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Information Technology in Collaborative Networks

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1. Introduction

The purpose of an information system is to manage data, information and knowledge connected with human activity. Information Systems in Collaborative Networks manage available data and describe conditions and information generated by data integration corresponding to the various stages of products and services in the network, and the actions taken by network staff in order to modify these stages. Starting from the information available, these systems integrate data and, by contrasting them with the experience accumulated in the system's memory, ensure optimum decision-making.

Collaborative Networks Information Systems have not been formally fixed, mainly because of their complexity but also because until very recently an automated data-processing system capable of attempting automation had not existed.

Nowadays the major obstacle to reach an adequate level of automation in collaborative networks information systems is the lack of systematisation. Overcoming this impediment is crucial to allow the development of an electronic network (e-network), which consists of an automated data-processing system trying to achieve computer-aided management of a Collaborative Network Information System.

This chapter presents an analysis and a modelization method for the decision-making process in a collaborative network, as the main target to be developed within the same network. Not only is this a technological change, it is something else. It proves to be the only way to share network knowledge in a co-operative manner, among professionals from several companies, and with different degrees of collaboration expertise. The results of the analysis of this innovative kind of proposed collaborative network process illustrate how collaboration is carried out through the various processes, and demonstrate the perfect way to tackle e-network development.

2. Designing a collaborative network

A simple definition of networks is "a set of actors connected by a set of ties" with actors being "persons, teams, organizations, concepts, etc." (Borgatti & Foster, 2003). Participation in networks has become very important for any organization that strives to achieve a differentiated competitive advantage. Among the wide variety of existing networks, collaborative networks are especially relevant. These have emerged over the last few years as a result of the challenges faced by both the business and scientific worlds, since

collaboration has become the key issue to rapidly answer market demands in manufacturing companies, through sharing competence and resources (Camarinha-Matos et al., 2009).

The collaborative network paradigm offers new possibilities for effective and agile organization of future manufacturing systems. In order to be successful in a very competitive and rapidly changing environment, companies need significantly improved competencies in terms of dealing with new business models, strategies, organizational and governance principles, processes and technological capabilities. In this context, collaborative networks show a high potential for value creation through new capabilities to cope with innovation needs, uncertainty, mass customization and fierce competition (Camarinha-Matos & Afsarmanesh, 2005).

A more comprehensive, fine-tuned description is again contributed by Camarinha-Matos and Afsarmanesh (2005); according to them, a collaborative network is constituted by a variety of entities that are largely autonomous, geographically distributed and heterogeneous in terms of their operating environment, culture, social capital and goals.

And yet these entities work together to better achieve compatible goals, using ICT for supporting the development of collaborative business opportunities. As dynamic inter-organizational models, communication mechanisms play a vital role in collaborative networks, alongside coordination as the method to support the exchange of information between interdependent activities or processes and among collaborative enterprises.

In this context, a collaborative network defined as a virtual global manufacturing network, is materialized by a group of dynamic enterprises in constant transformation, with horizontal and vertical connections set up among them and / or with other independent companies –even with competitors. This in turn dismisses the urge to maintain their internal manufacturing resources and manages and shares efficiently those resources available within the network.

2.1 Objectives of a collaborative network

A network knows well what it is doing; from an inter-organizational perspective, what will allow it to correctly define its processes, tasks, activities and ICT tools and mechanisms is not only the psychological processes underlying the behaviour of network actors, but also its evolution in time, its decision-making ability, and its knowledge of what really works (Gösling et al., 2007).

One feature of inter-organizational networks which particularly differentiate them from standard or traditional organizations is the absence of hierarchy. How can appropriation concerns and inter-organisational networks be managed, and how can tasks in networks be coordinated in the absence of pure hierarchy? (Gösling et al., 2007). The question of how to guide the behaviours of their collaboration partners to prevent possible confrontations makes it necessary to define the control mechanisms (outcome control, behavioural control, social control and institutions) and the processes (formal and informal), together with a good information system (ICT) to support them.

Control in collaboration relationships is necessary because it allows ensuring the optimal performance of the collaboration, identifying plans and activities of the actors, and regulating the conduct of factors in the collaboration. (Gösling et al., 2007). The collaboration reflects the achievement of a delicate balance between actors in the network, which will need to be constantly reviewed and renegotiated.

The benefits of collaboration can be pecuniary and non-pecuniary: financial, market access, interaction, sympathy. Actors should have positive expectations in order to have an

incentive to start and maintain an inter-organisational relationship. But inefficient collaborative settings, premature termination of a tie, negative expectations about the future value of an inter-organisational relationship, as well as failures of joint efforts and goals can be observed (Gösling et al., 2007).

