

# **THE EFFECT OF IT ON COORDINATION COST: IMPLICATIONS OF INCREASING COMPLEXITY**

## **Abstract**

Coordinating work among individuals and groups belongs to the essential tasks of managing organizations. The arise of various kinds of team support technology, such as groupware and workflow technology, can improve the coordination of work in different ways: automating existing routines, shaping new communication patterns and organizational structures, or reducing the need for coordination itself. At the same time the diffusion of the use of technology may result in negative effect considering the associated coordination cost.

This paper analyses the implications related to technology diffusion in organizations, focusing consequences of increasing complexity.

## **INTRODUCTION**

The coordination of work has a critical impact on organizational performance. In an era of ever shorter product life cycles and lead times, it becomes a crucial necessity for companies to manage the transactions between individuals and work groups in an efficient way, independent from the organization's structural variables. Information technology (IT) has become the major enabler for speeding up communication and improving information exchange. However, the expected gains in terms of reduced time and cost and improved quality can fall short if technology is used for supporting existing structures of information exchange, rather than for reshaping the organizational information flow. In the following we will show, that the use of a traditional transaction cost perspective in this kind of setting will result in sub-optimization of information exchange structures.

The alternative strategy we are going to develop is to strive for a major reduction of transaction cost by questioning the use of technology for maintaining a coordination and control structure as it is proposed in the bureaucratic paradigm, and advocated by the traditional transaction cost approach to IT.

On the other hand, we will outline aspects of IT impact on coordination cost in the light of transaction in various organizational settings and analyze it in accordance with the achievable cost/benefit.

## **TRANSACTION COST**

On a macro-level, transaction costs are generally defined as being the cost for gathering information, evaluating alternative options, negotiating, contracting, and the physical transaction of the object through a defined interface.

This cost is due to the fact that not all the information needed for the exchange is available, i.e. an imperfect information system. Subsequently the exchange, as described in the neo-classical model of perfect competition, will not take place. In fact, it requires that transactors possess the same information and that this information is adequate to support the transaction.

The uncertainty being present in the market, due to imperfect information, bounded rationality, strategic behavior and incomplete market, jeopardizes the market exchange structure. As a consequence, different structures, implemented to reduce uncertainty, must be developed in order to support the exchange system. Hierarchy and clan are thus structures of governance that reduce transaction costs associated to a certain exchange (Coase 1937; Williamson 1975; Ouchi 1980).

A hierarchy can generally be described as an organizational form where the "invisible hand of the market" (Smith 1776) is substituted by a set of goals and rules that prescribe behavior, drive individual choice in accordance with organizational needs and provide a common framework to be followed in situations where uncertainty occurs.

Considering that uncertainty increases due to an unpredictable and dynamic environment, the bureaucratic structure becomes insufficient for coping with the reduction of uncertainty given the condition of limited information-handling capacity of the organization (Emery 1969). In accordance with traditional neo-institutional analysis, a different structure of governance must be developed and employed. An alternative structure, providing more efficient mechanisms for organizational governance in this context, is the clan. Using the clan as governance form for

the organization reduces uncertainty by internalizing norms, values and traditions, developing a high identification of members with the group and a mutual sharing of goals.

These two different approaches, devoted to the reduction of uncertainty, are associated to different costs embedded in the construction and maintenance of organizational structures. It implies, that every structure of governance is efficient, as long as the cost related to its employment is lower than the transaction cost reduction being associated to it.

According to the theory of institutional economy (Coase 1937, Williamson 1975, Ouchi 1980) it is argued that an increasing amount of transactions, i.e. coordination cost, will result in failure of the coordination mechanisms within a market. Instead, as exchange related complexity increases, it becomes more efficient to use alternative governance models, e.g. formal organizations, or clans. These alternative forms are aiming at the reduction of uncertainty and opportunistic behavior. In the following, we will focus on aspects of formalized organizational structures.

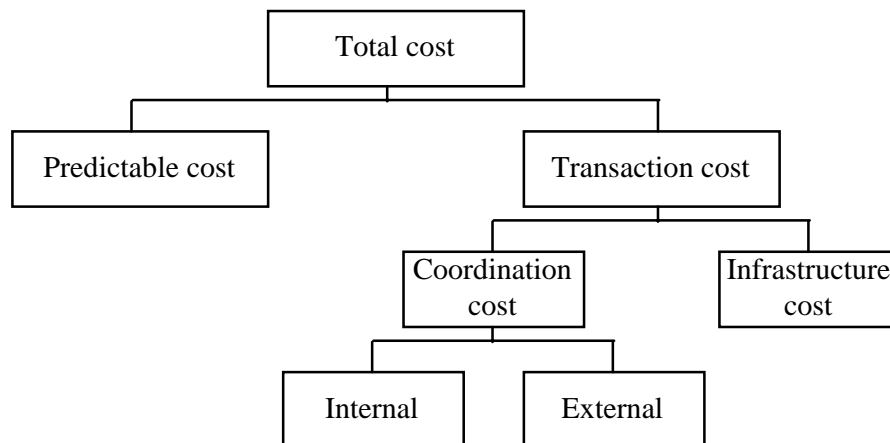
## **TOWARDS A MODEL OF TRANSACTION AND COORDINATION COST - THE "BUSY MESS BREAK-POINT"**

