

Integrating ERP into the Organization: Organizational Changes and Side-Effects

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Abstract

Faced with increasingly strong and varied forms of competition, firms are seeking more efficient organizational models. At the same time, the widespread application of information and communication technologies (ICT) is transforming the manner in which the information required for coordinating the units within an organization is collected, exchanged, and stored. The question then arises of how the installation of an Enterprise Resource Planning (ERP) program may affect these coordination mechanisms. The subordination of technological change to organizational change appears to underestimate the scope of the transformations that ERP can bring about within an organization. Theoretical and empirical arguments lean towards attributing direct effects to ERP, believing it to possess intrinsic organizational virtues. Because of the difficulty of making an ad hoc inventory of organizations employing ERP software, earlier statistical studies have largely ignored the integration of ERP into the organization.

Keywords: ERP, Organizational change, Coordination, Learning

1. Introduction

To clarify the issues surrounding the integration of ERP and organizational change, a simple, robust analytical framework was constructed, designed to enable the discussion and validation of various basic speculations.

We first present the foundations of the approach we have adopted, and then define the concepts of ERP and organization that we intend to apply. This approach is based on a dynamic relationship between technology and organization formulated in terms of coordination, the organization being by turns that which controls the integration of ERP software, and that which is transformed by it. The next section is devoted to the organizational changes connected to the incorporation of ERP, and then to its effects on the mechanisms for coordination between the organization's units. Lastly, we discuss the nature and role of the resulting learning effects within the organization.

1.1 *The Integration of ERP into an Organization*

In recent years corporate managements have faced a technological tipping point: integrated management (ERP) software packages are becoming the central component for collecting and applying management information (Grandlund and Malmi, 2002; Kocoglu and Moatty, 2010). In the fifteen years from the emergence of ERP to the widespread use of this tool, the majority of major companies have adopted or attempted to adopt its software. At both the practical and technical levels, this represents a substantial innovation which requires a comprehensive integration of the information process. One of the main benefits of integrating ERP into the organization is the ability to manage large quantities of data within a single, shared system. Over and above this significant technical advance, the installation of an ERP system presents a real opportunity for improving the firm's organization. In this regard the adoption of ERP constitutes a significant incursion into the firm's organizational life, and as such it is viewed as a real agent and actor for organizational change (Hanseth and Braa, 1999; Geffroy-Maronnat, 2010).

When we discuss ERP, the question at issue is whether it is the ERP system that (re)structures the organization, or whether it is the organization that determines the possibility of integrating ERP. In practice, the ERP system and the organizations determine the matter mutually, depending on the degree of advancement of the processes developed by the organization to order its activities.

1.2 ERP and Organizations

The dialectics of the relationships between ERP and organizations are particularly intense, since ERP systems represent technologies that act directly on the mechanisms that coordinate the organizations' components. The relationships between these technologies and the organizations are therefore intimate ones. The organizations' characteristics thus appear as constraints on the introduction of ERP. These characteristics are often determined by the nature of the firm's activity and environment. Organizations are not structured so as to introduce technologies - technologies are introduced to improve the organizations' efficiency.

Once they have been incorporated, ERPs contribute to changing the relative efficiency of organizational mechanisms (Spathis and Constantinides, 2003; Rowe & al., 2011). For example, if it is shown that ERP acts to increase the efficiency of a hierarchical decision-making system, by short-circuiting some of the intermediate levels of data-collection or the transmission of instructions, the potential reduction in hierarchic levels will lead to significant changes in the organization's structure and management.

We will begin by setting out the analytic components required for an investigation of the relationships between ERP systems and organizations.

1.3 Organization and Coordination

The neo-institutional theory (Coase, 1937, Williamson, 1985 and 1995) provides a convenient framework for analyzing the relationships between ERP and organizations, if we look at the organization as a set of coordinating mechanisms mainly intended to process and solve information problems (asymmetries of information, transaction costs arising from the need to collect and process information, etc.) and based on behavioral theories (bounded rationality, opportunism, etc.) which are also grounded in the connection between agents and the processing of information.

If we agree with Mintzberg (1979) in defining coordination as "the glue in the structure, the basic element which holds the parts of the organization together" and consequently see the organization as a set of mechanisms intended to solve the problems of coordination, we may then describe the organization as an assemblage combining two kinds of coordination mechanisms. One kind, related to the decision-making system and the division of labor between units, defines the structural features of the organization: its organizational mechanisms. The other kind clarifies the choices which, within these mechanisms, describe how agents resolve problems of the consistency of actions and of meeting commitments, i.e., the rules.

