

DOES INFORMATION TECHNOLOGY ALWAYS LEAD TO LOWER TRANSACTION COSTS?

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ABSTRACT

This paper reconsiders the effect of information technology on transaction costs in view of IT externalities and coordination costs. The aim of the paper is to show that IT has ambivalent effects on the overall transaction costs. This analysis is based on the idea that IT externalities have both positive and negative effects on coordination and thus transaction costs. Two different strategies to use IT in an organizational setting are identified: one to increase the amount of information available to decision makers thus to reduce the uncertainty and hence transaction costs. The other to reduce the amount of available information to decrease the complexity faced and thus coordination and transaction costs. Finally, the effects of IT externalities impose the awareness that one strategy is not a substitute to the other rather that they can both coexist.

1. INTRODUCTION

The diffusion of information technology (IT) into society is always characterised by an increased amount of information available. Moreover, the “information society” is not only defined by the greater need for information in a greater range of human activities but also by the increased number of sources from which information emanates. More unwonted and unsolicited information is received via traditional physical channels of communication such as mails and more and more via IT communication media such as e-mail and the internet. In an era of ever shorter product life cycles and lead times, it has become essential for companies to improve their internal and external information flows. More information is necessary to deal with the emergent complexity, so faster information processing is required. A key resource for survival in the new environment is the ability to manage and to improve the information flow. As Lewis (1996) argues: “professional and personal survival in modern society clearly depends on our ability to take on board vast amounts of new information. Yet that information is growing at an exponential rate”

IT has become the major enabler for the more efficient retrieval and exchange of information in organizations. However, conflicting approaches indicate that IT is either a powerful tool to support the organisation's ability to manage information or, conversely, one that it makes the coordination the organisation's work more complex and difficult. A clear indication of the first perspective is found in the IT studies based on the transaction costs approach (Ciborra C. 1993, Malone et al. 1987, Wigand R., Picot A, et

al. 1997) Such studies clearly argue that IT is a powerful tool to support the economic system because it makes more information available so that the uncertainty faced is reduced and hence the transaction costs are lowered. On the other hand, the literature dealing with the problem of information overload underlines the negative effects of IT because a greater level of complexity is faced as consequence of the increased quantity of information made available by the technology (Palme 1984, Schultze and Vandenbosch 1998)

The transaction costs approach sees IT as a tool to sustain the information systems, simply providing the extra needed information and information management power and thus justifying the claimed positive effects. Strangely enough, the transaction costs approach, based on the economic framework, does not consider the effect of network externalities that characterises the diffusion of IT (McKnight & Bailey, 1997). The information overload analysis mainly considers the effect of externalities associated with IT and its consequences for the efficiency of coordinating an organisation's activities. The aim of this paper is to reassess the transaction costs analysis of IT in the light of the IT externalities effect and its impact on the organisation's coordination processes.

The paper is structured as follows: the next section introduces the transaction cost approach. In section three the relationship between transaction costs, coordination costs and IT externalities is discussed. Section four introduces different strategies to deal with the ambivalent effect of coordination costs and IT externalities on transaction costs. Section five discusses this strategies in the light of the use of IT to reduce coordination costs rather the transaction costs. Section six conclude the paper.

2. TRANSACTION COSTS

The new institutional economics argues that different forms of economic organizations like market, hierarchies and clans are consequence of transaction costs (Coase 1937; Williamson 1975; Ouchi 1980). These costs are generally defined as the costs of gathering information, evaluating alternative options, negotiating, contracting, and the physical transaction of the object. These costs are consequences of the complexity and the uncertainty of the economic system. Uncertainty and complexity can either be related to human behaviour or environmental and unpredictable events. They are both the outcome of an unequal distribution of information between the actors involved in the transaction. Different economic organization systems are thus defined on the basis of their efficiency in managing this uncertainty. This efficiency is measured in terms of transaction costs.

According to the theory of institutional economics, increasing the complexity of transactions will result in the failure of the coordination mechanisms within a market because the transaction costs will be too high. Therefore, as exchange related complexity increases, it becomes more efficient to use alternative governance models, such as formal organizations or clans that manage higher uncertainty with lower transaction costs. These alternative forms aim to the reduce uncertainty by using different mechanisms to manage the transaction: rules in the case of hierarchy and common beliefs in the case of clans

2.1 Transaction Costs and Information Technology

Ciborra (op.cit.), Malone et al. (op.cit.) and Picot et al (1997) argue that information technology can be used to reduce transaction costs in different economic organizations. This argument is based on the idea of using information technology to make more information available to decision makers, thus contributing to the reduction of uncertainty.

