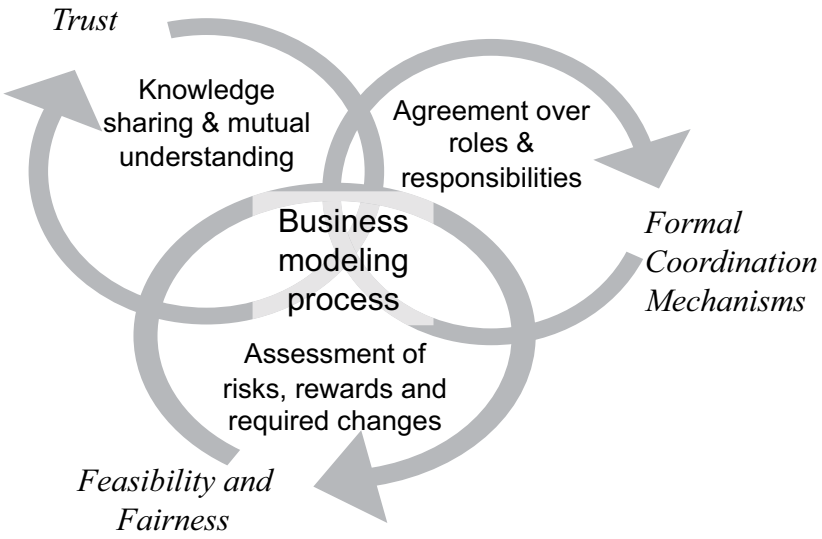
JYVÄSKYLÄ STUDIES IN COMPUTING
111

Marikka Heikkilä

Coordination of Complex Operations Over Organisational Boundaries



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UNIVERSITY OF JYVÄSKYLÄ

JYVÄSKYLÄ 2010

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ABSTRACT

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This thesis focuses on the topic of coordination in organisational networks. The aim is to gain more understanding on how activities can be coordinated, how coordination differs within time and context, and what is the role of information and communication technology in coordination.

Organisational coordination is examined as a dynamic phenomenon, focus of which shifted in the course of time from coordination of organisational activities within traditional boundaries of companies to coordination of joint activities that are spread over a network of companies. This shaped also the nature of the research, so that in line with the evolution of the phenomenon this thesis consists of two research methodological approaches, post positivism and pragmatism. The research builds on literature from multiple domains, such as organisational science as well as literature on organisational learning, organisational networks and information systems. This way it seeks to achieve a richer longitudinal view on the phenomenon. The empirical data for this thesis covers a period from 1990 to 2008.

The theoretical contributions of this thesis are related to coordination frameworks for collaborative business networks. Whereas traditional frameworks are suitable for describing coordination within organisation boundaries, new smart business networks, that emphasise learning and knowledge sharing, call for new kinds of conceptualisations of coordination. For this purpose, this thesis suggests network's business modelling process: A business model can be used as a dynamic boundary object for the negotiations between the potential partners over the key issues, including coordination mechanisms of the networked collaboration. Furthermore, this thesis provides some recommendations for future development of information systems towards better support of collaborative business networks.

Keywords: Coordination, business network, collaborative business network, complexity, business model, learning, change management, information systems, ICT.

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Furthermore, I would like to express my warmest thanks to my other supervisor, PhD Hannakaisa Isomäki who guided me through the last elemental steps of this thesis project. In addition to helping me in finalising the contents of this thesis, I wish to thank her especially for persuading me into *ex-post* evaluation of my research methodological choices. This led to a very enlightening and rewarding journey into research methodologies and research philosophies, and to more scholarly introduction of the thesis. Also thanks goes to professor of philosophy Sami Pihlström who commented on my writings about pragmatism and research philosophy in general.

This thesis includes chapters that I wrote on the basis of previous articles co-authored by prof. Samuli Pekkola, prof. Markku Tinnilä, prof. Kalle Lyytinen, prof. Lynda Applegate, prof. Jukka Heikkilä and Jari Lehmonen. It was fascinating to work together - thanks.

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As indicated by the large number of people I am indebted to, this thesis is not produced solely by me. This fact is reflected also in the writing style: I used

plural form ('we') throughout the thesis when discussing the research, the results and implications.

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Vaajakoski
10th March 2010
Marikka Heikkilä

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1 INTRODUCTION

Every organised human activity involves division of labour (Smith, 1776) into various tasks to be performed, and the coordination of these tasks to accomplish the activity (Mintzberg, 1979; Malone & Crowston, 1994). We can easily agree with Thompson (1967) and Galbraith (1977) that the more complex the overall task or the more parties are involved, the greater the problem of coordinating becomes. Therefore, today coordination has become even more important than before (Powell, White, Koput & Owen-Smith, 2005), when collaboration with several players, such as suppliers, complementors, customers and maybe even competitors, has grown to global scale (Nalebuff & Brandenburger, 1996). This brings out a question of the suitable conceptual frameworks for comprehending the phenomenon and for guiding the selection of coordination mechanisms in networked settings (Vervest, van Heck, Preiss & Pau, 2005). This is the topic of the thesis: we study coordination frameworks and pay special attention to the role of information and communication technology (ICT) in supporting networked operations.

This research builds on literature from multiple domains, such as literature on organisational science, organisational learning, organisational networks and information systems. This way it seeks to achieve a richer longitudinal view on the phenomenon. The intention is to advance scientific knowledge on coordination and to provide the reader with some theoretical models and frameworks that can be helpful when considering coordination mechanisms for business collaboration over organisational boundaries. Particularly we study the coordination model proposed by Galbraith (1977) and as alternative, business modelling framework for coordination of more collaborative networks.

1.1 Background: The increasing need to coordinate collaboration in networks

Markets and hierarchies are considered in economics the two generic mechanisms for coordination (Milgrom & Roberts, 1992). Nobel Laureate Williamson (1985) argued that both in markets and in hierarchies[1] the firm faces governance or coordination costs, which he illustrated as "*equivalent of friction in physical systems*" (p. 19). He characterised transactions by their frequency and investment characteristics (see FIGURE 1). The most efficient governance mode is determined by the sum of governance and production costs (Williamson, 1985).

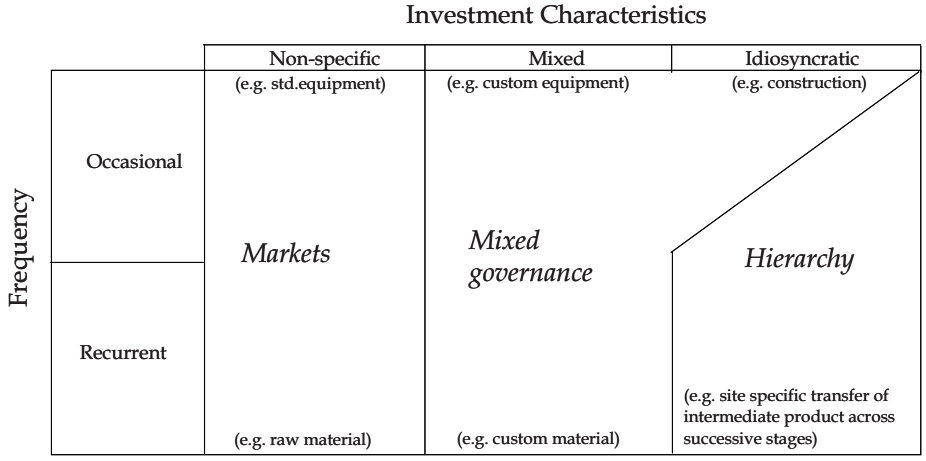

FIGURE 1 Efficient governance structures (modified from Williamson, 1985)

In case of common good market governance is the most efficient way to organise transactions (see FIGURE 1). But, the more the transaction requires exclusive investments in site, physical or human assets or otherwise dedicated assets the less favourable markets become in terms of production and coordination costs. In these situations markets are regarded as hazardous, since market has no effective coordination mechanism to allow adaptive, sequential adjustments to disturbances (Williamson, 1985). In this case, the minimum coordination mechanisms are considered insufficient alone, but must be

1 Free market, while appearing chaotic and unrestrained, is efficiently guided by 'invisible hand' to produce the right amount and variety of goods (Smith, 1776). In markets price movements direct production levels and buyers contract their suppliers based on the best combination of price and availability (Malone et al., 1987). Within a firm, in contrast, the coordination of 'invisible hand' is substituted with entrepreneur-coordinator, who directs activities (Coase, 1937 p. 388). In firms a managerial hierarchy was a prerequisite for realising the advantages of coordinating multiple units within a single enterprise (Chandler, 1977).

substituted with other types of mechanisms. Traditionally these mechanisms have been accessible within hierarchy.

The cases falling in between the polar ends of asset specificity – such as occasional production of custom equipment and recurrent supply of custom material - seem to show mixed governance structures, where some transactions are carried out in the markets with minimum coordination, but some others are carried out by applying coordination methods within a group of co-operating companies (Williamson, 1985). In the third governance mode, separate units are interactively seeking a suitable solution by coordinating their plans, activities and resources to each other (Håkansson & Lind, 2004).

There are various studies arguing that ICT reduces coordination and transaction costs (Shin, 1997; Clemons, Reddi & Row, 1993; Malone, Yates & Benjamin, 1987; Bakos & Brynjolfsson, 1993); and provides better means of information gathering and processing, monitoring, negotiating and enforcing contracts (Gurbaxani & Whang, 1991; Malone et al., 1987) also between organisations. Malone et al. (1987) suggested that this will lead to an overall shift toward proportionally more use of markets rather than hierarchies to coordinate economic activity. On the other hand, Clemons et al. (1993) proposed 'move to the middle' hypothesis: companies are expected to have long-term relationships with fewer number of suppliers. A comparative case study by Holland and Lockett (1997) showed how the governance often is a mixture of hierarchy and market components.

Actually the mixed forms have become more common – especially in societies of homogeneous background and institutional contexts with a sense of general reciprocity (Powell, 1990; Williamson, 1991). For example, the studies of Tsupari et al. (2001, 2004) on manufacturing networks in Finland indicate strong increase in business networking - during one decade (which is examined also in this thesis) the volume of partnerships between firms have more than doubled, where as the share of other types of relationships has dropped off (see FIGURE 2 on the empirical results of the evolution of manufacturing networks in Finland). A strong expansion of collaborative relationships was also found by Powell et al. (2005) who studied the formation of network ties over a 12-years period in the commercial field of biotechnology. The tendency seems to be a move towards network type of partnerships with higher levels of commitment and higher coverage of firms' operations.

This tendency clearly goes hand in hand with the trend of outsourcing (Kakabadse & Kakabadse, 2002). The companies are focusing on core activities (Leonard-Barton, 1992) and outsourcing some parts of organisational functions. Most companies must constantly improve their processes and products, which mean that the activities reach beyond organisational boundaries over an increasing number of relationships. This automatically means increased number of partners, vendors and communities of practices with whom the company has to coordinate its actions.

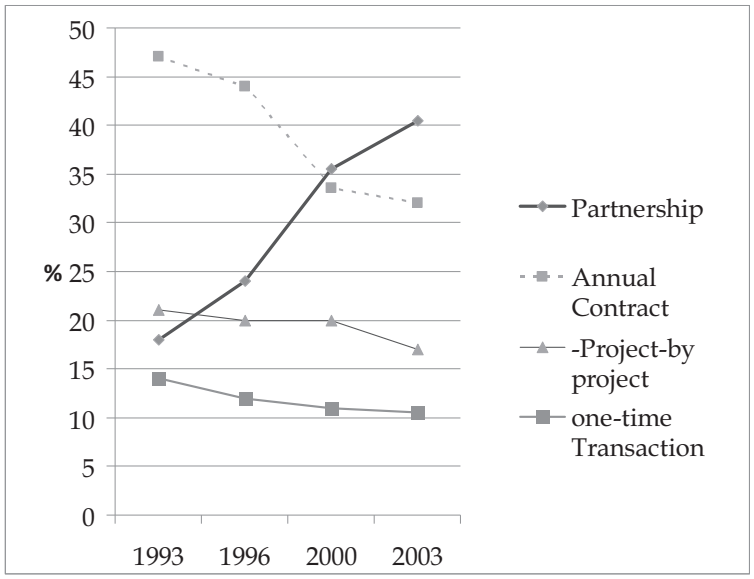

FIGURE 2 The evolution of manufacturing networks in Finland (based on Tsupari et al., 2004)

From the above discussion we can summarise two trends (FIGURE 3): a shift from using markets to building partnerships or networks and a parallel trend of giving up hierarchy by outsourcing. As a result, the firms are often cooperating with each other, forming various kinds of networks, where processes, communication and information are crossing the boundaries of traditional hierarchy. What used to be either coordinated by markets or by hierarchy is now often coordinated by mixed forms of governance.