This instrumental approach is useful in analyzing the organizational determinants of integrating ERP and, conversely, the impact of ERP on an organization. It will be supplemented by a more dynamic concept of the firm, taking into account some of the related effects on the organization over the longer term.

Any organization can be broken down according to two elementary coordination principles: the hierarchization of its units, and their interdependence. The combination of these principles allows us to define various types of organizational architecture. Reflecting their architectures, the information flows generated by the hierarchic principle and by interdependence among units will have different information densities, and must conform to a standardization which will be more or less comprehensive.

Hierarchization is the coordination principle which refers to the manner in which authority is distributed among the various components of the organization. This distribution of authority may be centralized, decentralized, or hybrid. A hybrid form is considered desirable, to allow for the reality on the ground. This hybrid form is located on a continuum, where the traditional forms represent the extremities. When one unit centralizes all the authority, stipulating to the other units the way in which they should behave, the information flows between the various hierarchic levels are large, frequent, and usually follow procedures defined in advance.

Interdependence refers to the way in which the work process is divided up within the company. It is characterized by the amount of autonomy that the units have in carrying out their tasks. The division of labor may be specialized, or alternatively may be based on a high degree of integration of the tasks. In the case of specialization the units are responsible for clearly-defined operations, whose execution assumes frequent, complementary interactions. In contrast, integration amounts to entrusting each unit with the coordination of a variety of tasks. In this case the units are less interdependent. In architectures based on specialization, the interdependencies between units are more significant and more frequent than in architectures based on integration. It follows that the needs for interactions and

thus for exchanges of information are more intensive in organizations whose architectures are based on specialization.

1.4 Nature of the Information Flows

The integration of ERP remains dependent on other variables such as the nature of the activities and the environment. In fact, it will depend on the activities, the more or less voluminous and more or less regular information flows between the units, the more or less easy-to-codify relationships, and so on. All these characteristics influence the relative significance of integrating an ERP system.

ERP systems provide automatic processing, transmission, restitution, and storage of information. The basic problem is that of the relationships between ERP and the coordination mechanisms (Grandlund and Malmi, 2002; Kocoglu and Moatty, 2010). Coordination mechanisms are based on the transmission of information flows between units. We may distinguish two main categories, based on the greater or smaller informational intensity of the coordination mechanisms, and the more or less standardized nature of the procedures for coordinating and processing information.

The informational intensity of a coordination mechanism is measured by the volume, frequency, and regularity of the information flows exchanged between the units. Low-volume exchanges, overly rare occurrences, or irregular relationships between the units do not require the installation - and do not always allow the profitability - of technologies which provide automatic transmission of information flows. As with any technology, ERP involves investments that are subject to criteria of utility and profitability.

The requirement for standardization affects the procedures for exchanging and processing information (Bernier, Bareil, and Rondeau, 2003; El Amrani & al., 2006). Firstly, it may be difficult or even undesirable to formalize the information exchanges which occur in the process of coordination. This is the case for the exchanges known as mutual adjustments, which do not follow procedures defined in advance but take place in the framework of uncoded interactions between units. It is often risky to make them automatic, because the units would lose the flexibility conferred by informal interactions, especially in situations of uncertainty. The use of ERP systems in coordination is thus closely linked to the nature, formal or informal, of the procedures which govern the inter-unit relationships.

Lastly, the information-processing procedures must be sufficiently uniform (Grandlund and Malmi, 2002; Sangster, A., Leech S.A., Grabski, S., 2009). Heterogeneous procedures are almost immediately expressed in high costs for the formalization of information. Information-processing procedures may be heterogeneous for a number of reasons. The lists used to codify the information may differ from one unit to another, similarly for the layouts of documents, the kinds of software, and the equipment employed. The existence of differing procedures for processing information thus constitutes a severe practical obstacle to the automation by ERP systems of the flows of information between organizational components.

The combination of the aspects identified (hierarchy and interdependence) and their various modalities enable the construction of a practical framework for analysis:

Insert Table 1 Here

The combination of two systems of coordination - hierarchization and interdependence - defines five types of organizational architecture. Each of these architectures is in principle characterized by a more or less intensive need for coordination and by whether or not it meets the requirement for standardization. They indicate the potential difficulties of integrating an ERP system and thus the organizational changes that must be implemented.