The key ingredients of alliance success (Bleeke & Ernst, 1995) include flexibility in the management of the tie, building trust with partners, regular communication, constructive management of conflict, continuity of personnel for the inter-organisational tie, managing partner expectations, and so on.

In this sense, relationships inside a collaborative network must be tolerant enough to permit obtaining a permeable organization, allowing simultaneous collaboration with a varied group of participants, all with different features. Organisation of the manufacturing network must be thought of as a permeable, flexible, open and dynamic system, in which relations occurring in the network facilitate the actors' connection and disconnection, their linking up with one or several sub-groups in the network, and the co-existence of participants with varied characteristics.

It can be anticipated that this dynamic system will be defined by low barriers to entry and exit, geographical flexibility, low costs, fast diffusion of technology, high diversification and exceptional economies of scale.

The paradigm of collaborative networks can help companies, namely SMEs, to face these challenges and reach competitive advantage. A company joining efforts with other companies may typically expect to achieve: a larger dimension; access to new markets and new knowledge; sharing of risks and resources; a collaborative environment for innovation, through the combination of synergies, competencies, culture and experiences; and joining of complementary skills and capacities which allow each entity to focus on its core competencies while keeping a high level of agility (Camarinha-Matos, 2009).

2.2 Construction phases of a collaborative network

In the construction of a collaborative network several aspects should be taken into account, such as the cultures of the network and the companies that constitute it, as well as the relationships already formed or to be created in the future among the companies that will constitute this network. The analysis of these factors will mainly allow establishing the various phases through which a network will pass during its construction.

In the design of a collaborative network as a virtual organization for global manufacturing, the cultural differences among the companies that are integrated in it, especially if they are to collaborate robustly, could pose a difficult challenge. Opposed focuses on activities such as, for example, internal communication, the realization of objectives, the professional career system, the structure of power or the relationship employee-superior, etc. may translate into conflicts in terms of task performance, expectations and practices in the collaborative network. For this reason, one could conclude that the organizational culture of the network will have to avoid a high degree of incompatibilities in the cultural practices of its members.

The relationships between the companies that may be comprised in the network generate a society that results in the appearance of a source of information on the reliability and capacity of both its current members and its potential participants. This society represents a dynamic system formed by the previous relationships and the current partners, and evolves in time as new relations and connections are established.

The analysis of the influence of these social networks in the construction of a virtual collaborative network is basic, since in the transactions between companies of a network,

relational capital is in many cases more valuable than economic capital (Luo, 2001). The companies participating in a virtual network may face a high risk of opportunistic conducts, due to the unpredictable behaviour of potential partners and the high costs that this would cause if it actually happened. This situation, originated in the lack of information on the reliability of the potential collaborator, whose conduct is a key factor in the success of the alliance, could be a source of uncertainty.

Social integration will enable the companies forming the virtual network to receive information regarding the capacities, aptitudes and necessities of new collaborators to the network, thus increasing reliability in the face of opportunistic conducts. These social relations need time to settle and seed but, once established, they will become a catalyst for managerial relationships inside the network.

Therefore, knowing the map of existing social relationships, besides being helpful when building the network, is fundamental in order to succeed. The virtual network will be closely related with the intensity of the social relationships present in it.

As described above, one of the key factors when constructing the virtual manufacturing network is constructing confidence. There are other key factors, such as transparency, clear-cut power relationships and fulfilment of commitments and obligations. These factors have an obvious influence on the social relations being built in a virtual manufacturing network.

Figure 1 shows the various phases of trust in the relationships between companies inside a collaborative virtual network. Point 1 is the denominated *structural trust* (Madhok, 1995).

