ORGANISATIONAL NETWORK MODELS AND THE IMPLICATIONS FOR DECISION SUPPORT SYSTEMS

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Abstract: Various models for cooperative organisational networks exist. The obvious differentiation is the structure of the networks. But these models, sometimes implicitly, assume different levels of autonomy of the network partner. This paper compares a number of such models. Depending on properties of the problem at hand that requires a decision, different models are preferable. Decision Support Systems that aim at supporting decision makers in various decisions ranging from strategic to operative nature have to support the varying degree of centralisation of decision making.

Keywords: Distributed Decision Support Systems, Decision Making, Cooperative Networked Organizations.

1. INTRODUCTION

In this paper, observations regarding requirements on decision support systems for cooperative organisational networks, from several European based research projects (e.g.: MaBE (Hämmerle et. al. 2002, FLoCI-EE (Fürst et.al. 2001), e-MMEDIATE (Hahn et.al. 2004), CrossWork (CrossWork 2004)), are accumulated. These observations are discussed using standard models of cooperative organisational networks, with focus on the distribution of decision power.

To structure the discussion Simon's Decision process (Simon 1960) with the three phases "Intelligence – Design – Choice" is assumed as the underlying paradigm that lead to the development of the models. Within the intelligence phase the environment is observed for potential problems, challenges, and changes where the decision maker has to act. In the design phase models are generated that allow to generate different solutions. In the Choice phase the best solution within the model and used value function, in the current context is selected (Vetschera 1995). In this paper the implications of the models on the decision process phases are discussed.

The rest of the paper is organised as follows. An overview of different approaches of cooperative organisational networks is given. First for each of these models motivations which lead to the development of that particular model is sketched (according to the Decision process this is a result of the intelligence phase). Then the resulting models are described (design phase). Then the limitations and strengths of the models which have impact on decisions made within the models are discussed. These decisions are then made within the choice phase. The discussions raise points that have to be taken into account by Decision Support Systems, either by trying to limit the impact of limitations or by fostering the impact of strengths. In section 3 the models are compared and put into relation to each other. Section 4 presents the conclusions of this work.

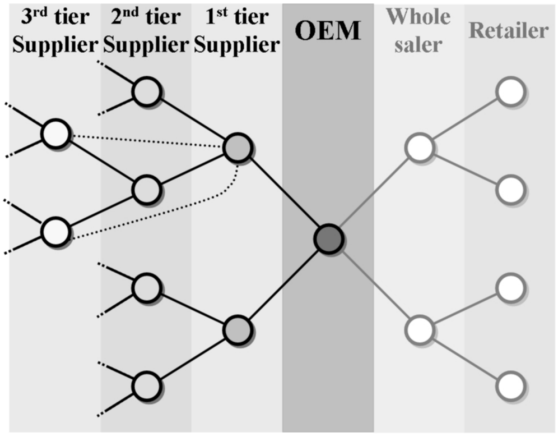

Fig. 1.Structure of a Supply Chain.

2. MODELS FOR COOPERATIVE ORGANISATIONAL NETWORKS

2.1 Supply Chains

Motivation. A classical example motivating the need for Supply Chain Management tools is the so called "Beer Game" (Ossimitz 2004, Senge 1995). Here it can be demonstrated how changes in the demand at the customer side can affect companies down the chain. Small changes can get more and more amplified the more a company is located at the beginning of the chain. Mainly a simple shortage in the supply of goods in conjunction with a wrong forecast of future demands, delays in delivery, and a limited communication within this type of organisational network are the reasons for this effect (Senge 1995).

Model Design and Structure Supply Chains are Models of cooperative organisational networks showing the cooperation of organisations regarding one product. Figure 1 depicts such a chain. On the left hand side suppliers delivering goods are shown. On the right hand side the distribution part of the chain can be seen. The structure of the supply chain models is that of a pyramid, where the OEM is on top.

Strengths, Weaknesses and Decision Support According to the model the design of the chain gets the most emphasis. Much effort is put into an optimised design of the structure. The process of optimising a Supply Chain follows a top down approach mainly from the OEM's point of view, setting various constraints regarding quality, price, time, and eventually even (pre-) selecting participating companies.

Since an optimised central model is sensitive to change, changes to the structure of the network have to be avoided. The model provides no support for such changes, it is sometimes even assumed, that after having established the chain the relationships are stable within the network. Users of the model want to get an overview of the whole process of how different companies work together to produce and sell one single type of product.

Strategic decisions are mainly made in this setup phase (Supply Chain Council 2004). The strategy for managing all the resources is laid at design time. A set of processes and rules for pricing, delivery and payment are developed. Schedules of activities necessary for production, testing, and packaging are made. Logistic processes are established to coordinate the receipt of orders. For all these steps metrics necessary for monitoring are established.