On a micro-level, i.e. when considering the costs being generated in an organization, we have distinguished two different main categories - predictable cost and transaction cost.

Predictable cost are defined, following the traditional microeconomic theory, as the cost that are not uncertain.

Transaction cost are referred to as the cost being a consequence of uncertainty economic agents have to face. Considering the focus of the paper, we will highlight the functional dependence of transaction cost from two different sub categories: infrastructure cost and coordination cost. Infrastructure cost means the cost for establishing the physical/communicational contact between members of the organization (Bressand and Distler 1995). Coordination cost includes cost due to imperfect information and opportunistic behavior of organizational actors (Milgrom & Roberts 1992), i.e. the factors contributing to uncertainty in the organization.

Following Brynjolfsson, Malone et al. (1994), we can make a further differentiation in coordination cost between internal and external coordination cost: The former is generated by the need to support hierarchical structure (management, control system, rule establishment and maintenance, etc.). The latter is the cost due to presentation (Williamson 1986) and the establishment of a contingent claims contract.



**Figure 1: The firm's cost scheme**

In the following, we will argue for a model building on the assumption that transaction cost is a function of infrastructure cost and coordination cost.

The firm's cost function will be:

$$C_F = C_T + C_p, \text{ where } C_i = f(C_i + C_c)$$

$$C_F = f(C_i + C_c) + C_p$$

where

$C_F$  is the firm's total cost;

$C_p$  is predictable cost;

$C_i$  is infrastructure cost;

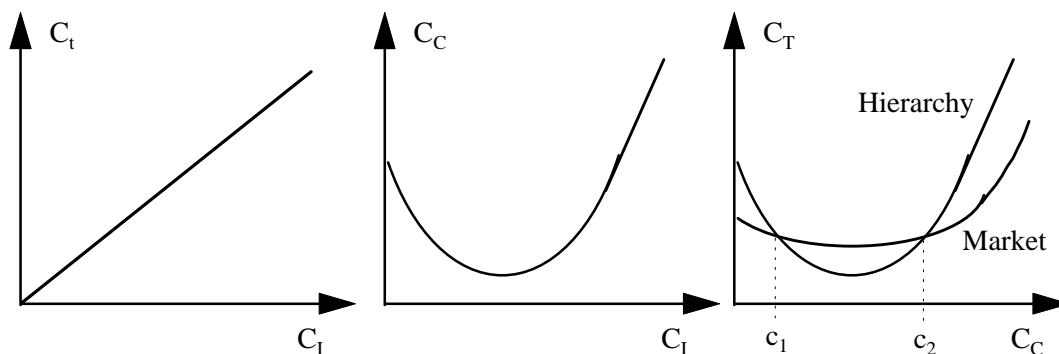
$C_c$  is coordination cost, and

$C_T$  is transaction cost

According to Coase (1937), organizational size determines the amount of information to be communicated. Using a micro-economic perspective, we can derive that the larger the organization, the larger the amount of information being required by top management for decision taking. Exceeding a certain size, i.e. after the "busy mess break-point" as we have chosen to term it, the number of transactions in the organization needed to handle the internal coordination needs increases to an extent, that market mechanisms become again more efficient than the planning and control mechanisms imposed by hierarchical structure. Considering increasing complexity, above the busy mess break-point, the external coordination is in fact less expensive: No infrastructure costs must be supported.

A corresponding argumentation, building on the functional dependence of transaction cost on coordination cost, is found in the justification of multi-divisional organizational forms. A coordination cost level exceeding the "busy mess break-point" results in a set of small hierarchical organizations, related to each other through a (internal) market system.

Thus we can conclude that the multidivisional form, being a hybrid between hierarchy and market, constitutes a solution to market failure due to complexity, and hierarchy failure due to coordination needs.