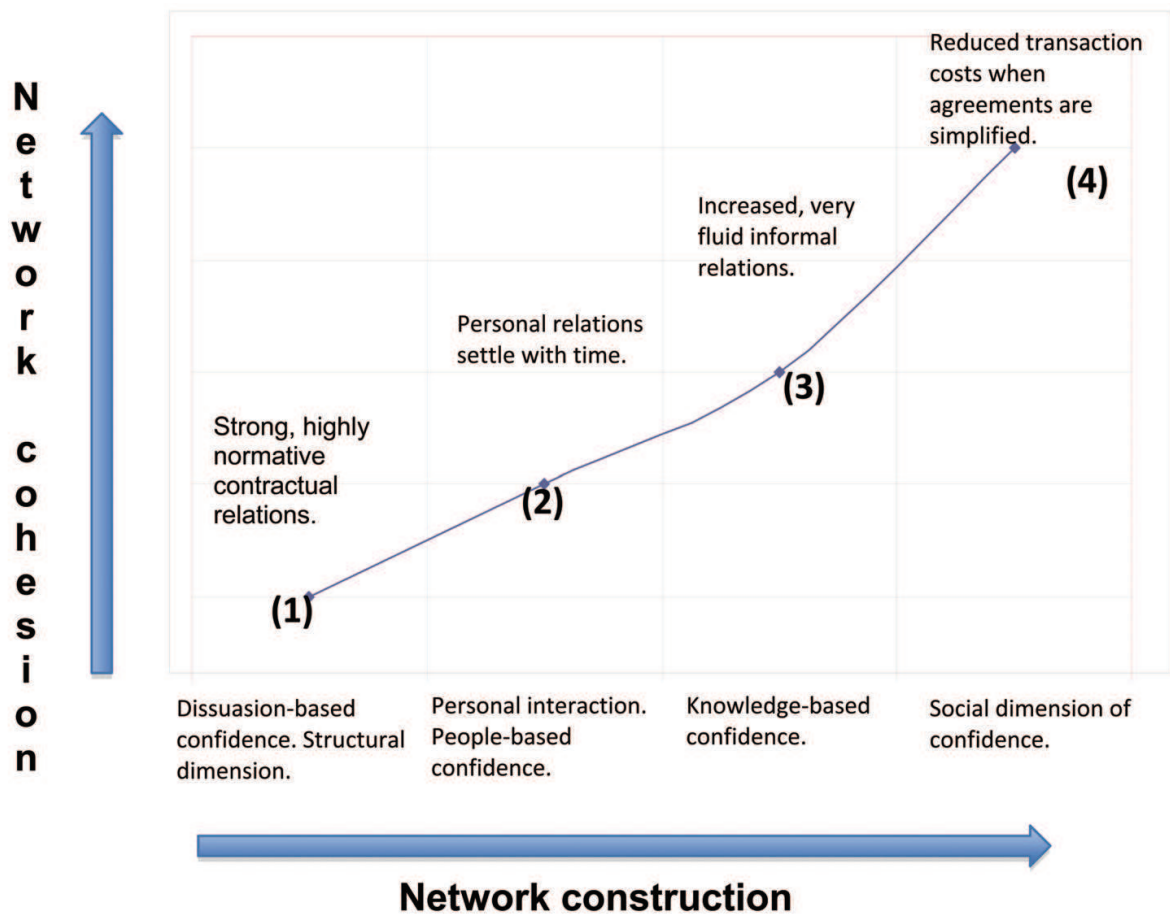


Fig. 1. Relationships between level of trust and degree of virtualization in the network. (Adapted from: Rodriguez-Monroy & Vilana-Arte, 2010)

This level of confidence is based on the tangible aspects of the collaboration. Explicit mechanisms are usual, such as very formal contracts including penalty systems or coercive measures to avoid opportunistic conducts. Although essential in the initial phases, it is not enough in the long run as it is unstable and easily affected by factors such as transparency or keeping commitments and it does not keep in mind the social aspect, relying on the symmetry of contributions.

With time, personal relationships develop and the interactions among persons from different companies generate a higher degree of confidence (point 2). In this phase the relationships in the virtual collaborative network are based on reliance rather than on a formal contract. The foundations of this trust have a cognitive component originated in the experience of previous interactions. This, according to Saphiro et al. (1992), is a kind of knowledge-based confidence, which expands into mutual understanding.

An important aspect of the virtual collaborative network is the directly proportional relationship between the degree of virtualization and the level of confidence attained. The collaborative network under construction will gradually become more and more virtualized, as time passes and honest trust among companies builds up.

In point 3 the actors of the network begin to establish more casual, fluid relationships, and this is what defines a phase of trust based on knowledge, where network processes become smoother and the costs of transactions decrease drastically.

With time, trust becomes a very effective mechanism in the relationships between companies, helping to mitigate the problems generated by strong competition among them, or the organizational complexity of the virtual collaborative network. Trust will also reduce the costs of transaction because it reduces the costs of design and negotiation of the contracts (point 4). This phase is denominated *social trust* (Madhok, 1995).

The conclusions are that confidence is a cultural mechanism in virtual networks which grows slowly with time and, if appropriate measures are taken in order to reduce transaction costs radically, managerial collaboration will flow more effortlessly and knowledge transfer will be eased.