Accordingly, the information problem that jeopardizes market efficiency can be fixed by supporting the system with information technology. Information technology can be used to reduce the cost associated with transactions. Accordingly to Malone et al. (op.cit) three different effects of IT on the exchange process can be identified:

- Communication effect: increase information flux per unit of time
- Electronic integration effect: easier linkage between buyer and seller

- Electronic brokerage effect: the contracting process between seller and buyer becomes more efficient and effective.

These effects increase the smoothness of the information flow so that, supported by IT, people involved in the economic system, both market and hierarchy, can better use the existing information and deal better with the uncertainty they have to face. Accordingly, *ceteris paribus*, IT reduces the transaction costs associated with uncertainty. Therefore, the argument in favour of striving for transaction costs reduction through the use of information technology to improve the organisation's information flow is very powerful.

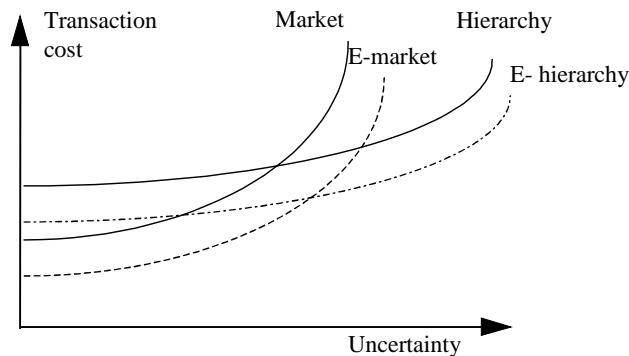


Figure 1: *IT-impact on transaction costs*

The next section introduces a more exhaustive analysis of the nature of transaction costs. This further analysis presents the functional dependency of transaction costs upon coordination costs. The effect of IT on transaction costs is then discussed accordingly to this revised model so that the IT externalities effect and its consequences on the coordination process of the organization are taken into account. Interesting outcomes emerge and unexpected consequences are highlighted so that the overall impact of IT on transaction costs and, more generally, on organization efficiency has to be reconsidered.

3. TOWARDS A MODEL OF TRANSACTION AND COORDINATION COSTS

In this section the hierarchical structure is analysed in detail using the transaction costs model. The analysis takes into consideration different categories of costs and the effects of IT support systems on the organization of the hierarchical structure.

The hierarchy has some embedded transaction costs related to the endogenous fixed costs of the maintenance of the basic needs of the organisational structure. These fixed costs are needed to establish the physical/communicational contacts between members of the organization (Bressand and Distler 1995). Among the others we can identify IT networks, buildings and other physical investments to provide the places and tools needed by the members of the organization to interact. Variable costs can be identified in coordination costs, defined as the emerging need of information and action sharing required by the hierarchical structure to support the joint action of its members (Alchian and Demsetz 1972). Moreover, variable costs “includes not only the direct cost of compiling and transmitting information, but also the time cost of the delay while the communication is taking place and while the decision is taken” (Milgrom & Roberts 1992), in other words the factors contributing to uncertainty among the members of the organization.

Following Brynjolfsson, et al. (1994), coordination costs can be further differentiated into internal and external coordination costs. The former is generated by the need to support the coordination mechanism in the hierarchical structure (information sharing, management, control system, establishment of rules and their maintenance, etc.). The latter is the cost of presentation (Williamson 1986) and the establishment of a contingent claims contract.

To have a more exhaustive understanding, a third dimension must be considered: the effects of externalities of the IT use and diffusion on the coordination costs and thus on the overall transaction costs. As a consequence of the adoption of IT, the number of possible contacts and communication channels drastically increases. IT networks are organized so that it is possible to have easy contact with all the users of the technology. The result is that the number of possible interactions is almost unlimited and the cost of interacting is negligible (Fowler 1997; Odlyzko 2000). The effects on coordination costs are not univocal. On one side IT gives more and better information so that coordination is easier, on the contrary an increased amount of information has to be processed in order to coordinate the organization's activity. Accordingly it can either result in lower or higher coordination costs to the organization.

This presentation of transaction costs requires the development of a model that takes into consideration the functional dependence of transaction costs from coordination costs and IT network effects.