During "runtime" of the supply chain, forecasts are propagated through the system to support the participants in their production planning. Operations research wise it is also of interest to monitor the critical path of that chain.

Software programmed to support the above described worldview, has to be capable to provide the information needed for forecasts and production plans. Such systems help to overcome the bullwhip effect and other problems described above.

But overall this is an optimistic approach assuming a stable and static supply chain where a critical path should be monitored. This Model doesn't point out that during execution of a supply chain regularly situations emerge which are not foreseen at design time. While in a stable environment this hierarchy can prove to be more efficient and predictable (compare also Bongaerts et.al. 2000), each participant is typically part of several chains concurrently. The optimisation and streamlining of a single chain will interfere with the other chains, and result in a suboptimum solution from a single participant's view.

2.2 Extended Enterprise

Motivation Browne et. al (1995) have identified a number of pressures, which combined force individual companies to take part in cooperative networks. The items related can be clustered in three areas being the underlying reason for the pressures. These areas are globalization, environmentally benign production and business and organisational structures which are under increasing stress. Along with these pressures five trends are identified:

- Reduced product lifecycles
- Time-based competition
- Total product lifecycle view
- Creating organisations which attract high quality people
- A appropriate manufacturing strategy

To be able to resist the identified pressures and having to respond to these trends, companies have to take part of collaborative inter-enterprise networks (Browne et.al. 1995).

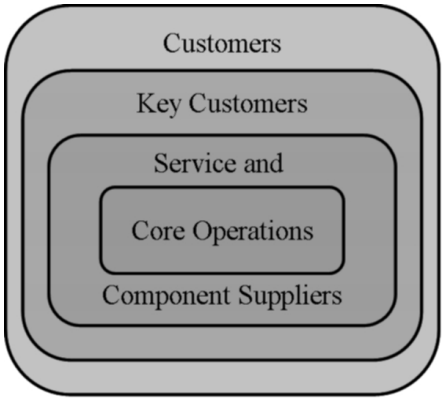

Fig. 2. The Extended Enterprise (Browne et.al. 1995).

Model Design and Structure. Figure 2 shows the structure of extended enterprises. It is a organisational network where different organisation are working together to cover large parts of the product lifecycle. In contrast to types of organisational networks described below, here still a clear hierarchy exists. A dominant organisation providing the core operations is on top of the hierarchy. Below this organisation, a number of other enterprises assemble to provide services and goods along the product lifecycle.

Strengths, Weaknesses and Decision Support Extended Enterprises in contrast to the supply chain take more of the product life cycle into account. Still a clear hierarchy exists, which limits the flexibility of the structure. By the dominance of a single company no real decentralisation can be reached, as all participating companies depend on the central company providing the core operations. However, as this model is designed to cover the most of the lifecycle, more freedom is provided to those companies providing services at different stages of the lifecycle. Decision Support Systems have to cover the whole product lifecycle taking more aspect than the production and the distribution of the product into account. But still the systems have to respect the hierarchy.

2.3 Virtual Organisations

Motivation The motivation for Virtual Organisations is based on the observation of shortened product life cycles and the need for flexible low volume production. By supporting marked based coordination mechanisms, more agility should be reached (Vetschera 1997, Camarinha-Matos and Afsarmanesh 2001).

Model Structure A Virtual enterprise is a temporal network of enterprises that share skills and resources to fast react to business opportunities (Camarinha-Matos and Afsarmanesh 2001). Emphasis in Virtual Enterprise research is put on the Information and Communication (ICT) infrastructure that supports the required agility of the organisational network. Camarinha-Matos and Afsarmanesh (2003) have identified capabilities of Virtual Enterprises. This form of organisation should be agile, the member have complementary roles, achieve dimension (the VE is larger as its members), and therefore should be more competitive. But in contrast to pure market based organisations more trust and shared decision making exist, which allows to share resources and promote innovation by supporting exchanging of ideas within the network (Camarinha-Matos and Afsarmanesh 2003, Vetschera 1997).

Strengths, Weaknesses and Decision Support Compared to the models discussed before, no explicit hierarchy exists by design. Having the emphasis on cooperation on a per project basis, competition between the companies will take place. Much more autonomy is given to the members as in the previous models. The design phase of the network is not of concern and a constantly evolution of the Virtual Organisation is allowed. Decision Support Systems for Virtual Organisations have to support a cooperative, but still competitive and distributed decision process (Vetschera 1997).

2.4 Collaborative Supplier Networks

Motivation. The models described above have in common, that in every case a single network is under consideration. But since optimisation of a whole supply chain is an impossible mission (cf. Karageorgos et. al. 2003 for a discussion of a scheduling problem in supply chains), in the Collaborative Supplier Networks model, while describing also some general organisational network structure like the VE, not the network is in focus, but the situation of the individual organisation. Emphasis is placed on trying to support the individual organisation in its cooperation. This model is a generalisation of the CrossWork project's Networks of Automotive Excellence (CrossWork 2004). It is assumed that an organisation takes part in a number of networks. Additionally if some virtual organisation is under consideration the organisation itself is a network.

