantly greater BPR efforts than the one actually deployed. Similarly, adaptive ERP adopters reflect the existence of fit between complex ERP requirements and the generation of advanced capabilities, which are based on a radical analysis of operations and on the development of specific process knowledge. Hence, in spite of the far more demanding needs that they face compared to other ERP adopters, these companies manage to achieve important improvements by adjusting the level of their knowledge investments to match the requirements of their operational environment.

In sharp contrast with firms in the frugal configuration, radical adopters respond to relatively simple requirements by generating complex capabilities and by engaging in a radical BPR effort that resembles that undertaken by adaptive companies. Based on the previous analogy, one may suspect that this configuration reflects a misfit between limited ERP needs and radical ERP capabilities and this misfit would generate a negative impact on performance. However, this is not the case: albeit this strategy may represent an unnecessary investment, the massive BPR efforts undertaken by these companies enable them to streamline processes and to achieve higher operational benefits than firms in other groups.

Finally, straitjackets also reflect a misfit between needs and capabilities, but with far more disadvantageous consequences than radical adopters. In this particular setting, limiting knowledge investments has obvious drawbacks. First, the implementation of “pre-configured” process templates further enhances the structural rigidities of the software, thereby hampering adaptation and reducing organizational agility, both of which would be badly needed in such a context. Second, the particular deployment model adopted –based on a centralized design of

⁵ Again, for further details on the scales used and their internal validity refer to: Masini, 2003.

procedures and on their rigid implementation at the local level, is not well suited to organizations that include multiple sites with different specific requirements. Hence, the efficiency gains generated by standardization are largely offset by the additional costs engendered by the lack of fit between the new procedures and the local context where the individual units operate. Finally, the top-down implementation model chosen clashes with the fluid organizational culture that is typical of these firms, and it augments the end users' difficulties to make adjustments when necessary.

Compared to...	<i>ADAPTIVE</i>	<i>STRAITJACKET</i>	<i>FRUGAL</i>
Focal Configuration <i>(ADAPTIVE)</i>			
<i>STRAITJACKET</i>	Lower operational improvements, lower information improvements, lower degree of goal achievement and end-user acceptance relative to adaptive ERP		
<i>FRUGAL</i>	Lower information improvements relative to adaptive ERP	Higher operational improvements, higher information improvements, higher degree of goal achievement and end-user acceptance relative to straitjacket	
<i>RADICAL</i>	Lower operational improvements and lower degree of goal achievement relative to adaptive ERP	Higher operational improvements, higher information improvements, higher degree of goal achievement and end-user acceptance relative to straitjacket	Larger information improvements, higher end-user acceptance, and higher operational improvements relative to frugal ERP. Lower degree of goal achievement relative to frugal ERP

Table 2: Predictive validity: pairwise comparisons between configurations. The table cells indicate statistically significant differences between the configurations in the row headings and the configurations in the column headings.