❶,❷ ERP is primarily employed in centralized architectures, because its information flows are numerous, follow formalized procedures, and are conveyed by homogeneous languages. Moreover when the architecture is specialized, ERP systems also see intensive use in the horizontal coordination between units.

❸,❹ On the other hand, their use runs into difficulties in decentralized architectures, where coordination relies on other tools in which there is a substantial amount of mutual adjustment. In addition, the insignificant information flows in vertical coordination, and the difficulty of meeting the requirement for standardization, are further obstacles to the installation of ERP. When the architecture is decentralized and specialized, there is likely to be a considerable need for horizontal coordination, but since decisions are decentralized the horizontal coordination tends to take place via mutual adjustments carried out as the need arises, which do not lend themselves to automation.

❺ In hybrid architectures, intermediate between the centralized and decentralized forms, the difficulty of integrating an ERP system is intrinsically linked to the nature of the hybrid architecture. These structures, found in almost all organizations (and often run by a manager whose decision-making power is poorly defined and who consequently

has difficulty in making decisions), favor the development of resistance to change and of difficulties in formalizing hitherto non-existent procedures.

To sum up, in organizations whose architectures are centralized and specialized, the integration of an ERP system is easier. Moreover the information-processing procedures tend to be standardized and assigned to a single authority. All the factors thus combine to make it easy to integrate ERP into the coordination of units along the line of authority. In certain cases the constraints of this adaptation will be costly, and may create significant organizational discords.

2. Effect on the Systems of Coordination

Implementing an ERP system to improve coordination between units has consequences for the organization. The analytic framework set out in Table 1 indicates that ERP systems may encourage the adoption of centralized and specialized architectures, since they strengthen relative efficiency. Nevertheless, it remains true that the role played by ERP in the organization's architecture is dictated by much more decisive factors, such as the need to adapt to the conditions of the market. For this reason the impact of ERP on organizations is seen more in their operating systems than in their architectures. We now discuss this type of impact.

2.1 ERP and Operating Systems

If ERP systems have an effect on an organization's operating systems, it is because they alter the relative efficiency of the various kinds of system. In general, the adoption of new systems results from a need created by external pressure, e.g., new standards. ERP can make it easier to adopt them, but it is a consequence, not a cause. It is nevertheless true that ERP can play a major role in the selection of operating systems. Although the general nature of a system of behavior is to represent a knowledge-based and therefore an information-based economy (Favereau, 1989), some systems require more information than others and/or a more complex processing and a shorter reaction time from the units. The more information the system uses, and the more complex and time-limited its processing, the more the use of ERP will improve the relative efficiency of the system (Brousseau and Rallet, 1997).

2.2 Sets of Mechanisms

The limited rationality of agents, and the presence of asymmetries of information, situations of uncertainty, and problems of opportunistic behaviors by agents, makes it necessary to have coordination mechanisms based on operating systems. We will attach to their basic features any real coordination mechanism that is a combination of these features (Brousseau, 1995). We will restrict ourselves to systems likely to be affected by the use of ERP, because ERP is closely linked to information-management processes. More specifically, we will describe all of the operating systems in terms of the two major types of problems that they must address: to ensure the compatibility of the agents' actions, and to force them to meet their commitments (Brousseau, 1996).

Compatibility of actions requires that systems be set up that dictate to the agents the behavior that they must adopt during the coordination process. The mechanisms that ensure this compatibility are of two kinds: rules, and the principle of authority, depending on whether the behaviors are defined *ex ante* at the time of establishing the contract, or *ex post* when it is carried out.

Rules consist of defining *ex ante* all of the possible behaviors, in a contingent fashion according to the various world states envisaged. Authority systems (Williamson, 1985, Ménard, 1990) describe the agency which, designated as the authority, will define *ex post* the behaviors which the agents must follow (delegation of authority). In a situation of uncertainty and over relatively long periods, none of the alternatives is optimal, and any organization will appear as a mix of rules and authority systems. The issue is to know whether ERP systems can alter the proportions of these mechanisms. The meeting of commitments made by the agents in order to comply with the rules or with the decisions of the authority requires the establishment of special mechanisms. Without these mechanisms the agents would tend not to meet the obligations they make, which would at once remove all efficiency (individualism). A traditional response is represented by reprisal mechanisms and incentive mechanisms. Reprisal mechanisms are based on the idea that if the costs of breaking a commitment are high, agents will tend to meet them, because in that case opportunistic behaviors turn out not to be beneficial (Williamson, 1985). Mechanisms which consist of encouraging agents to meet commitments by playing on their remuneration represent an alternative to reprisals. This is the aim of incentive mechanisms, which are based on the payment of bonuses (or on penalties) according to observed deviations from the norm of commitment. No solution is optimal: reprisals require a simple monitoring mechanism but the contract termination that may result from imposing them might prove to be costly for the parties involved. On the other hand, incentive arrangements involve the establishment of costly monitoring systems to accurately determine agents' behaviors and their contributions to the collective result.

