Enterprise Resource Planning and the Price of Efficiency: The Trade Off Between Business Efficiency and the Innovative Capability of Firms

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ABSTRACT Enterprise Resource Planning (ERP) business software offers the integration of business functions and can reduce data collection and processing duplication efforts. It has become one of the most successful products in the world. For many firms such as Microsoft, Owens–Corning, ICI, UBS and Procter & Gamble, it has changed the way they work (see Gartner, How Procter & Gamble runs its global business on SAP, CS-15-3473, Research Note, 25 February 2002). The market leaders in this highly lucrative business-to-business market are SAP, Oracle, Baan and PeopleSoft. This paper reviews the ERP and innovation management literature in order to shed light on the potential problems that may exist in rigid ERP systems. It seems there is increasing evidence that firms fail to obtain the benefits of these investments within the anticipated timeframes (B. dos Santos and L. Sussman, Improving the return on IT investment: the productivity paradox, International Journal of Information Management, vol. 20, No. 6, 2000, pp. 429–440). Moreover, and possibly of greater concern is the affect on the firm’s innovative ability. Especially in some creative working environments where previously autonomous and creative individuals are now being restricted to what’s on offer via ‘pull-down’ menus.

Introduction

Innovation is rightly recognised as one of the key instruments through which firms can gain advantages over their competitors. As a result substantial efforts have been undertaken with substantial resources to try to uncover how firms can become more innovative. As one might expect there are a variety of prescriptions, many of which are product and industry specific. There is plenty within the literature on the organisational characteristics that are necessary for innovation to occur. There is a significant amount of literature on the strategic dimension of competition. Many writers on innovation consider it mainly as a process that needs careful management, while others view innovation more as a cognitive and behavioural phenomenon. Despite their differences, most of these writers seem to accept that innovation is a phenomenon that can be subjected to human control and is considerably affected by human interaction.
Indeed, we know that individuals create knowledge through collaborating with others in groups/teams in an organisational context. In today’s competitive and complex business environment, helping individuals to achieve their full potential and contribute new knowledge is a critical management issue. It is because ERP systems have such a significant impact on the organisation, the working practices of individuals and on human interaction that we wish to explore their impact on innovation.

The roots of ERP systems can be traced back to Manufacturing Resource Planning (MRP) systems developed and implemented across the world in the 1970s and 1980s. Manufacturing firms implementing such systems reported improvements in control of stock, improved efficiencies in their supply chains and improved co-ordination between finance, sales and manufacturing operations. The technology was used to optimise well-defined, discretely functioning areas within enterprises. Information specialists created and maintained application software to automate certain business functions and link these together. ERP systems have taken this further by linking together all functions of an enterprise including HRM, marketing and R&D. The rationale for this is that in order for firms to compete successfully today they must produce their products better, faster and cheaper, and it is argued this can best be achieved through integration of all the information systems held within an enterprise. Substantial claims are made about the software’s capabilities. A complete system could take several years and several hundred million dollars to deploy.

Technology and the use of information have also affected the structure of organisations. Smaller work units and decentralisation through networking are common examples. Similarly office automation and the evolution of telecommunications are affecting the way organisations conduct all business processes and activities. It is, however, the ability of organisations to adjust to these changes that is the difficult part because the speed of change is almost always faster than the speed of the organisational response.

The evolution of computers has been followed by the evolution of software planning tools for the manufacturing enterprise. MRP systems were introduced in the mid 1960s as the first tool for planning material functions. This idea evolved to Manufacturing Resource Planning (MRPII). MRPII was designed not only to control material but also to plan and manage capacity. As the processing power of computers increased ERP systems evolved and began to grow and add enhanced functionality. The differences between ERP and MRP systems are now numerous. According to Ptak ERP systems use relational databases, fourth-generation languages, integrated computer-aided engineering tools, open system portability for the integration of systems such as advanced planning and scheduling (APS), finite scheduling systems and manufacturing execution systems (MES). All these advances in technology supported the birth of ERP systems. Additionally, companies in the last decade had embraced theories and philosophies related to supplier partnerships and just in time (JIT) in order to remain competitive. Therefore, the evolution of ERP systems was a logical step on the evolutionary path of computer tools that began in the 1950s. Indeed, electronic business processing (e-Business) in general and ERP systems in particular are now driving the world of commerce to more open communications.
protocols and systems. In addition, ERP providers have evaluated the potential opportunities of the sector and support their customers in numerous ways. For example, SAP AG implements applications for supporting customer requirements in the new global economy. The mySAP service is offered in order to support on-line services, including web transactions and on-line and real time information.