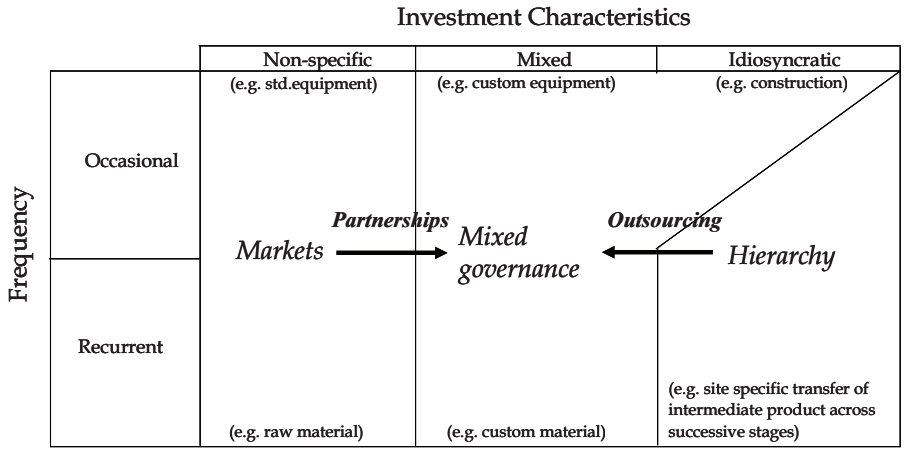

FIGURE 3 The trends in governance modes

Despite increasing importance of business networks, the majority of network research has focused on the general characteristics of networks, which were organically evolved, in essence examining their structure (Kumar & Christiaanse, 1999; Christiaanse & Kumar, 2000; Möller, Rajala & Svahn, 2005). Organisational scientists have been moving gradually towards a knowledge-based perspective of organisations or networks, seen as consisting of intelligent, learning, reflexive, creative and, communicative knowledge workers. Coordination is then perceived as a problem of creating, sharing and transforming knowledge (Kotlarsky, van Fenema & Willcocks, 2008) and taking actions accordingly. Although theory in this area has advanced significantly in the last decade, it is still focused mostly in the dyadic level (Basu, et al., 2005). Especially, more research is called for issues of intentionally formed networks, their development process, coordination and ICT support (Rodon, Busquets & Christiaanse, 2005). These are the themes that this thesis focuses on.

1.2 Research framework and objective

This thesis aims at contributing to the existing body of knowledge on coordination as defined in this thesis by combining views of traditional management and organisational science to the literature of learning organisations, networks and information systems. The topic of this thesis is coordination and its evolution (FIGURE 4). The focus is on conceptual coordination frameworks that aid the selection of coordination mechanisms in networked organisation modes.

The topic is examined in the evolving real-life context of independent companies turning into multi-unit corporations, and to supply chains and more recently to business networks. That is, the development of the phenomenon in our case studies reflects the trends in general – the shift from acting as a single independent organisation into establishment of co-operation in business nets. The viewpoints are ICT, learning and change management.

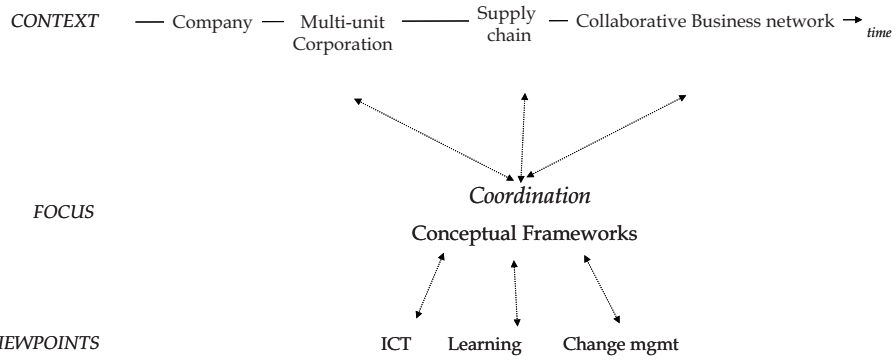

FIGURE 4 Research framework of this thesis

The main purpose of this thesis is to contribute to the existing theories of coordination frameworks by putting forward ideas, frameworks or models that would improve our understanding on how dependencies between activities can be managed in the context of networked operations where information, communication, and the technologies are of great importance. In other words,

> *The objective of this thesis is through multiparadigm research methodology to bring out conceptual coordination frameworks that can be helpful when considering coordination of complex operations over organisational boundaries. Of particular interest is the role of ICT in coordination.*

The backdrop is the trend of businesses evolving from independent companies, to multi-unit corporations and to business networks stressing the importance of knowledge sharing.

1.3 Research questions

Drawing from the objective, and building on multiple lines of theory and inquiry, we formulate the research questions below.

1.3.1 Coordination of complex operations - orchestration of global delivery projects

Previous literature provides multiple frameworks on organisational coordination that aim at better understanding of coordination problems and improvements. Classical organisation science and information systems field adopted the theoretical view that coordination is necessary to adjust the hierarchy so that the company can handle the complexity in its operations. Coordination framework proposed by Galbraith is considered to be one of the classics in organisation science (Groth, 2001). He depicted organisation as an information processing system which aims at sustaining productivity by achieving fit between complexity and coordination mechanisms. Building on classical organisation science this thesis seeks answers to the three following theoretical research questions.

> *Can coordination framework based on systemic view of organisation (Galbraith, 1977) be applied to illustrate patterns of changes in complexity and coordination mechanisms?*

Galbraith (1977) claimed that coordination aims at mitigating complexity by managing information. According to him rules and procedures are the basic means to handle uncertainty. If they are not sufficient enough then the organisation has two ways to react to increasing uncertainty, i.e. to lack of

information: either by lowering the need of information processing, or by increasing the capacity to process information. Even though coordination framework was proposed by Galbraith already in 1977 there is little empirical research on whether the framework is useful in depicting the changes in complexity and coordination. This issue is analysed in Chapter 4.

How coordination mechanisms evolve and affect each other?

The main point in Galbraith's thinking lies in changes: he proposed that if uncertainty increases the organisations should react by applying some coordination mechanisms. This means that the organisations are most probably continuously altering coordination mechanisms, or their relative importance, to be able to cope with complexity arising from changing business or organisational environment. However, previous studies do not capture this dynamic, time-sensitive aspect of the coordination. In this research we aim to provide insight into dynamics of complexity and respective coordination mechanisms applied to coordinate organisational activities. The analysis is provided in Chapter 4.

What kind of a role does ICT have in organisational coordination?

Galbraith (1977) proposed the use of vertical information systems as one mechanism to cope with complexity. Traditional vertical information systems collect and transmit data for planning and setting targets. As Galbraith states, investments in information systems increases the information processing at planning time, while reducing the number of exceptions, which overload the hierarchy. In recent decades information technology has advanced from supporting vertical information processing to supporting multiple purposes, also communication. How can ICT be applied to organisational coordination? This research problem is analysed in Chapters 4 and 5.

1.3.2 Coordination of complex operations - orchestration of emerging collaborative business

Second part of this thesis continues the examination of coordination by enhancing the context to coordination of work carried out in cooperation of several independent companies.

How can collaborative networks be coordinated?

In hierarchies the typical coordination mechanisms are authority, rules and procedural standards. Instead, in literature it is claimed that networks seem to rely more on trust (Powell, 1990; Adler, 2001; Ring & van de Ven, 1992; van de

Ven & Ring, 2006). But what actually means coordination by trust? How can networks coordinate their activities if they wish to enhance knowledge sharing and innovation between the members? Despite the attention given to the role of trust in network literature, only a limited number of studies have been done on the formation of trust in the networks (Lee & Mellat-Parast, 2009). This research problem is analysed in Part II.

What is the role of knowledge exchange and boundary spanners in network coordination?

Since we are interested in coordination of collaborative networks, which are assumed to be built on learning, we are interested in finding out how boundary-crossing knowledge exchange and learning is facilitated and carried out.

We are also interested in finding out who are the coordinators across boundaries in inter-organisational activities. Organisational literature has identified a number of roles related to boundary spanning activities (Thompson, 1967; Snow, Miles & Coleman, 1992). As the number of interfaces increases as a consequence of networked operations and outsourcing, the network also adds new dynamic interfaces with the outer world. Does this mean that the number of boundary persons should therefore increase in proportion to the number of firms, relationships, or complexity of the network? This research question is analysed in chapters 8 to 10.

Can ICT help network coordination?

It is most often assumed that due to ICT, the transaction costs are reduced to the extent that it is worthwhile to outsource ancillary operations and concentrate on core competences (Prahalad & Hamel, 1990; Malone et al., 1987; Picot, Bortenlänger & Röhrl, 1997). Often e-commerce, inter-organisational systems and business networks are formed by integrating existing ICT-infrastructures in order to make trading and production networks or supply chains more efficient (van de Ven, 1976; Wolters, van Heck & Hoogeweegen, 1999; Hoogeweegen, Teunissen, Vervest & Wagenaar, 1999). However, the networks between partners and even competitors can also be seen – not only as means of cutting costs – but as a source of new, innovative business ideas, where the network provides the customer with more added value than if the companies were operating independently (Nalebuff & Brandenburger, 1996; Dyer & Singh, 1998). What kind of requirements this sets for ICT? This problem is analysed in chapter 11.

1.4 Central concepts

Next we will shortly provide definitions for the central concepts of this thesis: coordination, business network and business model.

1.4.1 Coordination

Although we all have an intuitive sense of what coordination means, an explicit definition is hard to articulate (Malone & Crowston, 1994). According to Thompson (1967) coordination consists of protocols, tasks and decision mechanisms designed to achieve concerted actions between interdependent units. Webster's (1989) describes 'coordination' as harmonious combination, or interaction, as of functions or parts. Coordination has some aspects in common with words 'harmonisation', 'cooperation', 'communication' and 'management' (Malone & Crowston, 1994): It aims to formation of a consistent whole as in harmonisation. It implies an act of working or acting together for a common purpose or benefit as in cooperation. It implies the imparting or interchange of information as in communication. It also includes acts of handling and direction as in management[2].

In this thesis we use the definition of coordination by Malone and Crowston (1994, p. 90)

> *"Managing dependencies between activities".*

Dependence is one of the central points in this definition. It is consistent with the intuition that, if there is no dependence, there is actually nothing to coordinate (Malone & Crowston, 1994)[3]. Furthermore, it assumes that the task to be carried out consists of multiple activities.

With coordination frameworks we refer to theoretical constructs that help to analyse and explain actions taken to improve coordination (Van Laere, Vreede & Sol, 2005).

In the literature terms coordination, governance and management are often used interchangeably. Governance relates to consistent, cohesive policies, processes and decision-rights for a given area of responsibility. In the context of corporation, governance means the set of processes, customs, policies, laws and institutions affecting the way a corporation is directed, administered or

---

2 These terms have also other meanings not included in the term 'coordination': Harmonization usually means to act in order to become in agreement in feeling or sense; management connotes institutionalized authority; cooperation implies common goals among different actors; and communication also includes interchange of thoughts and opinions.

3 Malone and Crowston also point out that it is consistent with a long history of emphasizing the importance of interdependence in works of such authors like Thompson and Galbraith.

controlled. Management, in turn, means the members of the executive or administration of an organisation or the technique, practice, or science of managing or controlling. In this thesis we prefer mostly the term coordination, since the focus is on how a joint task, consisting of dependent activities, can be carried out by several actors. Our emphasis is on the collaborative nature of dependencies between the network actors, where there is necessary not a clear management level, or institutionalised authority making the ruling decisions.

1.4.2 Business network

The literature on business networks is already vast. Depending on the approach taken the network is defined differently. For example, Christopher (1998) characterises networks as being formed by connected and interdependent organizations that are mutually and cooperatively working together to control manage, and to improve the flow of materials and information from suppliers to end-users. His view augments the traditional supply chain view with emphasis on mutual co-operation and dependencies between the organisations. Another definition of business network is:

> *A group of firms with restricted membership and specific, and often contractual, business objectives likely to result in mutual financial gains. The members of a network choose each other, for a variety of reasons; they agree explicitly to cooperate in some way, and to depend on each other to some extent. (Rosenfeld 1995, 1997, as cited in Brown, 2000, p. 15).*

The above definition identifies the intentionality and restricted nature of the network. The aim is to provide mutual (financial) gain by engaging in cooperation and establishing relationships that make partner's business dependent on each other. An actor can, at least to a reasonable extent, influence the behaviour of other actors in the business network (Svahn, 2004).