Organizations usually combine incentives and reprisals according to the cost/benefit ratio of the monitoring associated with each mechanism; we wish to know whether ERP systems favor one of these types of mechanism.

2.3 ERP, Authority, and Incentives

ERP systems affect the relative efficiency of methods inasmuch as they alter their costs, sometimes in a major way. Because of their more information-intensive nature, authority and incentives represent approaches whose efficiency should, in principle, be improved by ERP systems. Since they correspond to expected behaviors, rules require little in terms of the exchange and processing of information when making decisions. Agents interpret the situation in which they find themselves and select the rule provided.

In contrast, in the case of a decision procedure based on authority - the type of decision adopted in situations of high uncertainty because it allows for greater flexibility - the authority-based decision involves the intensive management of information. The unit responsible for the decision must quickly assemble, select, and process many pieces of information and then rapidly transmit its decision. By facilitating the selection of information, by increasing the agents' computing power, and by accelerating the transmission of decisions, ERP systems lower the cost and improve the efficiency of making decisions based on authority as compared with rules. Such an impact is even more likely when uncertainty is high and demands more flexible decision-making systems.

As we noted, incentive mechanisms involve an intensive manipulation of information arising from the checks that have to be performed in order to calculate them. The effect of ERP systems is thus more conspicuous for incentive mechanisms than for reprisal mechanisms. The efficiency of reprisals is linked to their deterrent effect, designed to avoid serious derelictions whose consequences are by their nature easily observable. By lowering the costs of handling information, ERP systems are likely to alter the balance between methods whose purpose is to ensure that commitments are met. They therefore favor the incentive method. The instability of the environment in which organizations operate reinforces this tendency, because the ability to adapt which it demands of its agents depends in part on the possibility of managing their actions by means of an incentive system that is both discriminating and constantly updated (Batazzi and Alexis, 2006). The organizational impact of ERP systems is likely to be expressed by a tendency to favor the authority method for making actions compatible, and the incentive method for ensuring that commitments are met. This division will be even sharper when the organization's environment is unstable, or perceived as such by its executives.

2.4 Learning Effects and the Organization's Trajectory

The learning effects which underlie technological trajectories enable modifications and changes in the company's strategy. Ultimately, the initial conditions for incorporating ERP systems, the impact of contingent events, the inherent inertia of organizational phenomena, and learning effects offer a great variety of possible organizational trajectories.

The integration and use of ERP systems is the source of three kinds of learning, which progressively alter the organization of activities:

- In the first place, the introduction of ERPs necessitates a systematic study of the information flows which underpin the coordination mechanisms. Organizations are thereby led to model their actual operating procedures. The integration of ERP then becomes the occasion for the organization to develop a more detailed knowledge of its own functioning. The members of the organization are forced to (re)examine existing organizational solutions and to identify the inconsistencies and redundancies which characterize their information circuits. This initiates a discussion of the organization and implementation of necessary changes. The organizational changes then carried out constitute a form of organizational learning, for which ERP serves as both pretext and support (Besson and Rowe, 2001; Kocoglu and Moatty 2010).

- The second learning mechanism results from the broadening of the field of operations of information processing and of automated coordination procedures. ERP systems generate a stock of information whose use, whether local or in a network, creates tensions (access to information, validation and decision-making power, new connections between units, for example). The resolution of these tensions leads to organizational changes. The identification of local dysfunctions by applying tools for analyzing and assessing performance leads to reorganizations. The organization will evolve more or less quickly, depending on the way in which the integration of ERP is orchestrated (El Amrani, Rowe, Bidan, Geffroy, and Marciniak, 2006).

- The third mechanism is the learning of technologies by their users (Von Hippel, 1988). It constitutes another learning effect which creates organizational change. Users do not understand all of ERP's potentialities *ex ante*: they learn by doing. Learning does not only address the improvement and optimization of procedures, but also the mechanisms of coordination. This learning varies according to the ownership of usages by the users and according

to the difficulty of changing the existing coordination mechanisms. Organizations which begin by implementing ERP systems to improve the efficiency of existing coordination processes progressively discover the most suitable forms of organization for using the technologies which they are simultaneously learning to apply.