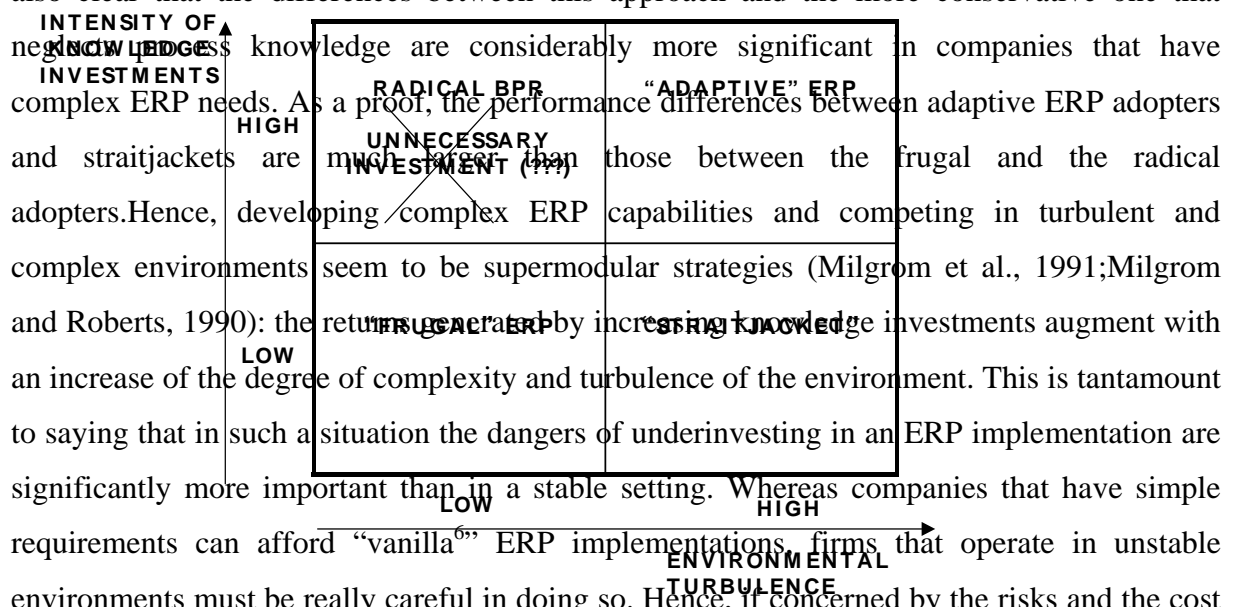
Conclusions

The stylized conceptual framework that we had initially developed suggests that companies that consider adopting an integrated information system should replace the question “which is the most effective implementation strategy?” with the more appropriate one “which strategy best fits the business requirements of our organization?”. The analysis of

over 80 ERP projects indicates the existence of four typical configurations that reflect the different operational environments and the different knowledge investments undertaken by the firms. It also indicates that these different strategies may display different degrees of efficacy, depending on the specific operational environment in which they are implemented. However, the analysis suggests that the posited contingency effect does not seem to hold evenly for the two archetypal knowledge investment strategies that we have found to be most common across adopters.

First and foremost it is quite evident that complex and dynamic environments generate ERP needs that are more difficult to satisfy than those produced by simple and stable operational contexts, regardless of the implementation strategy. Ceteris paribus, simple and stable conditions are likely to be more compatible with the nature of the technology (which is de facto a global process integrator) and appear a more suitable ground for its adoption.

That said, it is also clear that the returns generated by the two strategies followed to develop ERP capabilities are different, and that the magnitude of this difference is influenced by the external environment. On the one hand, generating adaptive ERP capabilities built upon deliberate knowledge investments is more likely to guarantee an increase in operational performance, even for companies that operate in stable environments. On the other hand, it is also clear that the differences between this approach and the more conservative one that develops complex ERP needs are considerably more significant in companies that have complex ERP needs. As a proof, the performance differences between adaptive ERP adopters and straitjackets are much larger than those between the frugal and the radical adopters. Hence, developing complex ERP capabilities and competing in turbulent and complex environments seem to be supermodular strategies (Milgrom et al., 1991; Milgrom and Roberts, 1990): the returns generated by increasing knowledge investments augment with an increase of the degree of complexity and turbulence of the environment. This is tantamount to saying that in such a situation the dangers of underinvesting in an ERP implementation are significantly more important than in a stable setting. Whereas companies that have simple requirements can afford “vanilla” ERP implementations, firms that operate in unstable environments must be really careful in doing so. Hence, if concerned by the risks and the cost associated with a “full implementation”, they should probably consider whether to adopt the system at all, rather than to compromise and adopt a low-cost solution that entails a number of additional disadvantages, especially in the long run.



⁶ In the ERP jargon, this term defines projects where BPR and software customization efforts are limited to a minimum or affect only few business processes (Davis, 1998).

Figure 1: Four configurations of ERP adopters

The results have also interesting managerial implications. Companies that operate in complex and turbulent markets, characterized by rapid technological changes, unpredictable demand patterns, and by the continuous emergence of new business models should consider whether an ERP implementation is appropriate at all, even before discussing the type of implementation to adopt (not to mention the choice of a particular vendor). They should also consider whether they possess enough resources/expertise to conduct a radical reengineering of their processes and to accompany the process codification efforts with appropriate upfront investments in process analysis. Conversely, firms that operate in very stable environments and have limited needs for integrating their processes across different locations should consider whether the results of a full-scale implementation would be worth the efforts and the investments they require.

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