ERP systems then focus on supporting the supply chain processes, which are involved in the business operations. This is the reason why ERP systems are sometimes referred to as supply chain management software (SCM). While ERP systems support business functions there are many drawbacks that need to be considered before their implementation and use. There are some logical steps that have to be followed in order to fit these systems to a company, but this is a moot point. Few technologies have raised so much controversy as ERP systems have over the last 10 years. Because ERP systems are designed in order to enhance e-business the strategic decisions based on the capabilities that they offer should be well considered especially the effect on a firm’s innovative capabilities. ERP vendors argue that their systems are a gateway to the emerging and evolutionary electronic economy. Therefore their evaluation by the customer should be thorough. Substantial research and self-analysis is needed in order to understand the advantages and disadvantages of using ERP systems especially for the small and medium enterprise (SME) sector in which investments in information technology is a matter of avoiding disintermediation from the marketplace. The selection of the right ERP system, however, is not an easy decision. According to Siriginidi there are certain criteria related to the selection of the ERP provider. Some of them are:

- The stability and the history of the vendor
- The implementing/installers
- The implementation support offered
- The record of sales of the ERP provider for the last 12-month period
- The availability of third party additional products to the ERP package
- The potential improvements of the selected ERP package

Organisations with experience of ERP systems suggest its implementation requires reinventing the organisation. This is because the integration of the operations across the whole organisation is not a trivial project and all the relevant issues should be considered before and during the implementation of an ERP system. ERP systems do not fit easily to any organisation. This fact introduces lists of benefits and limitations that arise during and after the implementation.

Given the above discussions the next section develops our key research proposition by exploring information exchange, tacit knowledge and the role of individuals in the innovation process. Section 3 addresses the efficiency gains from ERP Systems, while Sections 4 and 5 explore specific limitations of ERP systems. The final section pulls together some management implications of the trade off between efficiency and innovative capability.
Information Exchange, Tacit Knowledge and the Role of Individuals in Innovation Process

The management of innovation is a large and diverse body of literature. It recognises that while there is much complexity and uncertainty in managing innovation and new product development much is known.\(^1\) There is considerable agreement on many of the factors that contribute to success and the activities and processes that need to be undertaken if innovation is to occur. It is the development of network models of innovation that have helped highlight the prominence now given to internal and external interactions within the innovation process.\(^2\) For example, while the interactions of the organisational functions inside the organisation are important, so too are the interactions of the functions with the external environment. It is now accepted that, for innovation to occur, individuals within the firm especially scientists and engineers, need to be continually interacting with fellow scientists in universities and other firms about scientific and technological developments.\(^3\) Similarly the marketing function will need to interact with suppliers, distributors, customers and competitors to ensure the day-to-day activities of understanding customer needs and getting products to customers is achieved. Business planners and senior management will likewise communicate with a wide variety of firms and other institutions external to the firm, such as government departments, suppliers, customers, etc. All these information flows contribute to the wealth of knowledge held by the organisation.\(^4\) Recognising this, capturing and utilising it to develop successful new products is the difficult management process of innovation. Indeed, it is the interaction of these internal functions and the flow of knowledge between them that needs to be facilitated.\(^5\) Similarly, effective communication with the external environment also requires encouragement and support.\(^6\)

Innovation has been described as an information creation process that arises out of social interaction.\(^7\) In effect, the firm provides a structure within which the creative process is located.\(^8\) These interactions provide the opportunity for thoughts, potential ideas and views to be shared and exchanged. However, we are often unable to explain what we normally do; we can be competent without being able to offer a theoretical account of our actions.\(^9\) This is referred to as ‘tacit knowledge’.\(^10\) A great deal of technical skill is ‘know-how’ and much industrial innovation occurs through on-the-spot experiments, a kind of action-oriented research with ad-hoc modifications during step-by-step processes, through which existing repertoires are extended. Such knowledge can only be learned through practice and experience. This view has found significant support from a study of Japanese firms;\(^11\) where the creation of new knowledge within an organisation depends on tapping the tacit and often highly subjective insights, intuitions and hunches of individual employees and making those insights available for testing and use by the organisation as a whole. Hence, this implies that certain knowledge and skills, embodied in the term ‘know-how’, are not easily understood, moreover are less able to be communicated.