The firm's transaction costs function will be:

$$T_c = C_I + C_c$$

where $C_c = f(IT_e)$

T_c is transaction costs ,

C_I is infrastructure costs;

C_c is coordination costs and

IT_e are the IT network externalities

Galbraith (1977) argues that "the greater the uncertainty of the task, the greater the amount of information that must be processed between decision makers during the execution of the task to get a given level of performance". Firms can reduce uncertainty through better planning and coordination, often by rules, hierarchy, or goals. Accordingly, Galbraith states that "the critical limiting factor of an organisational form is the ability to handle the non-routine events that cannot be anticipated or planned for". When the exceptions become too prevalent, as a consequence of uncertainty, they overwhelm the hierarchy's ability to process them leading to higher coordination costs for the organization. Too much information has to be processed. Variations in organizational design arise from different strategies to increase planning ability and to reduce the number of exceptional events that management must resolve, i.e. to reduce the amount of information that has to be processed. On the contrary, IT can be used to increase the ability of the organization to handle information and thus facilitate the decision making process when exceptions (uncertainty), have to be handled.

The analysis by Galbraith supports the idea presented here of the effect of coordination costs on the overall structure of transaction costs; more resources are spent to try to coordinate the organization's action in these situations of information overload. The relationship between coordination costs and transaction costs can thus be graphically represented as follow:

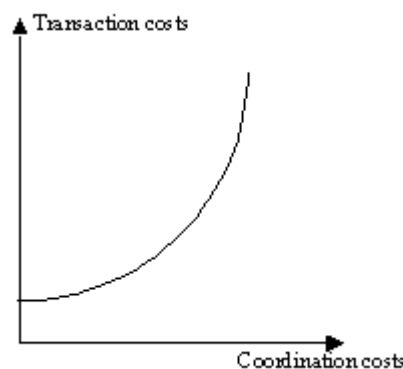


Figure 2: Coordination costs and transaction costs

This relationship between coordination costs and transaction costs does not take into consideration the infrastructure costs of IT and the consequent externality effects on the overall transaction costs function of the hierarchical structure. At a first level of analysis infrastructure costs effect transaction costs in a linear way, they are the costs arising from investment in IT, other infrastructural components, etc.

The transaction costs approach argues that investments in IT and the following network externalities reduce the transaction costs because the quantity and quality of available information increases (Ciborra, op.cit.; Malone et al, op.cit) so that ceteris paribus the uncertainty is reduced due to this extra quantity of accessible information. However, some extra transaction costs are faced as a consequence of the direct investment in IT that is otherwise clearly compensated for by the reduction of transaction costs direct consequential upon the better uncertainty handling capacity. Graphically the two effects result in the following function:

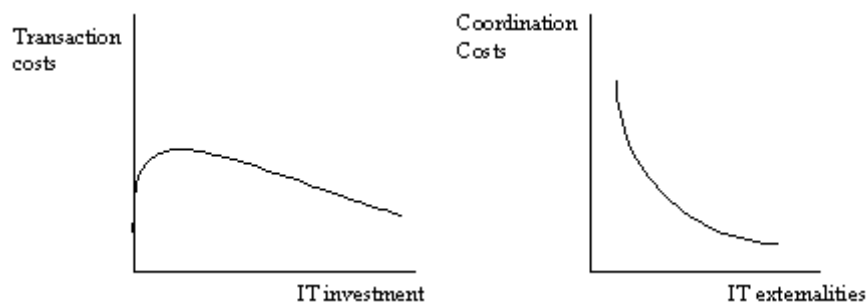


Figure 3: *Infrastructure costs and transaction costs: a first consideration*

Nevertheless this understanding of the impact of information technology does not take into account the effect of the new, increased amount of information that has to be processed. IT is used to provide more information and thus to reduce organizational uncertainty. However, the IT externalities make the network an unpredictable font of communication overload. As a consequence organizations have to deal with increased planned and unplanned information, such that the resulting information overload can cause “a major problem that seriously affects people at work and their ability to do their job” (Edmunds and Morris. 2000). Katz and Fletcher (1992) describe the difficulty faced by managers who, when their work is supported by IT, are bombarded by too much information that is produced too fast and that, paradoxically, is sometimes received too late. These effects are the consequences of the increased amount of information that has to be handled by the organization’s structure and of the subsequent reduced ability of the structure because of information overload. The coordination mechanisms of the organization are threatened by the increased amount of information that has to be processed in order to make coordination possible. The coordination costs of the structure increase as a consequence of the information overload caused by the effect of IT network externalities. This effect can be graphically represented as follow:

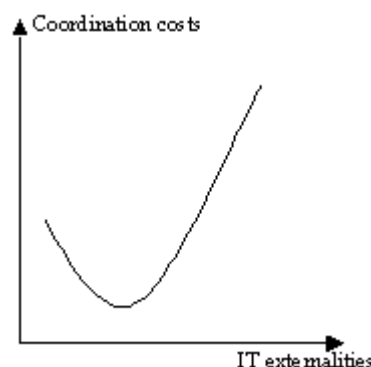


Figure 4: *IT externalities and coordination costs*

This graphical representation takes into account the effects of the adoption of IT by an organization in the light of the models presented of transaction costs and information processing. The former indicates that IT

can reduce the need for coordination because it supports better information sharing and thus easier coordination among organizational agents: IT externalities reduce coordination costs. However, the latter considers the effect of the increased need of information processing on the organization's capabilities for dealing with it: IT network externalities increase coordination costs. The augmented flow of information has to be managed by the organization thus, *ceteris paribus*, reducing the efficiency of the organization action as a consequence of the increased costs of coordination. This consequence can be simply explained using Palme's (1984) classical example of e-mail systems in organizational settings. When an email system is introduced in an organization, typically it can coordinate better because it is now easier, faster and more efficient to exchange the information needed to support the joint action of its members. However, when the e-mail system is heavily used, new e-mail based activities are developed so that it is easy to end up in a situation of e-mail overload (Whittaker & Sidner, 1996). Consequently, an IT implementation aimed to support organisational coordination results in a threat to these same capabilities. The number of exchanged e-mails is so large that every single member of the organization spends a longer time reading and answering them so that, as argued by Galbraith, the overall performance of the organization is overwhelmed by this information processing activity. The organisation's ability to coordinate work is thus decreased; hence the coordination costs are increased.

In the light of the combined effect of infrastructure costs and coordination costs the functional representation of hierarchy's transaction costs can be represented as:

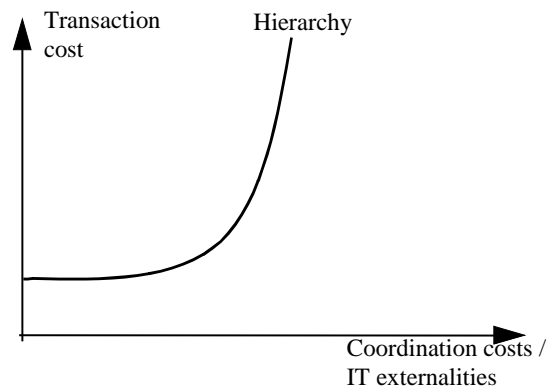


Figure 5: Transaction costs and IT externalities/coordination costs

Following the argument imposed by this model, the reduction of internal coordination costs, and thus transaction costs, must be an imperative for the firm as far as the efficient management of business activities and their related work and information flows is concerned.

4. REDUCING TRANSACTIONS, NOT ONLY COSTS

It was shown above that there is a direct correlation between the number of activities devoted to task coordination and the associated coordination costs. As the amount of coordinating work increases, transaction costs consequently increase radically. This implies that a focus on transaction costs reduction requires a great effort if the anticipated gains are to be realised.

On the other hand, due the functional relationship between coordination and transaction costs, a reduction of coordination costs itself would allow a significant decrease in transaction costs with relatively little effort.

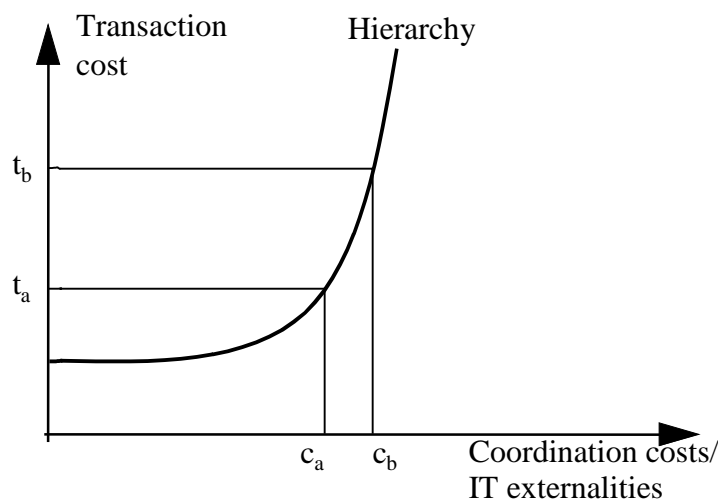


Figure 6: Impact of coordination costs reduction on transaction costs

As can be seen in the picture above, a reduction of internal coordination costs from $c_b \rightarrow c_a$ will result in a reduction of transaction costs from $t_b \rightarrow t_a$, where $\partial t > \partial c$. This relationship underpins the necessity of focusing on the reduction of coordination costs, rather than transaction costs.