In the development of a collaborative network, basic actions are instigated which facilitate teamwork between companies to quickly progress along the confidence curve:

- Social companies must invest their resources in improving confidence in the early phases of collaboration.
- It is necessary to minimize rotations of personnel so that social relationships have continuity and increase mutual trust.
- Intense collaborations should initially be avoided as the process of construction of social trust requires time.
- Social relationships can be improved by creating value for complementary capacities.

In short, the virtual collaborative network will focus initially on a reduced number of activities and main abilities that will be complementary to those of other partners. When these capacities are mutually appreciated, progress in future developments will strengthen trust and minimize opportunistic conducts.

It must not be forgotten that that one of the reasons for the existence of global production networks is their ability to transfer and utilize knowledge in a more efficient way than by means of external mechanisms of the market.

This type of knowledge constitutes one of the lasting competitive advantages (Gupta & Govindarajan, 2000). It is also a major factor in the managerial differentiation (Trice & Beyer, 1993). Knowledge transfer within the network could help approach cultural practices

(Hofstede et al., 1990). By diluting and expanding these assets in the network, a cultural homogenization process takes place. Figure 2 shows the cultural mechanisms occurring in the constitution of a network, both before the formalisation (*ex ante*) of collaboration and after it (*ex post*). This is a continuous process where these mechanisms are mutually recognised. These four cultural mechanisms-social integration, knowledge transfer, trust, and cultural similarities among network members, should not be understood as static mechanisms, or independent from the managerial collaboration process. They are dynamic elements that exert mutual and continuous influence during the whole life of the collaboration; they are in constant progress and are capable of reinforcing the relationship. For the network to be a successful one, it is not necessary that all the mechanisms have a strong activity, but rather, that a certain harmony or synchronization exists in them.