Vervest, Preiss, van Heck and Pau (2005, p. 20) describe smart business networks as:

> *a group of participating businesses –organizational entities or actors – that form the nodes, linked together via one or more communication networks forming the links or threads between the nodes, with compatible goals, interacting in novel ways, perceived by each participant as increasing its own value, and sustainable over time as a network.*

This definition stresses that a smart network is a collection of business actors that have established value adding relationships between each other (Vervest et al., 2005). Vervest, Preiss, van Heck and Pau (2005) emphasise that there are three features that distinguish smart business networks from other e.g. supply chains: Awareness, adaptiveness and capabilities to learn. With awareness they mean that the involved parties share relevant information. Adaptiveness means capabilities to take actions to coordinate the actions of network's members toward the new desired end-state. And, third, the network should have capabilities to learn; to innovate before forced to innovate.

In this thesis we use a combination of the above mentioned definitions for networks aiming at high levels of collaboration between the parties, here after

called **Smart business network or alternatively Collaborative business network**:

> *a group of participating businesses that agree to cooperate in some novel, knowledge enhancing ways and to depend on each other to some extent, in an aim to reach business objectives, perceived by each participant as fair play, and sustainable over time as a network.*

We see that collaborative business networks are formed by companies aiming at joint business goals. The companies agree to cooperate and to rely on each other. Often ICT has an important role in the aim of the smart network to share information, to learn and to being innovative. Moreover, the cooperation is expected to bring mutual gains, and is seen fair by each participant.

1.4.3 Business model

Business models have recently been a hot topic. Since the end of 90's there has been a vivid research stream proposing differing definitions, lists of components, taxonomies, change methodologies and evaluation models for business models (e.g. Timmers,1998; Amit & Zott, 2001; Gordijn, Akkermans & Vliet, 2000; Osterwalder & Pigneur, 2002; eFactors, 2002; Magretta, 2002; Faber, Ballon, Bouwman, Haaker, Rietkerk & Steen, 2003; Bouwman, 2003a, 2003b; Osterwalder, 2004; Haaker, Faber & Bouwman, 2006; Lambert, 2008). In essence, the topics discussed in the business model literature are not new: the components of business models have been recognised - at least to some extent - in business strategies and business planning for decades. But, the need for explicit analysis and description of the business model has become more inevitable as the introduction of information and communication technology has enabled completely new ways of making business. The definitions are many: Osterwalder (2004, p. 14) characterises business model as

> *the translation of a company's strategy into a blueprint of the company's logic of earning money.*

Venkatraman and Henderson (1998, p. 46), in turn, define business model as

> *"a coordinated plan to design strategy along the customer interaction, asset configuration and knowledge leverage vectors".*

That is, (see FIGURE 5) the purpose of business model is to mediate in an orchestrated way organisation strategy to architectural level. It depicts how the business works, i.e. the general logic that creates the business value in relation with the organisations architecture/infrastructure. Therefore the business model, as a representation of the corporate or network strategy, is the starting point for planning operative business processes (eFactors, 2002).

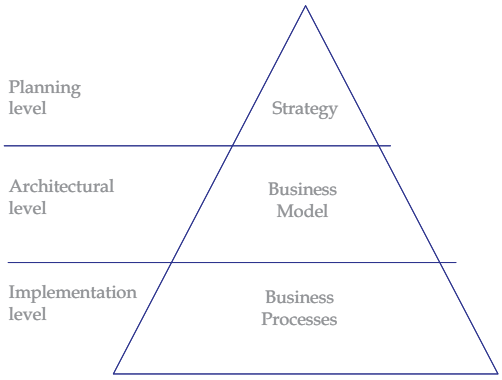

FIGURE 5 Business Logic Triangle (Osterwalder & Pigneur, 2002, p. 3)

Osterwalder and Pigneur (2002) point out that in its essence, a business model consists of four interrelated components (FIGURE 6): a) Service component defines what business the company is in, and the product innovation and the value proposition offered on the market; b) Customer relationship aspects consider who are the target customers, how the service is delivered to them and how to build the relationship; c) Infrastructure management component is about how to perform efficiently infrastructure and logistics issues, and d) Financials component includes the revenue and expense model.

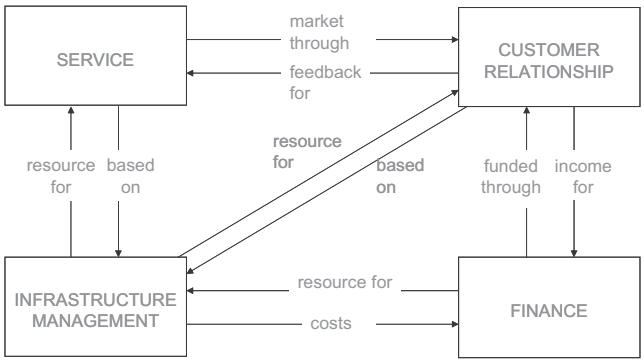

FIGURE 6 The four Components of Business Model Ontology (Osterwalder & Pigneur, 2002, p. 4)

The virtue of a business model is that it considers the business context from a conceptual level, which makes it somewhat independent of current processes and restrictions of the companies.

1.5 Theoretical approaches on coordination in organisational and cross-organisational context

The major research streams that this thesis builds on are traditional organisation science, change management and learning literature, information systems and research on networks (FIGURE 7). Next we will shortly characterise the previous research of these four research streams.

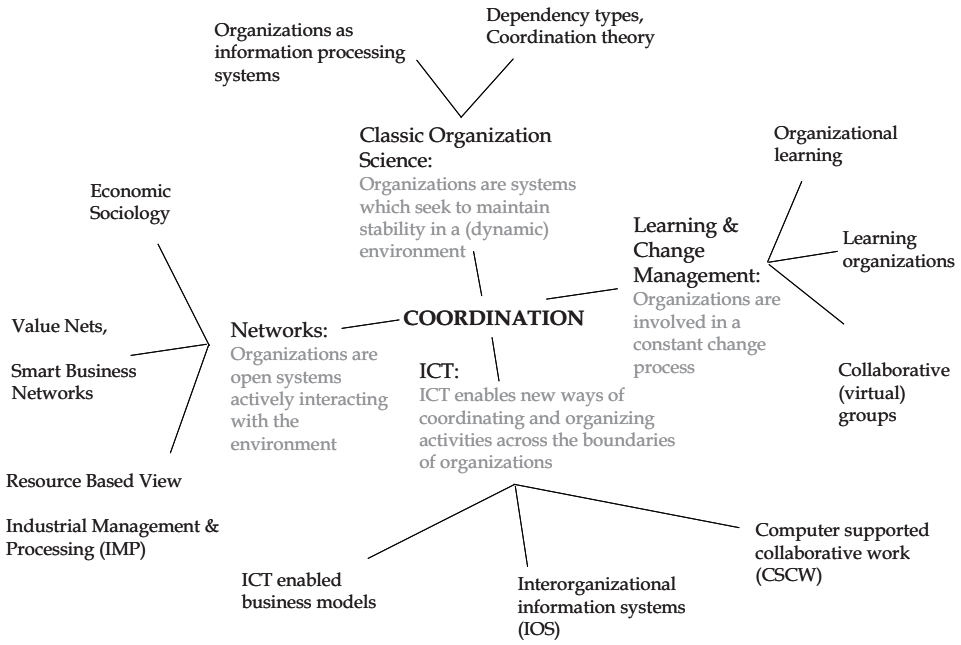

FIGURE 7 Main research streams referred in this thesis

The idea of ''fit'' between organisation and the characteristics of the environment is the central theme in the management and organisation science (Håkansson & Snehota, 2006; Stacey, 2007). Also this thesis starts with the classical view, which sees organisation effective if it is able to coordinate its operations to fit the demands of the environment. Galbraith's (1977) model of organisation as an information processing unit regards organisations as cybernetic systems where management's primary function is to interpret the environment and to coordinate the adaptations required of the hierarchy in order to pursue this strategy (Stacey, 2007). Organisations are regarded as systems and the environment being beyond the influence or control of the organisation. Whatever happens in the environment originates from forces outside the organisation itself. Even if it is sometimes admitted that political networking with competitors (as e.g. in Galbraith, 1977), for example, can

provide a way of influencing over some part of the environment, the fundamental assumption is still that the environment cannot be controlled (Håkansson & Snehota, 2006). Thus, opportunities existing in the environment can be identified and exploited by adapting to the environment, but opportunities can not be created or enacted. The traditional view is that the boundaries are given by the hierarchical (proprietary or contractual) control of resources (Håkansson & Snehota, 2006). This gives an apparently clear dividing line between the organisation and its environment.

In the later theoretical work these assumptions have been contested. Critique is presented e.g. within the tradition of soft systems and critical systems thinkers (Checkland, 1981; Jackson, 2006). Writers in these tradition hold that organisations are not actual systems to be found in real world. This critique therefore represents an important movement in thought from realist to an idealist approach in which organisations as systems are mental constructs (Stacey, 2007). A number of writers have suggested that an organisation's strategic development could be better understood as appearing in processes of learning (e.g. Argyris & Schön, 1978; Nonaka, 1991; Brown and Duguid, 1991, 2000), i.e. organisation's strategy and coordination decisions are caused by learning. Theoretical foundations of **change management and learning** have attracted increasing attention since the early 1990's. Most important difference to the main stream is that they consider organisations as dynamic rather than cybernetic systems (Stacey, 2007). This literature claims that change flows from a process of organisational learning. It is when people in an organisation learn effectively together and so creates knowledge that it changes (e.g. reflective practitioner, Argyris and Schön , 1996).

Another stream of research challenging the traditional view is the **literature on networks**. This stream of research widens the unit of analysis from single organisation to a net of interdependent organisations. Networks are being studied from several view points such as value creating nets (Parolini, 1999), supply chain operations and logistics (e.g. Smart Business Networks, Vervest et. al., 2005, 2008), resources and capabilities (e.g. Resource based view, Barney, 1991), relationships between actors (e.g. Industrial Management & Processing, Håkansson & Snehota, 1995), and economic sociology (e.g. Powell, 1990). The network approach generates another approach to the question of effectiveness and coordination in organisations (Håkansson & Snehota, 2006). In network literature the concept of environment is not perceived as given beforehand or predetermined, but as enacted. In networks interaction takes place between actors who are pursuing their own goals and acting purposefully. Coordination in such a setting is based on previous experiences on the co-operation, and changes gradually as the trust between the parties is building up during the interaction (Ring & van de Ven, 1994).

Intra- and inter-organisational coordination is also a constant topic in the field of **Information Systems**. ICT has been applied in organisations to improve information processing and to automate internal processes, but is also noted as the enabling factor in organisational change and innovation, within and across

organisational boundaries (Mooney, Gurbaxani & Kraemer, 1996). Various inter-organisational systems (IOS) and computer supported cooperative work (CSCW) systems have been studied and adopted to facilitate collaboration and coordination between organisations or actors (e.g. Ngwenyama & Lyytinen, 1997). A more conceptual literature building on transaction costs theory discusses the effect of ICT on coordination costs and on preferences between markets and hierarchies (Malone et al., 1987; Clemons et al., 1993). Another stream of theoretical literature on ICT systems crossing the organisational boundaries builds on the concept of boundary object introduced by Star and Griesemer (1989, see e.g. Gal, Lyytinen & Yoo, 2008). Also, the new, ICT enabled way of distributing work between the players in the field is debated: there may emerge totally new players, and new business models. This has evoked an active research stream on business models (Gordijn et al., 2000; Osterwalder & Pigneur, 2002; eFactors, 2002; Magretta, 2002; Faber et al., 2003; Bouwman, 2003; Osterwalder 2004; Lambert, 2008).

Our aim in this thesis is to analyse and develop coordination frameworks that combine views on coordination from the above mentioned scientific disciplines, and that fit to the complexity of coordination in the context of networked organisations and help to analyse impacts of ICT support and learning on coordination.

The next chapter presents the scientific approach and the research strategy of this thesis. Thereafter the thesis is divided into two parts based on the research methodological approach and central literature: Part I focuses on coordination of complex operations, especially orchestration of global delivery projects. It has a post positivistic approach and builds mainly on traditional organisation science and ICT literature. The following Part II studies coordination of complex operations, in particular orchestration of emerging collaborative business. It applies pragmatic research approach and adds learning and change management to the background literature. The thesis ends with conclusions part, where, first, the findings of the thesis are summarised and discussed, followed by presentation of major contributions, quality of the research and suggestions for further studies. The thesis closes with executive summary.