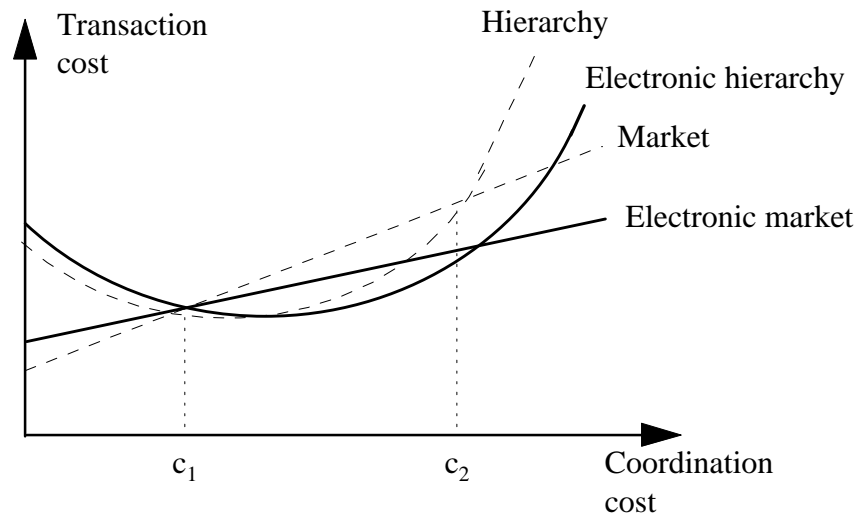
**Figure 2: Transaction cost as a function of coordination cost**

According to the model, it is advantageous to use a market model as long as external coordination cost is below  $c_1$ . In the interval  $c_1 - c_2$ , a formalized model is more cost efficient than the market. As internal coordination cost exceeds  $c_2$ , i.e. after the "busy mess break-point", using the market as governance form again becomes the more efficient strategy. This argumentation is not exhaustively covered by conventional transaction cost formalization.

Following the argumentation imposed by the model, we can claim, that the reduction of internal coordination cost, 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.

## TRANSACTION COST AND INFORMATION TECHNOLOGY

As it was argued by Ciborra (1993), information technology can be used for reducing the cost being associated to transactions. 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.



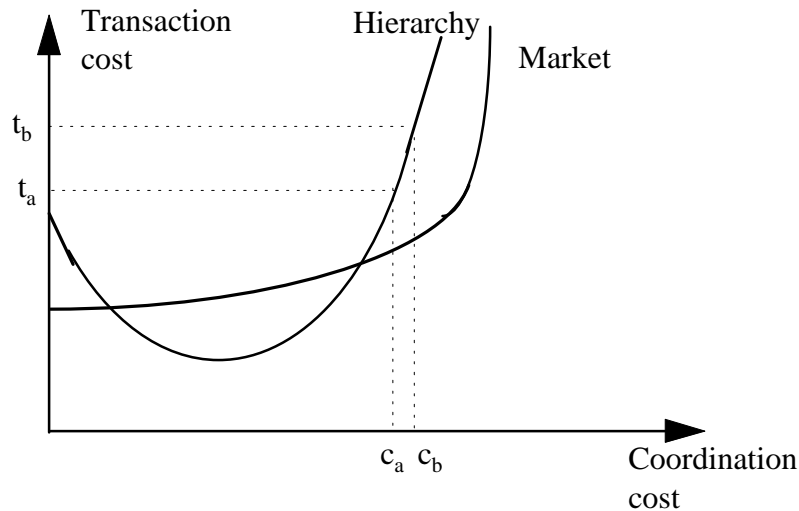
**Figure 3: IT-impact on coordination and transaction cost**

As we can see in the model, the reduction of uncertainty due to the introduction of IT basically results in a reduction of both coordination costs and transaction costs. However, due to the investments in infrastructure and technology, higher fixed costs are generated initially. The argument to strive for transaction cost reduction through the use of information technology for improving the organization's information flow is very powerful until internal coordination cost exceeds  $c_2$ . As internal coordination cost exceed the "busy mess break-point", the effort of processing further information due to the need of coordination is higher than the achievable gains. Following our earlier argumentation about the "busy mess", the result will be an increasing number of non-value adding information transactions, devoted to support the organizational framework that links and coordinates internal activities (Penrose 1959), rather than supporting a more efficient way of managing work.

## REDUCING TRANSACTIONS, NOT ONLY COSTS

As we have shown, there is a direct correlation between the number of transactions devoted to coordinate tasks. As the amount of coordinative work increases, sub-sequently transaction cost increase radically. This implies, that a focus on transaction cost reduction requires high efforts for achieving conceivable gains.

On the other hand, due the functional relation between coordination and transaction cost, a reduction of coordination itself would allow to drastically decrease transaction cost with relatively small efforts.