In addition to informal interactions, the importance of formal interactions has also been highlighted. There is a substantial amount of research stressing the need for a ‘shared language’ within organisations to facilitate internal
communication. The arguments are presented along the following lines: if all actors in the organisation share the same specialised language, they will be effective in their communication. Hence, there needs to be an overlap of knowledge in order for communication to occur. Such arguments have led to developments in cross-function interfaces, for example between R&D, design, manufacturing and marketing. Concurrent engineering is an extension of this; in this particular case a small team consisting of a member from each of the various functional departments manage the design, development, manufacture and marketing of a product.

This introduces a tension between the need for diversity, on the one hand, in order to generate novel linkages and associations, and the need for commonality on the other, to facilitate effective internal communication. Clearly there will be an organisational trade-off between diversity and commonality of knowledge across individuals. The above discussions introduce our key proposition that rigid ERP systems hinder the innovative ability of firms.

Positive Impact of ERP Systems on Organisational Performance and Innovation

Many companies using intranets, extranets and the World Wide Web have seen ERP systems as the perfect interorganisational information system. Intranets are supposed to promote knowledge sharing and therefore are the perfect infrastructure for an ERP system. Given that large and integrating technologies such as ERP systems affect the entire organisation, such systems are able to support multiple suppliers, multiple plants, multiple currencies and are virtually able to schedule an entire organisation. It includes functions such as plant management, inventory control and order processing and also integrates other processes such as human resources, procurement, transportation and distribution. A major advantage of ERP is that it provides a centralised repository of information for the massive amount of transactional detail, which is generated daily. ERP manages to connect suppliers, customers and distributors; the overall benefit is that information is shared on the ERP platforms among all the members of the interaction. Indeed, the management literature is full of case studies illustrating the benefits and virtues of ERP systems, e.g. Anglian Water, Unilever, Sunburst Hospitality Corp., Hi-Bred International Inc.

ERP systems also provide better opportunities for linking with e-commerce applications. The continuous data update of ERP systems allows hooking e-commerce applications to the ERP’s backend and meeting their requirements. The interoperability of these systems appoints them to be adaptive to any technology advances of the future. ERP systems not only integrate various business functions, but also provide back office support with standardised processes and information bases. Additionally, they support front-end applications, which handle customer and supplier transactions, update information records and control inventory.

ERP systems manage to map real world activities of a business in their database and therefore control all modules of business functions using common data resources. Enterprise-wide software such as ERP allows continuous updating of a central database in which every business process is recorded. With
such an impressive role-call of potential benefits it is small wonder then that commentators have suggested that ERP systems can make a significant contribution to a firm’s competitive advantage and market performance. Indeed, ERP systems are increasingly being referred to as Enterprise Business Intelligence Systems (EBIS).

In summary some of the potential benefits of implementing ERP systems are:

- More efficient business processes;
- Reduction of costs to several business procedures;
- Better coordination and cooperation between functions and different company departments;
- Better management monitoring and controlling functions;
- Modification and adaptation abilities accordingly to company and market requirements;
- More competitive and efficient entrance to electronic markets and electronic commerce;
- Possible redesigning of ineffective business functions;
- Access to globalisation and integration to the global economy;
- Inventory visibility and better decision support;
- Active technology for market research and media environment;
- Improving communication between partners of the channel.

Enterprise business intelligence systems in general have difficulties that may not lead to their successful implementation in the business processes. The successful implementation of enterprise-wide software depends on a number of essential factors:

- The integration of ERP into the corporate strategy;
- The involvement of business managers in its purchase;
- The careful implementation including user involvement to foster acceptance and adequate training provision;
- The federated approach adopted.

Above all, internal functional managers should drive the success of enterprise business intelligence. Past ERP implementations have shown that the companies that were most successful were those that had viewed them primarily in strategic and organisational terms instead of focusing on technical aspects. However, analysing the operations, which are enhanced by the use of ERP systems is a process that identifies their advantages and the potential vulnerabilities. Companies need data sharing in order to support their operations. ERP systems use data-centric computing models instead of client/server computing. ERP systems require multiple interdepartmental systems to cooperate and be adjusted to business needs and operational activities. Centralised databases are often used by ERP systems since these redeem the data-centric computing models. ERP systems may well contribute to a company’s efficiency, but have vulnerabilities and need careful installation, use and update. The human factor is now recognised as of major significance for all the steps of installing and using ERP systems.
Limitations of ERP Systems: the ‘Expectations Game’ and Long-Term Flexibility Needs

ERP products such as R/3 require huge investments in money, time and resources and any decisions of implementation should be carefully considered. Firms should not expect software vendors to inform them about their products’ weaknesses, indeed firms should expect to have to ‘dig’ into the detail of every important point and evaluate the limitations and any drawbacks themselves.