2 SCIENTIFIC APPROACH AND THE RESEARCH STRATEGY

In this chapter I discuss my philosophical choices regarding ontology, epistemology and methodological aspects of research. Then I will present the empirical research strategy and methods, as well as describe the cases comprising the empirical data. More details on data collection are given in the beginning of both sections of this thesis, in Chapter 3 for part I and in Chapter 6 for part II.

2.1 Multiparadigm research

The fundamental views of the researcher about science itself guides his or her decisions on how to set up, what methods to choose and how to interpret and generalise the results. This worldview may be described as a set of basic beliefs that deals with philosophical principles. It defines "*the nature of the 'world', the individual's place in it, and the range of possible relationships to that world and its parts*" (Guba & Lincoln, 1994, p. 107). The resulting choice represents the most informed and sophisticated view that the inquirer has been able to device - the basic beliefs are fundamental in the sense that even though they must be well argued, they still must be accepted simply on faith since there is no way to establish their ultimate truthfulness (Guba & Lincoln, 1994). That is, no paradigm can be raised over others on the basis of ultimate, foundational criteria.

In this thesis I approach the phenomenon of interest from two ontologically and epistemologically different views. Perhaps, the main challenge in applying multiple research paradigms is that the researcher must be familiar with a multitude of previous literature and also should be able to produce results that would add new knowledge to these 'stacks of previous knowledge'. This evidently takes time – in my case around ten years. However,

some scholars also point out potential benefits of multiparadigm research (e.g. in IS field Grover, Lyytinen, Srinivasan & Tan, 2008). Lewis and Grimes (1999) propose using multiple paradigms and their respective data collection and analysis methods as means of highest level of triangulation (as examples of multiparadigm studies they refer to e.g. Gioia & Thomas (1996), Lee (1991) and Sutton & Raphaeli (1988)). In multiparadigm approach it is assumed that a single paradigm offers only partial truths, and by applying several paradigms we can analyse the topic of interest from several angles and thus via multiparadigm triangulation are able to reach a richer and more extensive view on it. Ideally, Lewis and Grimes (1999) see that by putting paradigmatic explanations side by side may help researchers to translate constructs to a metaparadigm level and assemble a theory that links contracting representations. Here, similar to Lewis and Grimes (1999), this work is concerned with divergent methods of inquiry and with diverse theoretical and philosophical understandings of the various elements encountered in the act of research (Kincheloe, 2001).

I have aimed at epistemological and ontological sensitivity to the phenomenon of interest as it evolved during the research period. In sense, my thinking has similarities with the critical systems thinking (Jackson, 2001) where the methodological choices are made on the basis of problem context. Critical systems thinking (Jackson & Keys, 1984) distinguishes classes of research context based on complexity of the system and the plurality of goals of the decision makers (the complex system is seen as being composed of a large number of highly interrelated elements, open social systems, evolving over time). Thus, suitable methodologies are different for research problems in closed, unitary context than in complex, plural context. The former calls for hard and the latter soft systems approach (Jackson & Keys, 1984). In my thesis work I found that the problem context evolved from a rather closed system with a unitary goal to an open system with pluralistic views. For this reason the methodological choices were changing during my research endeavour. The result is a multiparadigm research as depicted in FIGURE 8.

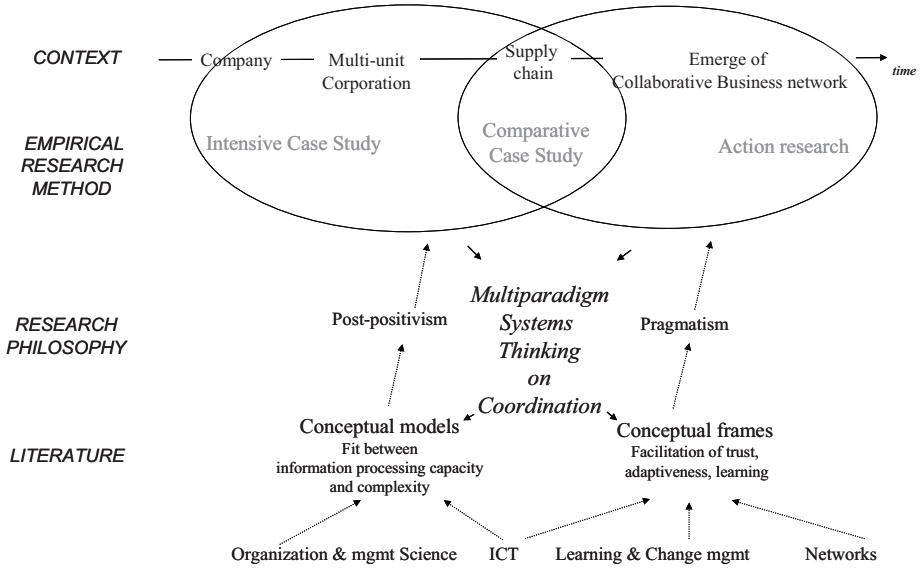

FIGURE 8 Multiparadigm research approach on coordination

Next, I'll present my research methodological choices, empirical methods and background literature (in FIGURE 8) in more detail.

2.1.1 Ontology, epistemology and methodological assumptions

The research approach can be characterised by identifying differences in research ontology, epistemology and methodologies:

Ontological assumptions are the assumptions of the very essence of phenomenon under investigation (Burrell & Morgan, 1979). Ontology is the study of being or existence, and it studies conceptions of reality. It aims to define what existence means (Guba & Lincoln, 1994). Secondly, it also aims to define what the most general features and relations of these elements are (Hofweber, 2005). For instance an object, phenomenon, or thing can exist permanently or just for a short moment. Some object may be emerging, being in the border of existence. Some object may be regarded as a mental construct, not concrete. The seminal question is "Is there a 'real' world out there that is independent of our knowledge of it". In other words whether the reality being investigated is external to the individual or whether it is the product of human mind (Burrell & Morgan, 1979). A classical comparison characterising differing ontological assumptions is realism vs. idealism (Pihlström, 1996; 2000). *Realism* is an ontological theory claiming that there exists reality that is completely ontologically independent of our conceptual schemes, linguistic practices, beliefs, etc., whereas *idealists* claim that ideas, or thought, form the whole or an indispensable aspect of any full reality, so that a world of material objects containing no thought either could not exist as it is experienced, or would not be fully "real" (Downing, 2004; Idealism, 2007).

Epistemology is the study of how we know what we know, the origins of knowledge (Burrell & Morgan, 1979; Guba & Lincoln, 1994; Steup, 2006). Do we know what we know about our world by observing it? Can we *know* something without having experienced it by thinking and logic? To what extent can knowledge exist before experience? Is knowledge out there just waiting for us to be revealed? Some theorists assert that all knowledge exists and need only be discovered as the unchanging truth. And some others claim we will never be certain because there is no unchanging universal truth to be discovered. Furthermore, epistemological questioning continues: How is knowledge best obtained? To give an example of differing views: *Rationalism* declares that knowledge is derived from the (logical) power of the mind. Reasoning (logical deduction) is the chief source of knowledge. On the other hand, *Empiricists* claim that sense experience is the ultimate source of all our concepts and knowledge. Literally, we "see" the world and then know it *(*Markie 2004; Tietoteoria, 2007).

The methodological assumption concerns the question of how can the inquirer go about finding out whatever she beliefs can be known? The answer that can be given is constrained by answers already given to the two previous questions. It directs the researcher to specific methods of collecting and analysing the material (Burrell & Morgan, 1979; Guba & Lincoln, 1994). Here, nomothetic and idiographic methodological assumptions characterise different views of scientific community. Nomothetic methodology approach is deductive and objective, characterised by systematic protocol and technique applied in controlled environmental contexts, often coined with quantitative approach (Burrell & Morgan, 1979; Luthans & Davis, 1982). Idiographic methodology, in turn, is inductive and subjective, typically applying qualitative methodologies, characterised by 'getting inside' (Burrell & Morgan, 1979; Luthans & Davis, 1982).

2.1.2 My Scientific Path

There are multiple viewpoints within the philosophical schools of thought - for example within pragmatism (Pihlström, 1996) – making any classification of various '-isms' rather difficult. Still, I took the liberty to draw the FIGURE 9 for the purposes of a confessional style representation (Schultze, 2000; Myers, 2009) of my philosophical orientation during the Ph.D. studies. It has not been fixed but has evolved from positivist paradigm towards more subjectivist and idealistic perspective. This does not mean that I would now, being at the end of my Ph.D. research, value positivistic approach less, but I have learned that depending on the research problem and context some research philosophical approaches may be more suited than others.

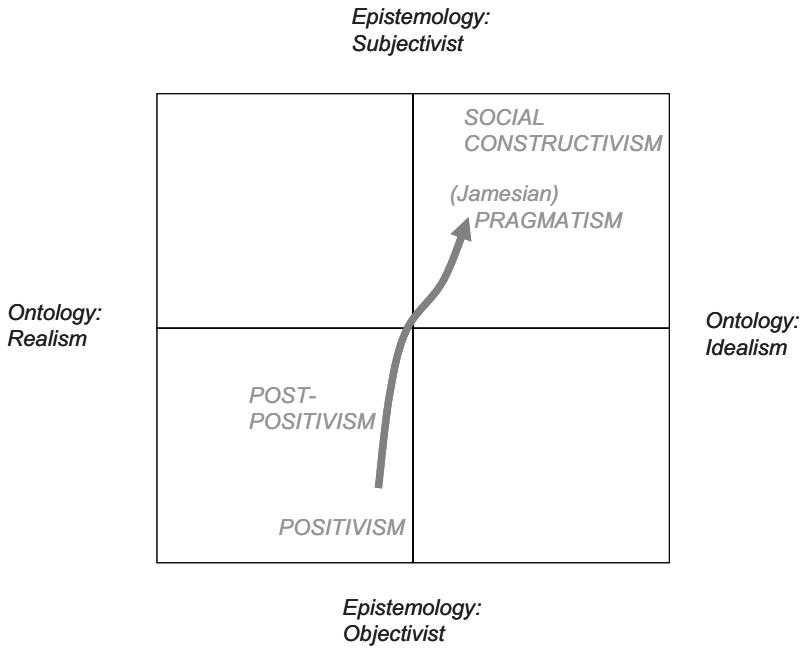

FIGURE 9 The path of my Research philosophical view

One paradigm, *Positivism,* has dominated the formal discourse in the physical science and social sciences, including information systems (Guba and Lincoln, 1994; Susman & Evered, 1978). Epistemological stand point is dualistic and objectivist; the inquirer and the investigated objects are assumed to be independent and investigation does not influence the objects. In positivism knowledge of "the way things are" is usually summarised in the forms of time- and context-free generalisations. Positivism applies nomothetic methodology, so that questions and or hypotheses are stated and subjected to test to verify them. A good theory or model is considered valid or true if it corresponds to or mirrors this given reality (Guba & Lincoln, 1994; Denzin & Lincoln, 1994).

2.1.2.1 Post-positivist case study

Also I was brought up to consider positivism as the 'right' way to carry out scientifically significant research (see FIGURE 9 picturing the path of my philosophical choices). Thus, when I started with my doctoral studies my initial aim was to verify a certain model by testing hypotheses drawn based on it. I framed my topic as "C*oordination of complex operations – orchestration of global delivery projects*" and took the coordination model by Galbraith (1977) as my starting point. The purpose of my study was to examine whether Galbraith's model from 70's was still valid. But, soon I learned that I could not generate metrics that would measure the parameters in the model well enough. The

concept of coordination mechanism was simply too difficult and theoretical to be examined by asking a pre set list of questions. Instead, I realised that I should give up the ideal of objective truth, but turn to *postpositivism*, arguing that reality can never be fully apprehended, but still, at the same time, placing emphasis on the discovery and verification of theories (Denzin & Lincoln, 1994).

Following postpositivist tradition, and especially being inspired by Sarker and Lee's (1998) example on using postpositivist ontology in case research, I used a case study approach and relied on multiple methods as a way of capturing as much reality as possible. I reframed my research questions as: *1) Can Galbraith's framework of coordination (1977) be applied to illustrate patterns of changes in complexity and coordination mechanisms? 2) How coordination mechanisms evolve and affect each other? And especially, 3) what kind of a role does ICT have in organisational coordination?*

The first part of this thesis considers these three research questions based on empirical data collected in studies carried out in collaboration with several other researchers (see appendix A about my contribution in the research projects; and Appendix B for a list of empirical data). Coordination is examined in the context of complex delivery projects, where customer specific products and services are engineered, produced, and installed world wide.