Model Design and Structure. This model structure of Collaborative Supplier Networks takes into account unstructured networks but allows and accounts for hierarchies as well. Essential here is the explicit distinction between intra-organisation and extra-organisation. Since organisations may consist of a number of smaller organisations and departments themselves, nested structures are allowed and hierarchies and holonic structures are possible (cf. Weichhart et. al. 2002). It is assumed that each organisation takes part in a number of networks and provides a number of services or goods. The focus of this model is on providing the infrastructure for process oriented dynamic coordination of the partners and a suitable information distribution, respecting the individual context and situation.

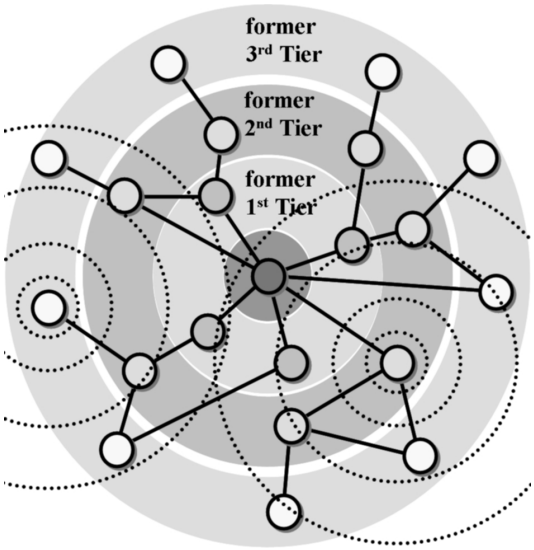

Fig. 3. Structure of a Collaborative Supplier Network.

Strengths, Weaknesses and Decision Support
Network partners have autonomy over their own decisions, but also responsibility towards the stakeholders of the organisation. It is assumed, that each partner is able to gain detailed information about the internal situation. This information in general is not provided to the outside. Therefore any planning of processes has to be distributed across organisations. The distribution of control (also referred to as decentralisation) and encapsulation of information is not limited to the planning phase, but also happens at execution phase. A changed situation results in the need for new plans. Different versions of new plans have to be developed and evaluated across relevant partners and networks.

The requirements and implications of networked organisations on decision support systems can be described as follows:

- Decentralisation and Autonomy: Decision support systems for this type of model have to support a collaborative style of decision making, for each organisation, and across the number of networks this organisation takes part in, taking its current context into account.
- Interaction: Since there is no single point of control, the interaction between network partners gains more focus. Decision support systems have to support a loose coupling between organisations.
- Reactivity: The overall situation from the individual organisations point of view is complex and unstable, especially if an organisation takes part in a number of networks. Decision support systems have to enable the users to recognise exceptional situations, and support decision making to resolve these situations.
- Individual view: The network partners have to have their individual view on the networks they take part in.

3. MODEL COMPARISION

Above different models of cooperative networked organisations have been discussed. In these models different degrees of hierarchical control and distribution of decision power exists. While in the first model, the supply chain, the Original Equipment Manufacturer, has a clear leadership role per se, the other models have a growing degree of distribution of decision power among the network participants.

There have been made great efforts to model supply chains for better planning, monitoring, and performance measurement. But since modern production not only involves a large number of participants, and the problem of optimising such a chain is of NP-hard nature (cf. Karageorgos et. al. 2003), the picture that is taken has to be fairly abstract. For larger supply chains only monitoring of critical paths is left, to not overwhelm the decision maker, but to point her to the most relevant issues. The more decentralised the models become, the less a detailed view of the overall network is necessary, as the model takes into account that the individual partners do not have full details, but only a personal snapshot. The degree of detail includes the access to timely information. But also with decentralised models, a common rough overview is still of interest as this provides a basis for decision making. So in any case, a distribution of current state information to all decision makers should happen.

The following tables compare different aspects of the organisational network models under consideration. “Model Focus” shows where the models place the emphasis for their support. The difference between coordination and collaboration lies in the point of view. To consider coordination issues, a super-position is taken and the interaction between partners is under consideration (cf. Webster (1996) “to bring into common action”). Collaboration issues focus on the common goal to produce something but from an individual point of view (cf. Webster (1996) “to work jointly with others”).