The functional division between vendors and implementers of ERP products frequently leads to a ‘bidding game’, where sales teams acting for vendors raise overoptimistic expectations in order to get lucrative contracts and implementers are then left to deal with the expectations delivery gap once the contract is won and implementation starts. The sales teams acting for vendors feel that they have to promise a maximum to gain the contract. They know that buyers have to justify their purchasing decision with significant anticipated efficiency and cost saving gains that leave little room for cautious promises and safety margins. For vendors to get a contract, they need to promise the maximum and to leave the problems for the implementers to deal with. This competitive bidding game must necessarily lead to disappointment and to enormous pressure on the implementers. Once promises can not be kept, the relationship can easily get strained and mutual trust can be eroded.

There is also incongruence between what is expected in the short term and the long term. Many of the cost savings are long term, whereas in the short term there is often only disruption and chaos. A humorous story within the industry of ERP is that SAP is an abbreviation for Stop All Production. There is plenty of evidence to suggest it can take several years for an ERP system to be successfully implemented owing to its vagueness and the different needs of each company. ERP systems affect the entire organisation and all the possible business functions and therefore, delayed and problematic implementation can prove expensive for the organisation. However, even if obstacles are overcome and ERP implementation may seem successful in the medium term it can still prove a failure because of the long-run implications of the project. The reason for this is that there can be a problem with flexibility and the need to constantly adapt to a changing business environment.

The decision to invest sometimes hundreds of millions of euros or dollars in an ERP system necessitates strategic planning for the long-term, if only to ensure a return on investment. However, such long-term planning for the way a business intends to operate may reduce a firm’s flexibility to respond to industry challenges. For example, a firm may seek competitive advantage in a fully integrated ERP system only to discover later that a concentration on core competences would involve outsourcing key parts of the very system that has been integrated with a major ERP investment programme.

ERP and its Impact on Creativity and Innovative Ability

From a macro perspective ERP systems have many disadvantages especially for small and medium enterprises, which are difficult to overcome. The marketing
departments of many software firms, however, over promote a technology years before it proves its value. This fact is of major significance for companies that are interested in ERP systems because they might be attracted by the theoretical advantages that ERP systems offer ignoring the drawbacks, which appear during installation, implementation and use.49

So far we have highlighted some of the drawbacks and difficulties associated with ERP systems implementation. They can be summarised as:

- Very expensive and long term investments;
- Very complex and large systems;
- Over-reliance on the ERP providers;
- Difficult to change and modify;
- Gains for some organisations may seem elusive.

We now turn our attention to our research proposition: the impact of ERP systems on the innovative ability of organisations and on the existent company operations.50 In short, ERP systems very often require a reconfiguration of work processes and routines. Many people, however, feel unhappy when they are asked to change established ‘ways of doing things’ and they may rightly feel that new standardised work processes may undermine their autonomy enjoyed in current non-standardised operations. ERP systems, however, can only deliver the promised efficiency gains with a standard information set and leave no alternatives to a standardised approach. However, it is not only that information processing and work routines have to be standardised; with an integrated system everyone’s performance and achievements become much more visible. Information sharing can easily be perceived as serving the purpose of tightening management control if the organisational climate has deteriorated in the ERP implementation process. If employees feel that they are losing their autonomy and that they are subjected to a culture of instant accountability, then this may have dramatic effects on their productivity and creativity and may nullify some of the potential ERP gains.

**Tacit Knowledge, Rich Information and Staff Morale**

There are several ways in which ERP systems operations may have a negative impact on individual creativity. First of all, ERP systems may reduce the richness of information content when informal communication processes become increasingly replaced by standardised data exchanges made available through ERP systems. We referred earlier to the fact that tacit knowledge is very important for organisational innovation and that tacit knowledge is embedded in social processes. If ERP becomes the key communication medium and information has to be made palatable to its data requirements, then tacit knowledge outside the system may be sidelined.51 As a consequence, explicit knowledge may get preference over tacit knowledge, but individual and group creativity is not only dependent on rich information. There are motivational factors at work as well. If ERP leads to a culture of instant control and accountability, then this may undermine the intrinsic motivation of employees and may lead to a culture where risk taking and experimentation becomes
increasingly less desirable. It will always be safer to use the available ERP data than to look elsewhere for inspiration. Diligent users of the ERP system are more difficult to blame for their mistakes or lack of achievement. ERP can become a very useful legitimating tool.