In the first section of the thesis it is illustrated how management can handle coordination of increasingly complex operations by applying several coordination mechanisms in the context of a network of interrelated business units. Unfortunately, I did not have data to analyse how environmental management coordination mechanisms, such as co-operation and alliances with other companies, would operate. Because the results suggested that their importance would without doubt grow in the near future, I saw that the next step of the study should focus on coordination of inter-organisational collaboration.

2.1.2.2 Pragmatic abductive action research

To my pleasure, the opportunity to study coordination mechanisms in the context of multi company co-operation came up the same year: In line with its new strategy, the case organisation was aiming to become in the (near) future more service oriented and focused on core competences. They were to provide localised services in global markets. Naturally, this would also mean increasing cooperation with local and global partners and subcontractors. Being unsure how cooperation should be established, and what kind of coordination mechanisms should be used, they asked us, a group of researchers, to form a consortium consisting of companies and research institutes, where these issues were studied and developed in parallel with practical negotiations and setting up of a business network. The aim was to establish 'rules' for joint operations of network of equal partners.

I formulated my research topic for Part II as '*Coordination of complex operations - orchestration of emerging collaborative business ´* Now I, together with my colleagues, was faced with a completely different research outset: Firstly,

this research work dealt with concepts and constructs that were emerging, being build, i.e. we could not expect that there exists reality that is ontologically independent of our conceptual schemes or beliefs. Secondly, we could not assume any more that the researchers and the investigated objects were independent nor that investigation did not influence the objects, since we were to take actively part in the establishment of the business network and formulating the rules for equal partner network. Clearly, we had to reconsider our ontological, epistemological and methodological assumptions so that they matched with the research topic and context. The group decided to turn toward social constructivism, specifically to pragmatism and action research method. To us this seemed to be suitable approach to study how new constructs (evolving complex systems) were being developed by several independent actors (pluralist context) during the research project.

Constructivist paradigm is arising from sociological and historical literature (Goldman, 1999; 2007), and it is grounded in the conception that such phenomena as science, knowledge, evidence and truth are *social constructions.* Knowledge and truth are created, not discovered by mind. Constructions are not "true", in any absolute sense, and they are alterable, as are their associated "realities". Constructivists are not looking for the essential and timeless truths of the positivists and logical empiricists. Instead, they believe that knowledge is impermanent and situated historically and culturally (Schwandt, 1994). Strong social constructivism claims not only that representations are socially constructed, but that the entities themselves to which these representations refer are socially constructed (Brey, 1997; Steup, 2006; Goldman, 1999; 2007). Pragmatism, in turn, was presented particularly by C. S. Peirce, William James and John Dewey (see e.g. Burch, 2006; Pihlström, 1996, 2008). One of the fundamental ideas of the pragmatist tradition has been '*attempt to achieve the good*' (Pihlström, 1996). Jamesian pragmatists' insight is that we can never distance ourselves from our purposive human action in the world, so that, as Pihlström (1996) remarks, what is 'pragmatic' can also be called 'purposive'. Thus, the pragmatist makes purposeful use of propositions, models or theories and questions whether they are useful in practice "*in the sense of helping people to better cope with the world or to create better organisations*" (Wicks & Freeman, 1998, p. 129). True ideas are seen satisfactory in the sense that they produce the maximum possible sum of satisfactions, including consistency with previously accepted truths and future experience (Pihlström, 1996). In constructivism and pragmatism the investigator and the object are assumed to be interactively linked so that the findings are literally created as the investigation proceeds (Guba & Lincoln, 1994) [4].

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[4] In constructivism (Guba & Lincoln, 1994) and in pragmatism (Pihlström, 2008) the distinction between ontology and epistemology becomes blurred; since what can be known is intertwined with the interaction between an investigator and a particular object.

There are several scientists in the fields of organisational science and information systems that count themselves as pragmatist. Especially, action researchers often build their research on pragmatist philosophy. For instance, Argyris and Schön (1996) state that in fundamental sense their view on organisational inquiry originates from pragmatism. Similarly, systems thinking seem to have pragmatic inheritance (Barton, 1999). In systems approach (e.g. Checkland, 1981; Jackson, 2001, 2006) "*systems are seen as the mental constructs of observers rather than as entities with an objective existence in the world*" (Jackson, 2002, p.6.). Baskerville and Myers (2004) point out the elemental premises for action research that arise from pragmatism: action research must explicate the theoretical purpose underlying the research, it must involve practical action in the problem setting, the practical action must inform the theory, and the reasoning and action must be socially situated. These premises are in line with pragmatist view to make purposeful use of propositions, models or theories and questions whether they are useful in practice.

The research topic of Part II '*Coordination of complex operations - orchestration of emerging collaborative business´* was investigated in a pragmatist action research study. I have modified the chapters from previous conference and journal article published together with the research group. Here, we are mainly referring to literature viewing organisations as dynamic, learning actors having multiple relations outside the legal organisational boundaries (Stacey, 2007). That is, we examine how coordination mechanisms can be agreed and established in the context of emerging collaborative business networks.

The FIGURE 10 pictures the overall research process of this thesis. It consists of two phases: the first one starts from a model (in the upper left corner), continuing with definition of research questions and settings, collection of data and reflection. This led to start of the phase II, where research is considered as repeated interaction among existing ideas, former findings and observations, new observations, and new ideas (Dubois & Gadde, 2002). This is depicted as a continuing loop of diagnosis, action planning, action taking, evaluation and specification of learning (Susman, 1983, as cited in Baskerville &Wood-Harper, 1998).

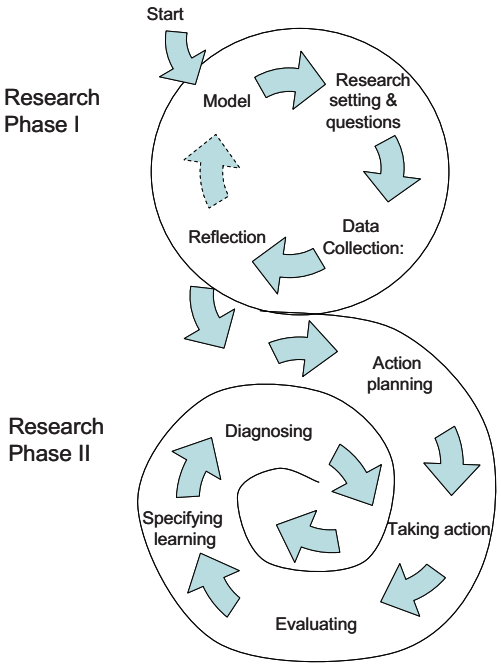

FIGURE 10 The research process of this thesis

2.2 Empirical Research Strategy and Methods

This thesis includes three case studies. Next we will describe the selection of network cases and the types of case studies conducted and data collected. We end with an explanation of the analysis process and theoretical reasoning.

2.2.1 Case selection

As the main purpose of case study is not to deliver generalisations, but to provide insight into an issue, the selection of case should be based on how much they offer opportunities to learn (Stake, 1994).

Access and entry are sensitive components, and the researcher has to establish trust with the case company in order to accomplish the case study (Janesick, 1994). Trust and rapport (Zolin, Hinds, Fruchter & Levitt, 2004) ensures that participants will be more willing to share their knowledge and opinions with the researcher. This often means that we should take a case that we can spend the most time with or that we already have trusting relationship (Janesick, 1994). This Ph.D. study started with co-operation with an organisation M, which had been involved in other research projects with our faculty, and a trusting relationship was already built (for instance, the group

support system for M's project management was designed and developed by a former student of the faculty). The research study was already started before I joined the research group in 1998.

In the beginning of the 1990's the company M was acting as an independent company, but during the decade co-operation intensified, so that later it operated in a network type of arrangement with several other business units of its corporation, added with subcontractors. The resulting organisational arrangement can be characterised as a hierarchy with a twist of network governance (see '**Network of business units**' in FIGURE 11 and TABLE 1). M produced, delivered and maintained heavy machinery facilities. It had 8 200 employees in 30 countries. M was headquartered in Finland and its turnover was 1.7 billion Euros in 2005. All the market transactions were organised as projects (or as the interviewed say, delivery projects). The expertise lay in the capability of delivering complex process manufacturing products and services globally. The goods were typically engineered to order, requiring substantial asset specific investments. It had become the leading supplier of capital goods in its own worldwide segment and was generally considered the technology leader in its field (see TABLE 1).

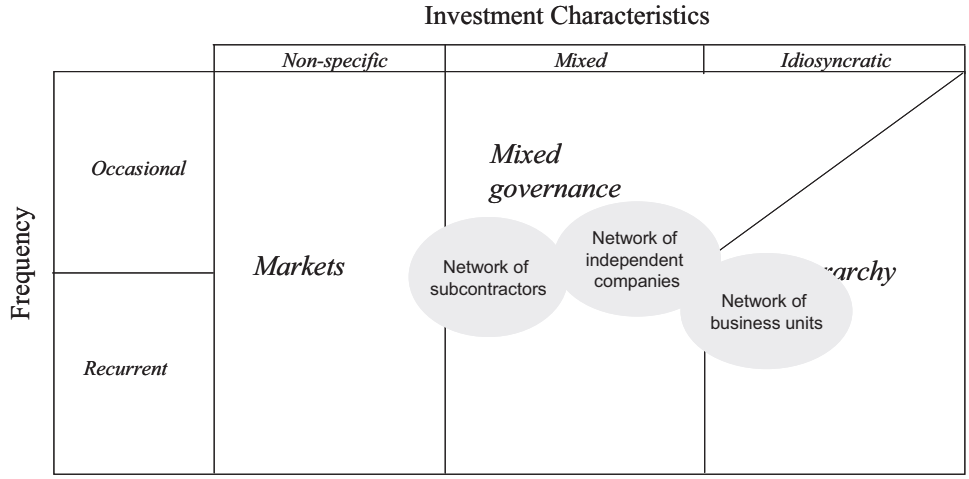

FIGURE 11 Characterisation of the cases analysed in this thesis

For the comparison case we decided to contact a focal company **N with a network of subcontractors** (FIGURE 11). N was one of the largest telecommunications hardware, software and services company in the world. Also its headquarters were in Finland. In 2005, N's turnover was 6.5 billion Euros and it employed more than 18 000 people in manufacturing, research & development and sales offices located all over the world.

According to Orlikowski (1993) in a comparative study the organisations should be selected for their similarities as well as their differences. Special attention should be paid to theoretical relevance and purpose of the comparison. Here, the relevance of the sampling was ensured by keeping 1) the

nature of the organisation, 2) operations and 2) the substantive area addressed similar – here the use of ICT to support coordination of projects:

1) Both M and N were Finnish companies, had office locations and customers in several different countries. Both companies operated in b-to-b markets and had a substantial market share. Furthermore, in both cases the total network consisted of altogether thousands of subcontractors and suppliers. The number of subcontractors in each project varied from less than ten to hundreds companies. Similarly to M, N was customer centric (Galbraith, 2002). They had long term relationships of decades with their customers and the customer base consisted of a limited number of customers globally. The whole market consisted of a few thousand customers at maximum.
2) The validity of comparison study was ensured further by the similarity of the operations carried out by the cases. The business was focused on design, manufacture and delivery of products. The products were complex technology products which consisted of both goods and services. They required high competence in design and manufacturing, but also in erecting and starting up the technology at customer's sites. Both companies organised the delivery of their products as delivery projects and considered the project management as their core competence.
3) Both M and N had during the past years developed own ICT systems to support the coordination of the global delivery projects. Equally, they had mandated the use of these systems in all projects. Furthermore, the project management systems were compatible across the two organizations in that they both covered all the phases of the project delivery.

There were also some clear distinctions between the cases: Besides differing industry sectors, the cases differed in the customisation of the products delivered (see also TABLE 1). M's products were larger in monetary value and always highly customised (engineered-to-order). Each customer deal was delivered to one customer site. On the other hand, the N's delivery project always included installations to multiple - sometimes to hundreds - customer sites. The goods were assembled-to-order, so that value add was achieved by customer specific installation and integration of standard products of the network. Furthermore, even though both relied heavily on the use of subcontractors, there were clear differences in the management of the network relationships. These differences in organisational conditions allowed useful contrasts to be made during the comparative study regarding the coordination of the network and functionalities of the ICT supporting the coordination work.