**Figure 4: Impact of coordination cost reduction on transaction cost**

As we can see in the picture above, a reduction of internal coordination cost from  $c_b \rightarrow c_a$  will result in a reduction of transaction cost from  $t_b \rightarrow t_a$ , where  $\partial t > \partial c$ . This relationship underpins the claim for a necessity to focus on the reduction of coordination cost, rather than transaction cost.

Following our definition of transaction cost,  $C_T = f(\text{infrastructure cost} + \text{coordination costs})$ , we can identify two useful strategies for their reduction. The first one is aiming at the reduction of uncertainty through increased information processing capacity, thus increasing infrastructure cost. Our alternative proposal is a strategy devoted to reduce uncertainty and infrastructure cost, and subsequently flattening the organization.

### Strategy 1

This approach, following traditional theory, builds on the idea of improving information processing capabilities for managing the complexity coming along with increasing size, as it has been described by Brooks (1995). Pursuing this strategy means to invest in information infrastructure to reduce uncertainty, without reconsidering structure itself. This strategy is valid, as long as the reduction of uncertainty cost exceeds the additional investments in infrastructure. In any case, there is a trade-off between both factors. As it was explained in the example of Mackenzie above, this strategy loses power, as the infrastructure no longer can manage complexity efficiently. From the “busy mess break-point“, this process accelerates exponentially, resulting in an implosion of the organizational information processing capability.

## Strategy 2

Considering the use of information technology, we can equivalently claim, that IT should not primarily be used for supporting existing coordination mechanisms, but to reduce the need for coordination itself, thus emphasizing on the flattening the organizational structure. An argumentation for this strategy has been developed in a certain way, among others, by Ciborra (1996) and Brynjolfsson and Malone (op.cit.). This will not necessarily result in the abandonment of all coordinative activities, but can reduce their amount to those contributing to the value creating activities of the organization.

Accordingly, we are proposing a use of IT not solely focusing on internal coordination cost minimization, but as a powerful tool to enable the reduction of coordination needs. This argumentation is supported by the fact that approximately 80% of the information in an organization is of local character, and that only a small percentage must be globalized (Langefors 1974).

The pros and contras of this strategy, and the organizational means for achieving it, have been extensively discussed by Emery (1969), March and Simon (1958), and others.

## DISCUSSION

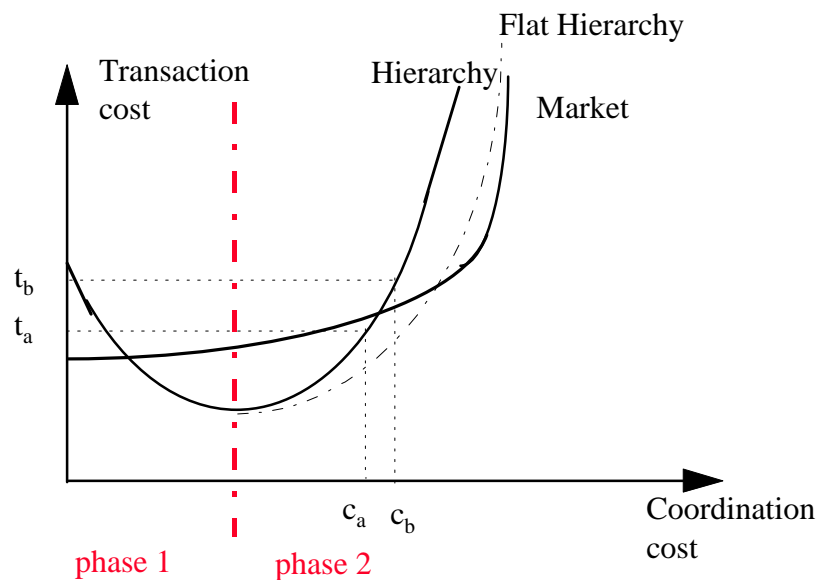
The analysis of coordination and transaction cost as it has been conducted in this paper has led us to the following, we think more exhaustive, analysis of the impact of IT on the way business are organized.

The use of a transaction cost approach is a powerful way of describing the potential of information technology for improving information flux and reducing cost, thus improving the organization's capacity for managing complexity. A typical example is the use of Electronic Data Interchange (EDI) in supplier-retailer collaboration settings (Simon 1996). However, this does not necessarily imply a reduction of the number of transactions. On the contrary, the number of transactions often increases, while the volume of the individual transaction is reduced. Nevertheless, a reduction of transaction cost can be achieved, since the decreasing cost per transaction exceeds the cost associated with the increasing number of transactions.