Following the definition of transaction costs, $T_c = f(\text{IT externalities; coordination costs})$, and the functional dependences, two useful strategies can be identified for their reduction. The first one aims to reduce uncertainty through increased information processing capacity, thus investing in IT following the traditional transaction costs approach. The alternative proposal is a strategy devoted to decreasing coordination costs by reducing information overloads and thus limiting the investment in, and the use of, IT as proposed by the information overload and information processing views.

Strategy 1

This approach builds on the idea of improving information processing capabilities to better manage the coordination needs that accompany organizational solutions to deal with complexity, as described by Brooks (1995). Pursuing this strategy means investing in information infrastructure to reduce uncertainty. This strategy is valid as long as the reduction of uncertainty, and thus transaction costs, exceeds the cost of the additional investment in infrastructure. In any case, there is a trade-off between both factors. According to the argument proposed here, the trade-off changes as the infrastructure produces negative returns of scale as a consequence of the network externalities (as illustrated in figure 5).

Strategy 2

Considering the use of information technology, it should not primarily be used to support existing coordination mechanisms, as proposed by Galbraith (op. cit.), but to reduce the need for coordination itself. A preliminary idea for this approach can be found in Ciborra (1996) and Brynjolfsson and Malone (op.cit.). This will not necessarily result in the abandonment of all coordinating activities, but can reduce the number of those that don't contribute to the value creating activities of the organization.

Accordingly, IT must not be solely focused on internal coordination costs minimization, but used as a powerful tool to enable the reduction of coordination needs, reducing the amount of information dispersed in the organization. This argument is supported by the fact that the majority of the information in an organization is of local character, and thus it is necessary to make only a small percentage collectively available to support the decision making process (Langefors 1974; Feldman & March, 1981).

5. DISCUSSION

The analysis of coordination, transaction costs and IT externalities proposed in this paper has led to the following, more exhaustive, analysis of the impact of IT on organizations costs.

The use of a transaction costs approach is a powerful way to describe the potential of information technology to improve information flow and to reduce transaction costs, thus improving the organisation's capacity for managing complexity. However, this does not necessarily imply a reduction in the complexity of the coordination mechanism. On the contrary, the level of complexity often increases. Nevertheless, a reduction of transaction costs can be achieved, since the more efficient way of managing complexity exceeds the cost associated with the increasing level of complexity.

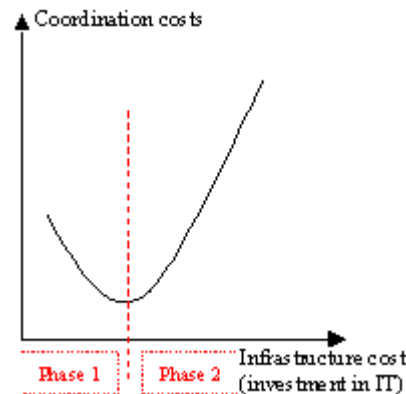


Figure 7: IT effect on different organization phase of organisation's structure

This strategy, however, reaches its limit at the point when the externalities associated to IT exceed the benefits associated with the use of IT. The externalities associated to IT form being positive become negative. Increasing information exchange in this setting will result in significantly increased transaction costs because of the associated extra coordination needed to handle to higher information flow. Subsequently, the use of information technology will be unable to contribute to more efficient information handling and organisational workflow, but will contribute to the creation of an electronic mess and sub-optimality in the organisational setting. Accordingly, the use of IT may present diseconomies of scale when the externalities associated to its diffusion reach a certain level.

The traditional strategy: use IT to increase information availability is undoubtedly efficient in the left side of the figure 7 (phase 1). By speeding up and increasing the amount of information and its exchange rate, IT makes the organisation's activity easier and more efficient, reducing coordination costs and thus transaction costs.