TABLE 1 Case networks in this thesis

	Network of business units	***Network of subcontractors***	***Network of independent companies***
Industry sector	Industrial	Information Technology	Industrial & Information Technology
Markets	Global	Global	Global
Products	Goods & services engineered-to-order	Goods & services assembled-to-order	Goods & services assembled-to-order
Transaction	Organised as projects	Organised as projects	Organised as projects
Focal Company	M	N	M,B,C
Life cycle phase of the network	Maturity	Maturity	Introduction
Characterisation of the network	A network of several business units from the corporation M added with subcontractors.	A network of subcontractors managed by the focal company.	A network of equal partners added with local subcontractors.
Number of subcontractors	Tens of subcontractors participate in a project. Totally thousands subcontractors.	From some tens to some hundreds subcontractors participate in a project. Totally several thousands subcontractors.	Several subcontractors participate in a project. Totally hundreds subcontractors.

The Part II of this thesis concentrates on a case of **network of independent companies** (FIGURE 11), where one of the partners, **M** was already familiar to us from Part I. The network included also companies B and C. Company **B**, a software house, had been moving towards a more customer centric strategy. Until that time it had acquired the needed additional industry specific knowledge primarily through company acquisitions. Its clientele included, among others, M and C (the dyadic relationships being over 30 years long with the former and around 10-15 years with the latter) and also many customers of M around the world. They therefore shared the same clientele and were also competitors in some product groups. Company **C**, in turn, had been serving M and B plus some of their clients mainly in Scandinavia. It primarily searched new markets for its value-added infrastructure services, both by expanding the existing clientele and by providing new services to and with the companies of the network. The aim of the third case organisation – the network of independent companies - was to provide global customers tailored services requiring medium level of asset specificity.

Our third case shares many similarities with the previous cases: global markets, industrial customers and projects based business. More over,

including both industrial machinery and IT sectors, it combined the business sectors of the previous two case networks.

The third case was of the utmost important for this thesis in two qualities: First, since company M was participating also in our first case study we could collect longitudinal data from a period of 18 years and still keep many of the context variables as constant as possible. This provided us the possibility to follow the evolution path of organisational coordination. We could examine how views and focuses of coordination changed in the organisation within time. Second, one major feature differed the last case network from the previous cases; whereas the first two cases concerned focal company led case networks, this was about building of a network consisting of three equal partners. There was no single authority, but the goals were defined and actions coordinated jointly by several companies. These two qualities helped us to understand the dynamics of the phenomenon and to study the suitability of conceptual frameworks in company and in networked settings.

All companies in this thesis were listed on stock exchange(s).

2.2.2 Case Study Types

Cunningham (1997) classifies three different classes of case studies: *intensive, comparative and action research*, each of which is conducted in this thesis (see also TABLE 3 in p. 46). In intensive case studies the researcher develops a very intensive understanding of the events and practices of one person, group, or organisation. The aim is to provide a history, description, or interpretation of unique and typical events. The Chapter 4 has characteristics of an *intensive explanatory case study*, where the phenomenon was discussed through the lenses of previous theories. According to Cunningham (1997) an explanatory case study allows the researcher to factually record and draw inferences, to illustrate a certain point of view, and to offer details of the reasons for the events or the concepts behind them. Explanatory cases are concerned with providing accurate events and explanations; much like scientists does in an experiment (Cunningham, 1997 p. 404).

In Chapter 5 we, in turn, present a comparison case (Stake, 1994), where we fixed attention upon the few attributes being compared instead of providing a 'thick description' of the cases. In the comparison, the analyst develops an understanding why certain conditions did or did not occur, and then offers interpretation.

The third type of case study, in Cunningham (1997, p. 406), is Action Research that "*focus on research and learning through intervening and observing the process of change*". More often action research is separated from case research. However, if we contend that the case study is actually not a methodological choice, but a choice of object to be studied (Stake, 1994), then also action research can be used as an inquiry method in a case study. It is a process of learning and change where researchers and clients develop a long-term interest in understanding and resolving a problem or issue. The Part 2 of this thesis

applied action research approach with the purpose to develop concepts which facilitate the process of establishing coordination mechanisms.

2.2.3 Data collection

The data collection methods for this thesis were mainly qualitative: semi-structured interviews, and especially in the second phase, active participation in workshops and meetings. In addition the researchers kept diary during the research phase II (Jepsen, Mathiassen & Nielsen, 1989; Newbury, 2001, see Appendix E: an excerption from the diary). Furthermore, some quantitative data, such as financial and production figures was collected. In all, this thesis builds on hundreds of pages of transcribed interviews, memos and diary notes (FIGURE 12 and TABLE 2).

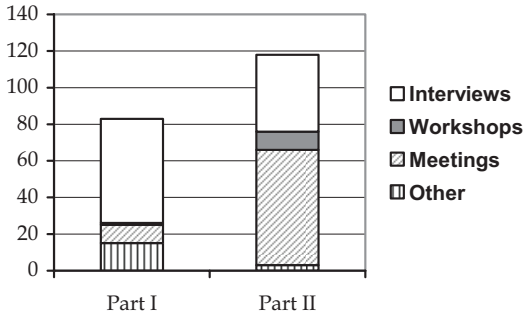

FIGURE 12 Research data of Part I and Part II

A list of the data is provided in Appendix B and a more detailed discussion on research designs are provided in the beginning of Part I and Part II.

TABLE 2 Research data of this thesis

Research Data Instances	*Part I*	*Part II*	*Sum*	*Documentation method*
Interviews	57	42	99	91 audio taped, 76 transcribed, 8 filed as memos
Workshops	1	10	11	Memos
Meetings	10	63	73	Memos
Other	15	3	18	Memos
Sum	83	118	201	

I want to forewarn the readers that even though this work builds on large research data, it includes only few direct quotes etc. in the text. The reason for this is that the participants regarded the data as confidential, and did not feel

confident releasing direct quotes, even when their personality and company background was disguised.

2.2.4 Theoretical reasoning and Analysis

In line with systems thinking (Checkland, 1981; Jackson, 2001, 2006) the decisions over suitable empirical study methods were made based on the context and research questions. In the first part of this study, I started with a theory and supplementary literature, and deduced questions that were analysed in the empirical case study. Thus my approach followed *deductive reasoning* where a previous theory was used as a basis of conceptualising the research and for preparing the research questions. However, I did not aim to statistically proof the theory, but instead aimed at gaining more knowledge on why the model would or would not reflect the reality.

The research phase II followed pragmatist paradigm and its logical reasoning can be described as abductive[5]. Even though having been heavily criticised, abduction is seen as a method to test new ideas or for making sense of new (or unknown) situations by moving back and forth between empirical discovery and theory (Richardson & Kramer, 2006). It is proposed that abduction gives reasons for suggesting a hypothesis, as distinguished from reasons for accepting hypothesis (Niiniluoto, 1999). Although there is no manual for making discoveries, there is a conceptual and logical issue how hypotheses are suggested: Abductive process moves from data to theories and to new explanations, hypotheses and conceptual patterns (Paavola, 2004, 2006). In abduction the original theoretical framework is successively modified, partly as a result of unanticipated empirical findings, but also of theoretical insights gained during the process. Thus the researcher is in a constant move between asking questions, generating hypotheses, and making comparisons (Dubois & Gadde, 2002) [6].

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5 Abduction is formally formulated as follows: "The surprising fact, C, is observed; But if A were true, C would be a matter of course. Hence, there is reason to suspect that A is true." (Peirce, 1903, as cited in Paavola, 2006, p. 39)

6 *The Stanford Encyclopedia of Philosophy* provides good examples of differences between deductive, inductive and abductive argumentation. It considers an example of balls in an urn.
Deductive reasoning: goes as follows "All balls in this urn are red; All balls in this particular random sample are taken from this urn; therefore, All balls in this particular random sample are red."
Inductive argumentation, in turn goes: "All balls in this particular random sample are red; All balls in this particular random sample are taken from this urn; therefore, All balls in this urn are red."
Abduction argument then becomes: "All balls in this urn are red; All balls in this particular random sample are red; therefore, All balls in this particular random sample are taken from this urn. What we have here is nothing at all like an argument from population to sample or an argument from sample to population: it is a form of probable argument entirely different from both deduction and induction. It has the air of conjecture or "educated guess" about it. This new type of argument Peirce called abduction (also, retroduction, and also, hypothesis)." (Burch, 2006).

Even though this thesis includes studies following deductive reasoning and abductive reasoning, we can identify similar tasks in analysis of data. The biggest difference between the approaches is in the timing of the tasks. Whereas in deductive analysis the tasks are carried out in the presented order after the collection of data, in abductive approach the tasks may be repeated several times in varying order before, while or after the collecting the data.

The analysis includes tasks of:

- Familiarisation in the research data by listening to tapes, reading transcripts, studying notes and, especially in Part II, by discussing about the themes with the research group.
- Identifying a thematic framework, i.e. discovering the key issues and concepts by which the data can be referenced.
    - In deductive approach the research questions were deduced from a theory before the collection of data. This theory directed heavily the analysis of the data by providing the main concepts and issues to be located in the data.
    - In abductive approach previous literature was used to provide possible constructs for the identification of themes, but the interaction with the practitioners affected the themes as well. The result was a mixture of previous theories and practical concepts.
- Referencing and interpreting data by recognising associations with constructs. The data was scanned against the selected issues and concepts. Various methods were used, such as charting, tabularisation and mind mapping.
- Feed-back was collected from the practitioners mainly by presenting the results in workshops or in specific feed-back meetings. Based on the comments received the reports were revised and often also published as academic articles in reviewed conference proceedings or journals. The feedback from academic community was again taken into consideration when the papers were rewritten for the purpose of this thesis.

2.2.5 Summary of the research strategies and methods

The following TABLE 3 summarises the research strategies and methods of this thesis. The approach is multi-paradigm research where we conducted post-positivist intensive case studies, comparative case studies and pragmatic action research studies. The aim was to study and improve the current models on organisational coordination, and to propose new frameworks that might be helpful when considering coordination of networked organisations.

TABLE 3 Research strategies and methods of this thesis

	Chapter 4	***Chapter 5***	***Chapters 6-11***
Paradigm	Post-positivism	Post-positivism /Pragmatism	Pragmatism
Reasoning	Deductive	Abductive	Abductive
Purpose	To develop theory or concepts from intensive exploration	To develop concepts or theory based on case comparisons	To develop concepts or theory which facilitate the process of change
Assumptions	Creativity through comparison with existing theory	Comparison of cases leads to more useful theory	Theory emerges in the process of changing
Situation	Evolves out of a researcher's intensive experience with organisation	Concepts are developed from one case compared with another case	Developing theory to assist practices and future science
Case study	Intensive Case	Comparative Case	Action Research
Type of case	Explanatory	Benchmark	Experimental
Case Network	Network of business units	Network of subcontractors	Network of independent companies
Data collection methods	Interviews Historical data	Interviews Workshop	Workshops Meetings Interviews

PART I: COORDINATION OF COMPLEX OPERATIONS - ORCHESTRATION OF GLOBAL DELIVERY PROJECTS

3 RESEARCH DESIGN OF PART I

This chapter describes the empirical research design of Part I. The delivery of the empirical research, suitability of research method (Yin, 1984; 2003) and data collection method are discussed.

This thesis starts with the domain of classical organisation science and Information Systems with a theoretical view that coordination is necessary to adjust the hierarchy and information processing so that it can handle the complexity in its operations. Thus coordination can be analysed with the help of conceptual models describing the fit between information processing capacity and complexity.

We studied the changes in the organisational coordination in a long run by applying one of the models presented in the literature. Following post-positivistic research tradition we approached the challenge by combining deductive reasoning and a longitudinal case study. The research data was collected in a research project where I was hired as a researcher. I had the access to all the data collected before I signed on the project. Later on, the data was collected and analysed primarily by me (see also Appendix A and B for detailed info).

I continued the research on coordination further by initiating and carrying out a comparison case study where the focus was put on application of ICT systems in coordination.

3.1.1 Case study

According to Yin (Yin, 1984) the approach suitable to a specific study depends primarily on the form of research question, required control over behavioural events and possible focus on contemporary events. Yin proposes that case study approach is especially suitable when we are asking "how" and "why" questions about a contemporary set of events, over which the investigator has little or no control. This is because "how" and "why" questions often deal with - rather than mere frequencies or incidence - operational links needing to be traced over time that cannot be done in a survey or an examination of archival records.