This strategy, however, faces its limitation at the point we have chosen to call the "busy mess break-point". At this point, when satisfying coordination needs exceeds the benefits associated with the use of a structural organization, the market model becomes more efficient than the hierarchy. In fact, increasing information exchange in this setting will result in significantly increasing transaction cost. Subsequently, the use of information and technology will not be able to significantly contribute to a more efficient information handling and organizational workflow, but will contribute to the creation of an "electronic mess" and a sub-optimality in the organizational setting.

The "traditional" strategy is undoubtedly efficient in the left side of our graphic (phase 1). Speeding up and incrementing the amount of information and its exchange rate, IT renders easier and more efficient the organization activity, reducing coordination costs and thus transaction cost.

If we now consider the effect of an increment in information flux on the right side (phase 2) of the graphic, we can easier understand that the amount of coordination, needed to support this information mass, is radically growing. It means that close to the busy mass breakpoint IT related effect on the busy mess condition become really evident.



**Figure 5: IT effect on different organization phase of organization structure**

In the above figure, the reason for our proposal of a different consideration of coordination structure and use of IT is provided graphically.

Reducing the amount of information, filtering it and reducing the coordination needs it is possible to reduce the internal coordination and the related cost and thus maintain the organization setting more efficient than the market.

## **IT FOR REDUCED COORDINATION COST**

New technology and ways of employing it, such as agents and various forms of team support, may help to achieve these goals, allocating information where necessary, filtering it and reducing the information's surf and overloading in the organization, thus providing an "information just-in-time" concept.

An agent may be considered as a "personal assistant who is collaborating with the user in the same work environment". (Maes 1994) It is a system allowing new ways of human-computer interaction. The user is involved in a cooperative process where the other party is the "personal assistant". It follows that as a consequence of an interactive process both (human and agent) provide new ways to enhance communication, to scan information, to filter and to signal the ones that it has been defined relevant by the user. Through different algorithms, the agent is able to learn and increase its efficiency over the time.

Agent technology can be considered as a new way of using IT: It is possible to delegate certain task to technology, reducing the time and effort spent in collecting, filtering and distributing information. Accordingly, agent technology allows a new approach to the evaluation of IT effects on organization structure. Using the conceptual approach underlying agent technology we can conclude that the role of technology is changing considerably. From being a tool for speeding up daily work, it becomes part of the actor network, working autonomously as other single or aggregate actors.

The traditional transaction cost analysis of IT, shown in phase 1, leads us to take into account the shifting effect of the use of IT for supporting the organizational exchange structure. Following our model, this effect is not sufficient to describe the dynamics in all phases of organization development. We are proposing a shift effect in the hierarchical structure due to a

reduction of coordination needs in phase 2. Obviously, following our argumentation, this effect is enhanced by IT when technology is used as a tool for reducing the coordination need, information overload, and organization's growth.

This shift will result in a reshaping of the hierarchy function (see figure 5). Thus, the effect of changes in coordination cost on transaction cost will become less apparent. This because the cost related to the implementation will virtually be replaced by the substitution effect due to the reduction of cost required to support organization structure: we call this organizational flattening process. (see Flat Hierarchy in figure 5)

Consequently, we are proposing to focus the use of IT on coordination costs in a double sense. Reducing uncertainty through improving information exchange in phase one, and as a tool that leads to a reduction of coordination needs among transactors, flattening the organization, in phase two.

## **CONCLUSION**

In this paper we have tried to analyze the effect of coordination cost on transaction cost. Following this analysis, it has been possible to evaluate, possible effects of information technology on organization structure.

We have distinguished two different approaches: the "traditional" one and the "flattening" one. The former is mainly based on the analysis of effects of IT-use on transaction cost and argues, that using IT it is possible to reduce transaction cost and thus to achieve a more efficient exchange structure.

Considering coordination cost as one of the independent variables of transaction cost, it has been possible to divide the analysis of organization structure efficiency in two different phases. Phase 1 is well analyzed within the traditional approach. On the contrary, phase 2 requires a more exhaustive analysis than being possible by using the traditional approach. It has been developed by using coordination cost as focus of the analysis. Therefore, it is necessary to evaluate IT effects on this cost gender. Another effect of the analysis is that new forms of employing IT must be considered.

Accordingly, we are proposing to use IT also as a tool for decreasing coordination needs inside the organization, reducing the information flux and organization structure devoted to support coordinative activities. Following this strategy, it is possible to reduce internal coordination cost, and thus transaction cost. Accordingly, it is possible to avoid the implosion of the organization as a consequence of information overload and structural over-development.

Emerging technologies, such as agents, can provide the technical support for realizing the strategy being proposed in this paper, e.g. the support for "new traditional" activities, such as managing incoming information.

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