Table 1 Model Comparison Part 1

Model	Model Focus	Decision Making
Supply Chain	Optimised Design and Planning of the Structure	Centralised
Extended Enterprise	Support of product lifecycle	Partly Centralised
Virtual Organisation	ICT Support for Coordination	Decentralised
Supplier Network	Support for Collaboration	Decentralised

Table 2 Model Comparison Part 2

Model	Decision Support for Simon's Decision Process Phases
Supply Chain	Monitoring of the chain; Support for Intelligence Phase
Extended Enterprise	Information exchange along the lifecycle; Support for the Intelligence Phase
Virtual Organisation	Support for Market-like Coordination; Support for the Intelligence and the Choice Phase
Supplier Network	Support for Collaborative Problem Solving and Monitoring of the actual Situation of an Organisation; Support for the Intelligence, the Choice Phase and limited support for a (Collaborative) Design Phase.

4. CONCLUSION

A look at different cooperative network models is taken and put into relation with special focus on the (de-)centralisation of decisions.

In the Intelligence phase, an overview of the whole value chain needs to be provided. With some appropriate Information and Communication system, the available information can be spread within the network to lower the information asymmetry, and each partner can base decisions on the same data.

For the design phase the decentralisation has more impact, as different local models of participating organisations need to be considered, synchronised, and aligned. Having established a common model allows then the network partners to base their operative decisions on this common model. This common model should also help to support trust between network partners.

For the choice phase a common model allows network partners to make autonomous decisions based on the same information, and a common interpretation of that information, reducing coordination costs. This of course can only be done in a trusted environment. But in general, what still can't be assumed to be equal within the whole cooperative network is the value function which is used to select the best alternative (Laux and Liermann 1993). But the same holds also true with the company internal and centralised Principal – Agent relationships.

Both centralisation and decentralisation is associated with different types of costs. While an appropriate Information and Communication Technology (ICT) Infrastructure is also associated with costs, the total costs can be lowered. This is true on the one side, because ICT allows better monitoring of sub-ordinate agents and reducing information asymmetry and associated costs.

But also coordination using a decentralised marked like coordination mechanism is associated with costs, like searching for appropriate service provider, ICT there also helps in lowering the overall costs (cf. Vetschera 1995, Weichhart 1998).

So since ICT can lower the coordination costs for decentralised and centralised models, the different models described above have advantage in different situations.

A decision of strategic nature has a high impact if made wrong. These types of decisions have the advantage that there is only limited time pressure. At the strategic level, decision support systems have to provide an overview of almost all parts of a process. The timeliness and level of detail of the information, due to its strategic nature, is not of that much importance.

Decisions on operative level on the other hand have to happen fast, but have less impact on the overall performance if a certain trust level is assumed and also there is also the common will to cooperate. Here the actual situation (and context), within a decision is made, has to be provided to the decision maker. An individualised look is necessary to consider in detail the available and relevant information. Decision Support Systems have to provide more support for exception handling and fast responses to unforeseen situations. Here such systems should provide local up to date information. Of advantage is a Decision Support System that takes the individual situation of the decision maker into account.

Decision Support Systems for cooperative organisational networks that aim at providing support for the whole decision process have to support various level of decentralisation.

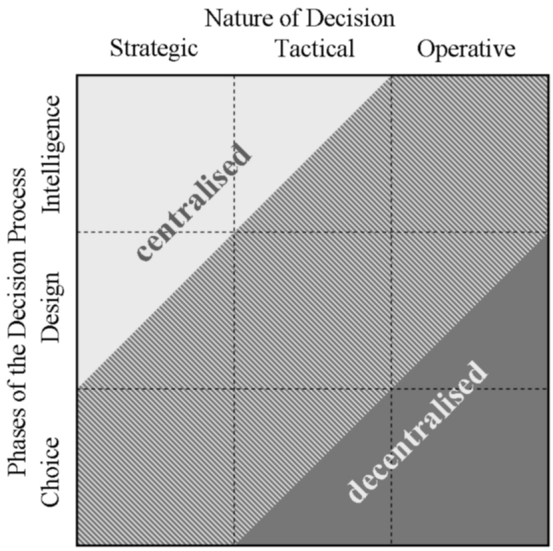

Fig. 4. Centralised versus Decentralised Decision Support Systems

Table 3 Model DSS Properties

	Resp. Time	Dec. Power	Flex.	Desired Optimisation
Decentral	Fast	Distributed	High	Local
Central	Slow	Centralised	Low	Global

Strategic decisions need more support for the intelligence phase, as here decisions are made that trigger model design on tactical level. On operative level if a model is already in place, the decision maker performs her choice within the model. This is summarised in figure 4.

For choosing the right model some problem (network) properties have to be considered. All models have their pros and cons in different problem settings. The attributes here listed here (desired response time, the distribution of decision power, the flexibility of the network, and the desired optimisation level) are examples where advantages of a centralised or decentralised model can be easily recognised.

The optimal DSS would support all described models allowing the decision maker to shed light on issues from various perspectives, being able to choose what he finds best and not being restricted by a predetermined model which restricts his world view.

5. ACKNOWLEDGEMENT

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