Furthermore, Yin defines a case study as an empirical inquiry that: "*investigates a contemporary phenomenon within its real-life context; when the boundaries between phenomenon and context are not clearly evident and in which multiple sources of evidence are used*"(Yin 1984, p. 23). The strength of a case study is that the object or phenomenon is studied as a part of real life context, to the contrast to, for example, an experiment where the phenomenon is deliberately divorced from its context (e.g. controlled). This is especially important for relevancy of studies within organisational and information systems disciplines. And also in our research, since we aimed at achieving better understanding on how organisation reacts in terms of its coordination mechanisms when it is experiencing complexity. Moreover, our focus was on finding out the changing importance and use of differing coordination mechanisms, it required that we knew about the historical context and that we could also follow the development during the forthcoming years. To achieve this we decided to carry out a longitudinal case study, which instead of giving snapshots analyses the process over a long period of time. Also for this purpose case study is suitable, since Eisenhardt (1989) emphasises the potential of case studies to capture the dynamics of the studied phenomenon. ''*The case study is a research strategy which focuses on understanding the dynamics present within single settings*'' (Eisenhardt, 1989, p. 534). Longitudinal case research means collection of data over several years (here 1997-2002), having the same subjects (or comparable) from one period to next. We also collected some of the material by asking the informants to reflect back what happened during the first years of 1990's. To our knowledge coordination methods had not been studied before using longitudinal case approach.

3.1.2 Comparative Case study

The longitudinal study was accompanied with a comparison case study (the company representatives preferred to call it benchmarking), which focused on specific functionalities of coordination software. It is suggested that case studies involving more than one case are well suited to building theory or constructs, because they permit replication and extension among individual cases (Yin, 1984; 2003; Cunningham, 1997; Eisenhardt & Graebner, 2007). Central to building theory from case studies is replication logic (Eisenhardt, 1989): similar to a series of laboratory experiments, multiple cases serve as replications, contrasts, and extensions to the emerging theory (Yin, 1984). But unlike laboratory experiments, case studies emphasise the real-world context in which the phenomena occur (Eisenhardt & Graebner, 2007). In the case comparison approach, the researcher develops an understanding of why certain conditions did or did not occur, and then offers interpretations. Instead of relying on in-depth information about the case, there is a more general aim at using cases for illustrating and testing the soundness of concepts (Cunningham, 1997).

In Chapter 5 following the technique of theoretical sampling (Eisenhardt, 1989; Orlikowski, 1993), we selected two cases for their similarities as well as for their dissimilarities. Our focus was fixed to the role of ICT in coordination. We

compared the ICT support for coordination in two networks, M and N. The comparative research design allowed us to contrast between the project management information systems implemented in two case networks. By studying the characteristics of the technologies which were build to serve the same purpose – i.e. orchestration of networked, customised project deliveries - we could direct attention to the contrasts between the network structures as potential explanation of divergent views on coordination means and characteristics of the information systems.

3.1.3 Data collection

According to Eisenhardt and Graebner (2007) a key approach to limit bias in case study data collection is using numerous and highly knowledgeable informants who view the focal phenomena from diverse perspectives: These informants can include organisational actors from different hierarchical levels, functional areas, groups, and geographies, as well as actors from other relevant organisations. For Part I we carried out 57 in-depth interview sessions of total 48 individuals each taking about 2 hours (TABLE 5). The main focus of interviews carried out in 1997-2000 at Company M was on project manager's task in delivery projects (in 'project management'-arrow in FIGURE 13). Since 2001 the focus of interviews was directed also towards other parties involved (other arrows in FIGURE 13). We interviewed people from all main phases of the project (engineering, production, scheduling, material management, delivery of the products, customer training and feed-back). An additional case comparison data was collected in 2006 in Companies M and N. The respondents belonged to the same respondent groups as in the previous study.

Instead of random sampling we used a purposeful strategy, snowball sampling (Arber, 1993) in acquiring data. The majority of the interviewees were selected based on suggestions of our key informants, senior vice managers. They provided us with insights into projects and initiated access to the interviewees. The interviewees were selected and other data was acquired to obtain new information on the construct of interest and to enhance confidence in the measurement through constant triangulation. This way we hoped to gather both subjective assessments and quantitative measures. The advancement of the study was recorded and analysed in a narrative (see Appendix C) which also helped in pinpointing missing data and in focusing the coming interviews and steps of the research. In addition, a useful strategy to identify additional informants or sources of evidence was to follow interviewees' suggestions.

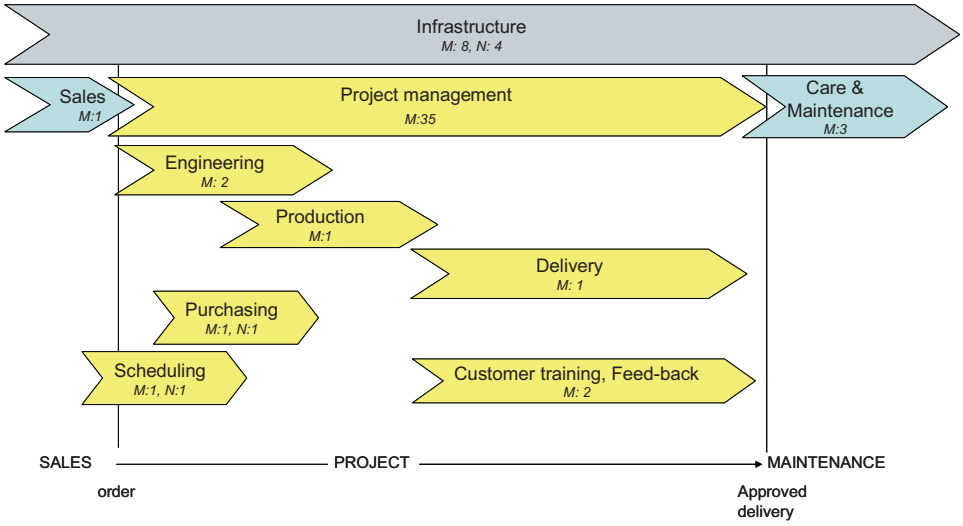

FIGURE 13 Position of interviews within main activities (shows the number of interviewees in M and N)

The interviews were semi-structured, i.e. open-ended and carried out in a conversational manner, but followed a set of questions derived from the case study protocols. During the interviews we used triangulation tactics such as (1) verifying interpretations and data gathered in earlier interviews, (2) new interviews for additional insight, (3) re-interviews of some key persons and (4) in some instances use of multiple interviewers/observers. TABLE 4 shows the interviewees categorised to projects managers, assistants, vice presidents and others. Note that the numbers show individuals interviewed. They differ from the interview session counts of the previous table, since in some interviews we had several interviewees.

TABLE 4 Interviewees for Part I

Interviewees	*Year*	*97*	*98*	*99*	*00*	*01*	*02*	*06*	*Total*	*Individuals*	*Ref*
Project managers	*1st interview*	14		2	2	1			26	19	P1,P2…
	Re-interview	2	1	1		1		2			
Project assistants	*1st interview*		1	1	1			1	5	4	A1,A2…
	Re-interview					1					
Vice presidents	*1st interview*	1				7	2	1	14	11	V1,V2…
	Re-interview				1	1	1				
Other	*1st interview*	1	2			6	1	4	16	14	O1,O2…
	Re-interview							2			
Total		18	4	4	4	17	4	10	61	48	

We were also able to make direct observations as we attended multiple in-house user-training sessions. In addition, to gather information on the companies' background and products the interview data was added with

following documents and quantitative records from the Company M (in TABLE 5 categorised as other data):

TABLE 5 Data for Part I

		-97	-98	-99	-00	-01	-02	-04	-05	-06	Total
Data collection method	Meetings		1	2	1	1			3	2	10
	Workshops									1	1
	Interview sessions	18	4	4	2	15	4			10	57
	Other		1		1	10		1		2	15
	Total	18	6	6	4	26	4	1	3	15	83
Documentation method	Memos		2	2	2	23		1	3	5	38
	Audiotapes	18	4	4	1	15	4			10	56
	Transcripts	18	4	4	1	3	4			10	44

1. Specific financial data of orders booked and net sales.
2. The number and division of staff in the references and project department.
3. A database of all 218 projects finished during the research period, describing the scope of delivery, start-up date, the customer.
4. Estimate on average length of projects.
5. Reliability of the delivery (whether it was on time, early, or late and a brief explanation why).
6. Reports on customer satisfaction interviews.
7. Formal study on the quality costs within the company M.
8. Project organisation charts of typical projects carried out 1990- 1999.
9. Project meetings schedule proposal.
10. Data on use rates of Notes databases.
11. Statistics on number of personal computers.

12-14. Participation to an internal groupware user-training course in -97, -04 and -06.

Furthermore, we collected from both M and N

15. Data on functionalities of ICT systems (in Appendix H).

We also had altogether 10 several hours long meetings with the case companies where we discussed about the subject and presented the results. Furthermore, one work shop was arranged with several participants from companies M and N.

We recorded all but one interview and also transcribed most of them (44 out of 57). Otherwise, the key findings or statements were written down to a memo note. The audio files, notes and transcripts of the interviews were all collected to cd-discs, if no digital version was available to paper archives.

3.1.4 Limitations of the research method

Every time a qualitative case research method is chosen, there are certain aspects that have to be taken into account when examining the results of the study. Traditionally, the most concern is posed on generalisation of the result. However, as Yin (1984) argues, case studies cannot (and should not) be contrasted with for example surveys. In surveys generalisation is obtained through statistical findings, whereas in case studies the point is in the analysis of the in depth data. The case studies can provide us with valuable information concerning the phenomenon of interest for instance by analysing how it evolves within a longer time span and how it is related to other concepts in time. Even though we cannot provide statistically significant findings, we are rather confident on analytical generalisation of our results because they build on previous theories, parts of which have been tested in other research studies - also statistical ones.

The size of the research sample, the use of in-house literate material in the case study and the limited time and resources available, need to be taken into account when evaluating the research results. The Part I includes total 83 accounts of data gathered in a period of ten years. Unfortunately due to lack of resources we were able to gather empirical data only from the focal companies of the networks, meaning that for example subcontractors and customers were not interviewed. This biases our findings regarding coordination towards external parties. In-house literate material is also some what problematic, since it can not be revealed to public for confidentiality reasons. In this thesis for instance the exact monetary profitability figures were transformed to relative figures (e.g. Euros/number of staff).

4 COORDINATION OF COMPLEX PROJECTS WITHIN A NETWORK OF BUSINESS UNITS

Business and organisational structure has been changing with an increasing speed. Highly complex knowledge-intensive products and services are sold in markets where competition is intense and customers demanding. To sustain their profitability organisations need to find efficient coordination mechanisms to handle complexity created by these changes. Coordination can be achieved through a variety of means and coordination frameworks have been advanced also in scientific literature (e.g. Thompson, 1967; Malone & Crowston 1994, March & Simon, 1958; van de Ven, Delbecq and Koenig, 1976; Mintzberg, 1979). Galbraith (1977) claimed that coordination aims at mitigating complexity by managing information and that the success of a firm depends critically on the organisations' capabilities to efficiently handle its information processes (Mendelson & Whang, 2000). According to Galbraith (1974, 1977), rules and procedures are the basic means to handle uncertainty. If they are not sufficient enough then the organisation has two ways to react to increasing uncertainty (i.e. to lack of information): either by lowering the need of information processing, or by increasing the capacity to process information.

Even though coordination framework proposed by Galbraith is considered to be one of the classics in organisation science (Kunz, Christiansen, Cohen, Jin & Levitt, 1998; Groth, 2001) there is little empirical research on how coordination mechanisms are used and how they impact on organisation's performance. Generally, these surveys provide descriptions on companies' coordination mechanisms at a given time point. However, the main point in Galbraith's thinking lies in changes: he proposes that if uncertainty increases the organisations should react by applying some coordination mechanisms. This means that the organisations are most probably continuously altering coordination mechanisms, or their relative importance, to be able to cope with complexity arising from changing business or organisational environment. Unfortunately previous studies do not capture this dynamic, time-sensitive aspect of the coordination. In this research we aim to provide insight into

dynamics of complexity and respective coordination mechanisms applied to coordinate organisational activities. Specifically, we focus on the role of ICT in affecting the dynamics of coordination. The research questions we seek answers are: *Can coordination framework based on systemic view of organisation (Galbraith, 1977) be applied to illustrate patterns of changes in complexity and coordination mechanisms? How coordination mechanisms evolve and affect each other? And what kind of a role does ICT have in organisational coordination?*

We approach these questions by modifying coordination framework based on organisational literature that has tested or challenged Galbraith's views, and then by carrying out a case study on dynamics of complexity and coordination. Using multiple sources of data we examine the interplay between complexity and coordination mechanisms within longer time periods.