Technology and Work Processes

The users’ approach is very significant while the system is being set up. The user is the most appropriate link in the interaction for the evaluation of the system. Most firms, functions and departments will be familiar with a variety of Management Information Systems (MIS). These, however, are required to sit on top of an ERP system. They extract data and then allow it to be viewed (sliced and diced) in numerous ways. These normally get updated every 24 h and are used by management on a weekly or monthly basis. The main distinction between ERP systems and other MIS is that ERP focuses on the integration of a firm’s functions such as: Finance, Production, Warehousing, Sales and Distribution etc. Therefore it is an on-line transactional processing (OLTP) system, that is, to take a sales order and offer a delivery date to your customer you must key the details into the system. The data needs to be entered in real time. This is frequently cited as an enormous change in working practices. Departments are more familiar with a system that gets the goods out the door and then catching up on the transactions the next day.

While there is much made of the ability to fit the system to a business’s own needs, ERP systems are nonetheless based on a common platform that one solution fits all types of business, that is, purchasing is purchasing no matter what business you are in. It is true adjustments and modifications can be made to fit a firm’s specific requirements, but it is unlikely to fit all of a firm’s customers’ requirements in all areas.

Routines and Procedures

More significantly, firms must recognise that ERP systems (like any databases) are driven from master data such as customer records, Bill of Material records (BoM), and like other databases are unforgiving. Get a field entry wrong and it can cause serious problems. Most likely the internal logic of ERP systems will require large amounts of time being devoted to ensuring the correct entry is made. This is yet another example of how the IT infrastructure is impacting on people’s working practices. A simple example may be useful here. Consider the activities of an architect working for a major property developer in Europe. The architect develops a variety of homes for consideration and specifies the building design and materials required. While in the past the architect may have flicked through some trade catalogues or contacted suppliers for what might be available, now all possible options available are prescribed via a pull-down menu. The advantages are clear to see: reduced time searching and order processing at the press of a few keys, but what about the impact on the creativity of the design of the building?
Management Style

We have seen that the literature on innovation places great emphasis on the role of the individual in the innovation process; hence any restriction on the activities of individuals would clearly be viewed as potentially harmful in terms of innovative capability.\textsuperscript{52} The working environment within an ERP system requires individuals to operate in certain ways and follow set procedures. Indeed, departments have to learn to recognise the impact of their actions or lack of action on others. Prior to this, departments probably had peculiar ways of working that have grown up through custom and practice, but these have to be replaced with a universal accepted way of working. This places great emphasis on the training during and after implementation.\textsuperscript{53}

Discussion and Management Implications

This paper has discussed the well-documented benefits that ERP systems can deliver, and it has also emphasised the potential limitations of such systems that are not so well understood. Moreover, it is the impact on innovative capability that is the cause of most concern.

ERP is expensive both financially and in terms of its impact on organisational processes. It is a practice often driven by a drive for efficiency and cost savings, but needs to be aligned with long-term strategic direction of the organisation. ERP represents the spirit of integration, rational planning and management control, although it can be modelled to open avenues for greater participation and transparency. If employees see and experience mainly instant controllability and a reduction of autonomy this may seriously hinder the creative potential of the enterprise. Senior managers contemplating the introduction of an ERP system need to consider carefully the potential detrimental affects, so frequently overlooked in the literature that such a system may bring to their enterprise. Unlike other IT MIS, ERP has a dramatic impact on the way people work. Indeed, such systems force change on an organisational structure, working practices, policies and procedures. The interdependence of the organisational components is never more clearly illuminated. Moreover, it is the knock-on effects of ERP in other aspects of the organisation such as staff skills, budgets, performance measurement procedures and so on that frequently cause most angst.

The level of personal autonomy individuals have and perceive to hold, as well as the loss of perceived created space, is frequently cited as one of the key people issues during the implementation of ERP systems.\textsuperscript{54} There is much more emphasis on correct routines and prescribed ways of working, indeed individual peculiar working practices have to be removed for ERP to be effective. Staff may find their daily activities dominated by highly prescriptive procedures on their computer screens. Indeed, previous diverse means of communication is replaced by a more standardised approach resulting in a loss of richness of data. The overall perception is often one of the enterprise moving towards a more autocratic, centralised management style.

The key for ERP success is acceptance and leaving or creating more space for
creativity and information exchange. ERP should not dominate organisational practices, even if limiting its scope may well reduce the scope for efficiency gains. Senior managers may wish to consider carefully between a full-blown firm wide system and a more selective implementation, which may preserve space for creativity and innovation.

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