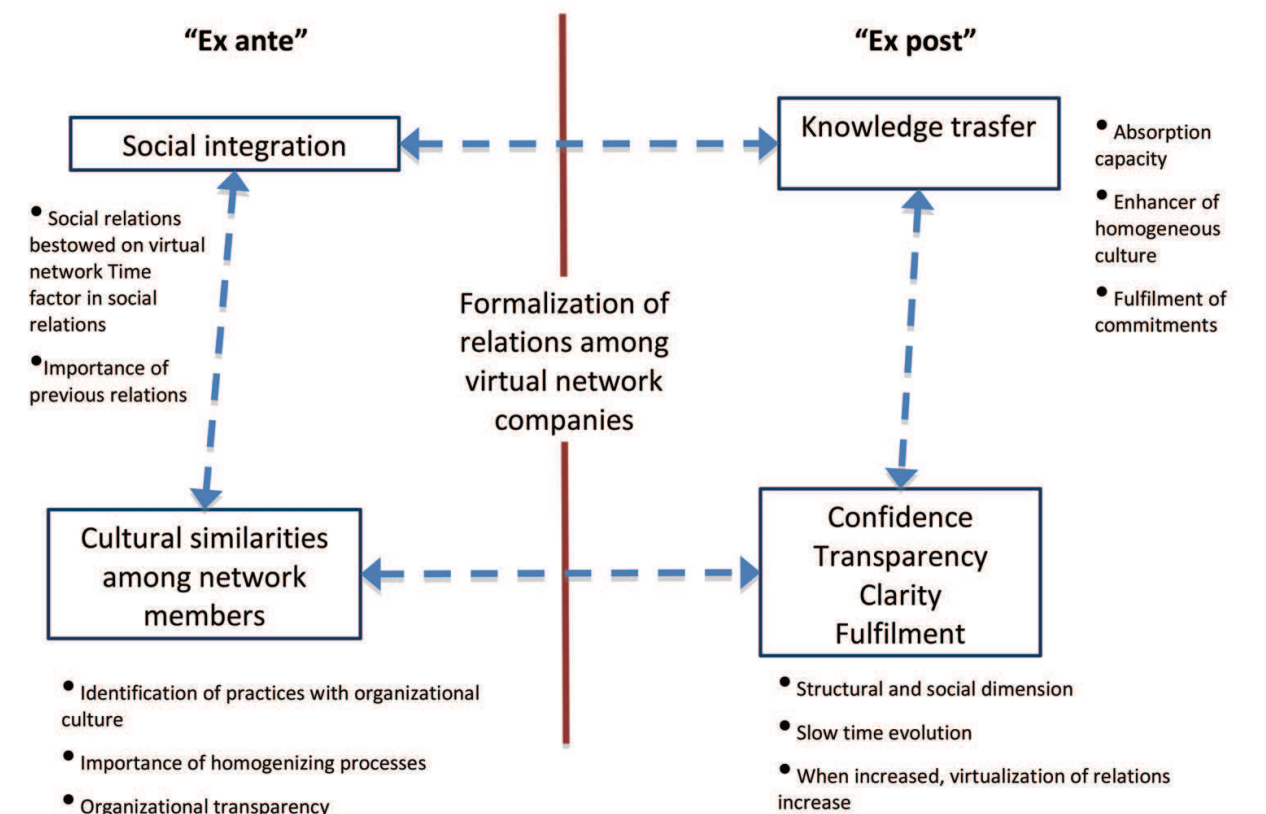


Fig. 2. Cultural mechanisms in the network. (Adapted from: Rodriguez-Monroy & Vilana-Arte, 2010)

3. Information in a collaborative network

Support of collaborative networks modifies the traditional focus of the enterprise information system design. Collaborative networks being open organizations, they require open information systems. These systems must allow for uncomplicated and fluid communication between the different actors of the network, whether they are inside or outside the perimeter of the organization. This means an opposed approach to the integration view of information system design. The ability to capture and share information between different information systems of various companies is often limited by the diversity of the business processes,

organizational units, structures of data and technologies, as well as the difficulty of sharing knowledge between the solutions of the different partners (Vatcharaphun et al. 2010)

3.1 Information flow in a collaborative network

The information flows that have to interact in a collaborative network come from information systems used by independent organizations; this makes it necessary to re-define the concept of interoperability, which should be re-formulated in order to reduce the complexity in the articulation of the problem.

At a strategic level, information flows are determined by communications and messages that respond to the management of common objectives in the collaborative space. They seek control and coordination between the activities of the partners. At an operational level, information resources such as data, technology and software components should be specified up to interface level for each particular information system. These flows should be negotiated with and directed by software components, aligning them with the different process levels of the company. This alignment process of the different levels of the participant companies should not be interpreted as a process of "information system integration". As described in section 2.2 above, trust is a key factor in network building, but there are other factors affecting information flows to a larger extent: transparency and clarity in power relationships. These key factors should be taken into consideration when establishing the information flows of the virtual network, so that they settle down between the appropriate decision-makers of each participant company.

The classical corporate boundaries have recently begun to blur and the value chain is losing its attributes, and being replaced by a web of fluid and flexible relations, as stated by Camarinha-Matos (2009). In decision-making processes inside a collaborative network, clients are a core asset in terms of value creation; they contribute to increase the operational efficiency of the network by introducing new possibilities and their innovations identify unique competitive advantages.

In the collaborative network, the role of clients is evolving from that of mere consumers of products and services to being "partners" in the process of value creation. As described by Camarinha-Matos (2009), the paradigm of collaborative networks offers new opportunities in the implementation of agility in production, as well as in other industrial sectors. A collaborative network involves a group of companies or actors in the network, together with another group of clients, supported by an appropriate platform and infrastructure (section 3.1). This platform is basic for the decision-making process (at strategic and / or operational levels), with many of these decisions being agreed among diverse network actors.

Interaction gaps between network actors could pose a serious problem in order to effectively involve other actors: this obstacle should be overcome by network-wide decision-making, as well as by an appropriate operational structure. An example of implementation of a knowledge-based information system for decision-making can be found in Vatcharaphun et al. (2010).

4. Conclusion

Technology improves at an ever-increasing rate, but the speed at which companies adapt their strategies and competencies to develop technological innovations and exploit market opportunities remains limited. While networks provide an option to increase agility through collaborative access to relevant external competencies, we know little about systematically managing such networks (Katzy & Crowston, 2008).

When building or designing a virtual global manufacturing network, cultural differences among the companies integrated in it for intense collaboration are one of the main

challenges and must be treated with care. Opposed focuses on activities, such as internal communication, attainment of objectives, professional career, power structure, hierarchical relationships, etc. could cause conflicts in the performance of functions, expectations and practices. The conclusion is that an appropriate dynamization of the network will avoid a high degree of incompatibilities in the cultural practices of each of its members.

In order to build a virtual global manufacturing network, an incremental process must be adhered to, and a reduced number of activities and main abilities that will be complementary to those of other partners must be identified and focused on. When these capacities are mutually appreciated, progress can be made in future developments to reinforce confidence and to minimize opportunistic conducts.

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