The interactions of the determinants of change which we have discussed constitute a basis for examining future organizational trajectories. Other variables need to be included in the analysis in order to make it more dynamic: barriers to exit, resistance to change, and the occurrence of contingent events.

The barriers to exit seen in the area of technical change (David, 1986; Cowan, 1990; Foray, 1991) also exist in the area of organizational change. The technical solutions adopted to resolve organizational problems involve both the physical systems, and the procedural formalizations which act to strengthen the coordination mechanisms to which these solutions are applied. They therefore commit the organizations to specific development trajectories. Assuming that ERP systems allow the promotion of incentive systems, it will be more difficult to go back to reprisals, even if the seeming efficiency of these systems leads the organization to develop a costly system of monitoring. The fact that incentives are favored will argue in favor of integrating ERP systems, which support this type of coordination. The dependence of technical/organizational change on past choices is a prime factor in explaining the variety of trajectories followed: similar external conditions (type of activity, of market, etc.) will not lead to a convergence of technical/organizational choices among different entities if their previous choices have put them onto different trajectories.

Resistance to organizational change constitutes another source of variety in development trajectories (Scapens and Jazayeri, 2003; Greenan, N., and Walkowiak, E., 2010). The organizational changes caused by ERP systems may give rise to conflicts, inasmuch as they lead to changes in the division of labor and/or needs for different skills. Such conflicts may delay or prevent change, or restrict such change to the original organization. Resistance to change may also be explained by the difficulty of predicting its long-term consequences. Mistrusting radical reorganizations, agents display a preference for localized changes or for deferred change. Such resistance, which offers substantial inertia, tends to perpetuate existing organizations, or at least forces them to develop slowly. In addition, the actors sometimes tend to use resistance to change, unconsciously at times, as an implicit tool in salary negotiations.

Once it has been completed, the integration of ERP commits the organization to a trajectory which limits its future technological options (adaptation costs, successive versions of the ERP system, exit costs) and consolidates the initial choice via learning effects. Because of this, contingent events are especially influential at the start of the trajectory, as long as a few degrees of freedom remain for making procedural choices and, if need be, to direct the learning process. There is a risk for the organization of becoming locked into a technological trajectory, assimilating contingent events as they appear until a point is reached where it is no longer possible to react to sudden changes in the environment, owing to the accumulated inertia. Such a rigid technological trajectory may sometimes expose the firm to exit and mobility costs that are unsupportable.

3. Conclusion

In this paper we have attempted to construct an analytical framework for the process of integrating ERP into organizations, based on a small number of variables which express the principal features of organizations (organizational architectures and methods of coordination). The issue selected arises from an organizational determinism tempered by a consideration of the organizational impact of an ERP system, and of learning effects. The initial conditions of ERP's integration (the various types of organizational architecture) play a determining role because they define its use and delimit the scope of its organizational impact. This impact acts mainly on the methods for ensuring the compatibility of actions and ensuring that commitments, once made, are met. ERP forces organizations to favor information-intensive coordination methods such as authority and incentives, inasmuch as changes in their environment push them in the same direction. Learning effects relay these changes over time via the knowledge which the organizations acquire about themselves and about the potential of ERP. What matters is that the technology-organization pairing should work coherently together. The development of both aspects can be achieved only through technological and organizational learning. The analytical framework proposed here cannot provide answers to all the questions raised by the organizational trajectories when looked at from a dynamic viewpoint. The choice of an ERP system actually tends to support previous choices, given that the results of radical changes are risky and unpredictable. Situations in which organizations are forced to change their operating models are situations of open crisis, where the organization's survival is threatened and it has no other choice.

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Table 1. Integration of ERP Software in Organizations (Based on Rallet and Brousseau, 1997)

		Hierarchization (vertical coordination)		
		centralized	hybrid	decentralized
Interdependence (horizontal coordination)	Specialized	❶ Strong vertical and horizontal coordination. High informational intensity	❷ Imperfect horizontal and vertical coordination Mutual adjustments. Poorly-defined decision-making power.	❸ Weak vertical and significant horizontal coordination. Informational intensity and mutual adjustments.
	Integrated	❹ Strong vertical and weak horizontal coordination		❹ Little need for coordination.