In order to take into account the consequences of IT externalities and the associated effects on coordination costs, an approach other than the traditional has to be identified. This is needed to avoid the failure of the organization as a consequence of very high coordination costs and thus transactions costs.

By reducing the amount of information, filtering it and reducing coordination needs, it is possible to decrease the internal coordination and the related cost and thus maintain the efficiency of the organizational setting.

5.1. IT to Reduce Coordination Costs

New technology and ways of employing it, such as enterprise resource planning (ERP), agents and various forms of team support, may help to achieve these goals, allocating information where necessary, filtering it and reducing the broadcasting and overload of information in the organization, thus providing a concept of "information just-in-time".

For example, agent technology can be considered a new way to use IT: it is possible to delegate certain tasks to technology, reducing the time and effort spent to collect, filter and distribute information (Maes, 1995). Accordingly, agent technology allows a new approach to the consideration of the effects of IT on organizational structure. Looking at the conceptual approach of agent technology, it is clear that the role of technology changes considerably: from being a tool to enlarge the amount of available information, IT has become a tool to reduce and choose the information received by the organization's members.

Similarly, ERP attempts to integrate all departments and functions across a company onto a single computer system that can serve all those different departments' particular needs. IT combines them all together into a single, integrated software program that runs off a single database so that the various departments can more easily share information and communicate with each other. That integrated approach can have a tremendous payback in terms of coordination costs. Take a customer order, for example. Typically, when a customer places an order, that order begins a mostly paper-based journey from in-basket to in-basket around the company, often being keyed and re-keyed into different departments' computer systems along the way. All that lounging around in in-baskets causes delays and lost orders, and all the keying into different computer systems invites errors. Meanwhile, no one in the company truly knows what the status of the order is at any given point because there is no way for the finance department, for example, to get into the warehouse's computer system to see whether the item has been shipped. This results in complex coordination process and thus higher coordination costs. With ERP, when a customer service representative takes an order from a customer, he or she has all the information necessary to complete the order (the customer's credit rating and order history, the company's inventory levels and the shipping dock's trucking schedule). Everyone else in the company sees the same computer screen and has access to the single database that holds the customer's new order. When one department finishes with the order it is automatically routed via the ERP system to the next department. To find out where the order is at any point, one need only log into the ERP system and track it down. With luck, the order process moves like a bolt of lightning through the organization, reducing the internal need of coordination and hence its costs

This use of the technology presupposes the acknowledgement of the relationship between the IT network externalities and coordination costs. In these cases, the technology is used to lower coordination costs reducing the need for coordination and the quantity of information used by the coordination processes. This is done by changing the effect of IT externalities: the interconnection and interlinking between technologies and users is used to reduce the amount of information exchanged and to direct the information only where it is useful and needed. Consequently, it is necessary to focus the study of IT on coordination costs to consider the different needs of the organization: to reduce uncertainty through improving information exchange in phase one, and as a tool that leads to a reduction of coordination needs among actors, in phase two.

6. CONCLUSION

This paper analyses the effect of IT externalities and coordination costs on transaction costs. This has enabled an evaluation of the possible impacts of information technology on organizational structure.

Two different approaches have been identified: one mainly based on the analysis of effects of IT on transaction costs and argues that by using IT is possible to reduce transaction costs and thus to achieve a more efficient exchange structure.

Considering coordination costs as one of the independent variables of transaction costs, it has been possible to divide the analysis of IT effects on organizational structural efficiency into two different phases. Phase 1 has been thoroughly analysed within the traditional approach. Phase 2 requires a more exhaustive analysis than the one presented in the traditional approach. This more exhaustive model has been developed using coordination costs and IT externalities as the focus of the analysis. Therefore, it is necessary to evaluate the effects of IT on this cost category. Another effect of the analysis is that new forms of employing IT must be considered.

Accordingly, IT should also be used as a tool for decreasing coordination needs inside the organization, reducing the information flux and organizational effort devoted to supporting coordination activities.

Following this strategy, it is possible to reduce internal coordination costs, and thus transaction costs. Accordingly, it is possible to avoid the paralysis of the organization as a consequence of information overload and structural over-development: to avoid the negative effect associated with the diseconomy of scale in an increase in IT use and diffusion.

Emerging technologies, such as agents and ERP, can provide the technical support for realizing the strategy proposed in this paper, such as the support for new instantiations of traditional activities, such as managing incoming information to reduce the amount of information processed.

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