This chapter is organised as follows: First we introduce Galbraith's coordination frameworks and empirical studies on relationships between complexity, coordination mechanisms, and performance. Then we discuss the role of ICT in organisational coordination. Based on literary review we construct a modified coordination framework. After that, we present our empirical case study where we explored changes in organisational complexity, coordination mechanisms and performance. The chapter 4 ends with findings and discussion.

4.1 Galbraith's Coordination model

According to Galbraith, rules and procedures are the basic means of an organisation to handle uncertainty. They are simply decisions made in advance. The virtue of rules is that they eliminate the need for communication for routine events. When the uncertainty increases to such high level that it cannot be handled with rules, Galbraith states that in these situations the managers must adopt at least one of the following five coordination methods (depicted in FIGURE 14). If it does not consciously choose one of the mechanisms, slack resources will follow automatically (Galbraith, 1974; 1977).

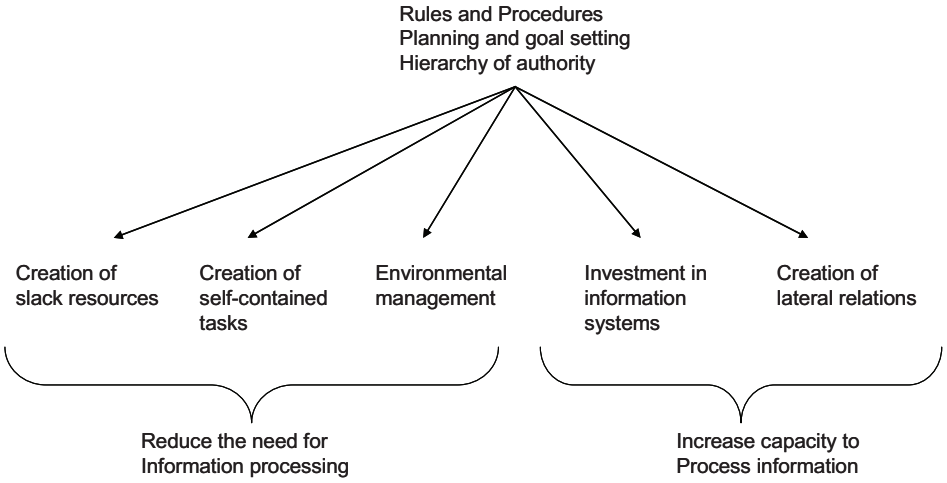

FIGURE 14 Galbraith's (1977) Coordination Framework

Creation of slack resources: Slack resources mean increasing resources for production of each output, for instance by increasing man-hours or relieving time schedules. In this way the organisation reduces the number of exceptions. This generates costs to the organisation, but it is likely that the task is finished in time.

Creation of self-contained tasks: According to Galbraith the amount of information processed can be lowered by change from functional task design to one in which each group has all the resources it needs to perform its task. The criterion used for grouping normally reflects the interdependencies that are seen as most important (Groth, 2001, Mintzberg, 1979). These self-contained units could be created around major sections of the product or product lines, geographical areas, client groups etc. There is less resource sharing, and the output diversity faced by a single collection of resources is reduced.

Environmental management[7]: In the mechanism that Galbraith named as environmental strategy, the organisation tries to modify directly the sources of complexity. Environmental management includes contracting, co-opting and coalitions. In contracting, the company negotiates an agreement with other parties to exchange goods, services, information, etc. over some time period. Co-optation is a process of absorbing new elements into the leadership, or policymaking structure of an organisation as a means of averting threats to its stability. For example firms needing capital resources often have bankers on their board of directors. Even more interorganisational cooperation can be arranged for instance through cartels, joint ventures or fusions. The reasoning

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7 Galbraith also mentions simplified product designs as a mean to lower uncertainty. Empirical support is found that improved performance is achieved through reduction of the number of parts, which means easier data handling, and assembly instructions (Flynn & Flynn, 1999).

behind is to trim down complexity related to the behaviour of other parties by interacting with them actively and also adapting the current processes towards cooperation.

Investment in information systems: Galbraith proposes the use of vertical information systems as one mechanism to cope with complexity. Vertical information systems collect and transmit data for planning and setting targets, i.e. the coordination is built on pre-specification. As Galbraith states, investments in information systems increases the information processing at planning time, while reducing the number of exceptions, which overload the hierarchy. Traditional formal information systems belong to this category. Accounting, finance and logistic systems are typical examples of vertical information systems, which are used to collect data and transmit information to the higher level of organisation. Similarly ERP, management information systems and decision support systems aim to derive meaningful information from operational data for decision making at the management level. Vertical computing technology provides organisations with the ability to handle more complex situations through basic functions of calculation and analysis (Lee & Grover, 2000).

Creation of lateral relations: Lateral coordination mechanisms are designed to encourage liaison contacts between individuals in order to coordinate the work of two units (Mintzberg, 1979; Brown, 1999). The idea of lateral (sideways) relations strategy is to employ and formalise decision processes, which cross lines of authority. Galbraith (1974) was the first to propose a continuum of lateral relations mechanism. The simplest form of lateral relations being a direct contact between two people who share a problem. He proposes more formal mechanisms as being more powerful mechanisms and suggests the use of integrator roles and teams to handle lateral coordination[8].

4.2 Empirical Studies on Galbraith's mechanisms

The underlying axiom of the Galbraith's coordination model is that the fit between uncertainty and coordination mechanisms is a strong antecedent to organisational performance (Galbraith, 1977; Bensaou & Venkatraman; 1996). Premkumar et al. (2005) found support for this view with a cluster analysis in an interorganisational supply chain context. Also parts of Galbraith's coordination model, such as the relationship between uncertainty and use of coordination mechanisms, have been empirically validated (see also TABLE 7).

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[8] Later on, Galbraith simplified the continuum to include 'formal groups' and 'integrator roles' and 'informal organization'. He defines the informal organization in terms of non-structural design actions that promote voluntary, cooperative problem-solving across unit boundaries (see also Galbraith, Downey & Kates, 2002).

Many studies have observed, as predicted by the theory, greater use of routines in low-uncertainty settings, and increased use of lateral coordination in high-uncertainty settings (Aiken & Hage 1968, van de Ven et al. 1976). For instance, Brown's study (1999) provides support for the use of multiple types of lateral mechanisms in highly complex settings, and that lateral coordination mechanisms eliminate or reduce the communication barriers associated with hierarchical structures to achieve cross-unit collaboration.

There are also several studies that examine possible performance effects of the coordination mechanisms. For example Gittell (2002) and Gittel, Seidner and Wimbush (2009) show empirical support that both routines, and boundary spanners and team meetings (vertical coordination) are associated with improved performance. Similarly surveys by Flynn and Flynn (1999) and Swanson (2003) provide evidence that increased use of multiple coordination mechanisms relates to better performance within manufacturing industry. The coordination mechanisms was shown to moderate the relationship between complexity and performance of the firm.

4.2.1 Role of ICT in Coordination

The studies testing Galbraith's coordination model show conflicting results on the mediating effects of information systems on the relationship between complexity and performance. For instance, Flynn and Flynn (1999) did not found support for the hypothesis that investments in information systems would moderate the relationship between complexity and performance[9]. To the contrary, Swanson (2003) shows positive results: the extent of use of computerised maintenance management systems[10] was positively related to performance. Besides differing research settings and measures, e.g. measuring investments in IT vs. extent of use of IT, we suggest two primary reasons for conflicting results: first, the complementary role of information technology and interaction effects between coordination mechanisms, and second, the advancement of information technology to cover also support for communication.

1. Flynn and Flynn's (1999) study did not find investment in information systems to be an effective coordination mechanism. They proposed that a possible explanation to this contradictory finding against Galbraith's model is that information systems are means to cope with increased

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9 In their study of 164 manufacturing plants complexity was operationalised by taking the mean of various indices, which indicate complexity in the areas of customers, labor, output, manufacturing and process diversity. Performance was measured with cycle time, lead time, inventory turns, on-time delivery and customer service. Investments in information system were measured by plant's IT expenses (hardware, software, telecommunications, services, personnel) as a percent of sales, and with percentage of increase (or decrease) in IT expenses in the past year.

10 The study included 222 responses from 180 different plants. The measure of CMMS use included eleven items asking the respondents to report the extent to which computer systems were used to support different maintenance activities.

complexity, but on the other hand they can also increase the complexity (Flynn & Flynn, 1999). This point out that adoption of coordination mechanisms can improve the organisations ability to cope with a certain type of complexity but at the same time this change can cause more complexity in some other areas of activities. Kling et al. (1996) claims that information systems can be used to solve existing coordination problems without any substantial side effects, if problems and technologies are simple. But as coordination problems become more complex and interdependent, so do information technologies that are intended to solve them. As a result they suggest that the implementation of a new technology is more likely to succeed, if the degree of change required is low. If more advanced ICT for coordination is adopted, the organisation should prepare for increased complexity by providing social and institutional supports that facilitate the organisation's adaptation. The above findings suggest that ICT should be applied simultaneously with other coordination mechanisms, has interactive effects (Gittell, 2002), and its importance may vary in time.

2. As Galbraith states (1977) investment in vertical information systems (accounting, finance and logistic systems etc.) can be regarded as a coordination mechanism which can be used to reduce uncertainty by collecting and transmitting data to the appropriate places in the hierarchy. More recently, he (Galbraith et al., 2002, p. 75) writes about e-coordination:

> *Although it (ICT) can't replace face-to-face interaction completely, technology has the potential to remove significant time and space barriers to communication as well as organisational barriers of hierarchy and department. The organisation becomes opened up to virtually limitless communication. Informal networks or communities of interest spring up naturally through chat groups and electronic mail distribution lists on a company's intranet. Lotus Notes, Microsoft Exchange, and other group interaction tools allow instant messaging, group discussion, scheduling and group calendar management, and document and work flow management.*

It seems that IT would be helpful in reducing equivocality, which denotes ambiguity, the existence of multiple and conflicting interpretations about situation (Weick, 1979; Daft & Lengel, 1986). This means that equivocality makes communication and lateral relations more critical. Today, ICT can be used to support negotiation, communication and information sharing (Gurbaxani & Whang, 1991; Malone et al., 1987), which are seen essential in *equivocal*, complex situations. Against this backdrop we propose that, in addition to vertical computing technology, we must consider also coordination mechanisms applying communication technology (Lee & Grover, 2000). Examples of information and communication technologies enhancing lateral communication are phone, mobile phones, fax, e-mail, electronic conferencing, group support systems, radio-phones, Internet etc.

The coordination mechanisms are collected in TABLE 6 giving a brief description of the mechanisms, examples and related literature.

TABLE 6 Description, examples & related research on coordination mechanisms

Coordination mechanisms		*Description*	*Examples*	*Related Research*
Reduce the need for information processing	*Environmental management*	Advertising, public relations, managing customer base, Standards	Reduce environmental complexity by influencing the demand or by co-operation. Helps external coordination.	Flynn &Flynn 1999; Malone et al., 1987, Jensen & Meckling, 1973; Gulati & Singh, 1998; Clemons et al., 1993, Fairbank et al., 2006; Lakemond et al., 2006.
	Self-contained tasks	Groups created around major sections of the product or product lines, geographical areas, client groups etc.	Less resource sharing and output diversity. Helps internal coordination.	Flynn & Flynn, 1999; Groth, 2001; Mintzberg, 1979; Fairbank et al., 2006.
	Lateral relations	Informal, voluntary organisation, Formal groups, Integrator roles	Easier transmission of information upward. Helps internal coordination.	Brown, 1999; Gittell, 2000, 2002;,; Gittell et al., 2010; Flynn & Flynn, 1999; Groth, 2001; Mintzberg, 1979; DeSanctis & Jackson, 1994; Adler, 1995; Fairbank et al., 2006.
Increase capacity to process information	*Computing technology*	Use of MIS, Knowledge systems, DSS	Less stress on hierarchy. Helps internal and external coordination.	Flynn & Flynn, 1999; Lee & Grover, 2000; Fairbank et al., 2006.
	Communications technology	Use of LAN, e-mail, phone, cellular phone, fax, electronic conferencing, group support systems	Easier transmission of information within communicating parties. Helps internal and external coordination.	Shin, 1997; Clemons et al., 1993; Bakos & Brynjolfsson, 1993; Gurbaxani & Whang, 1991; Malone et al., 1987; DeSanctis & Jackson, 1994; Fairbank et al., 2006.

4.3 Coordination model of an organisation

In order to operationalise Galbraith's model (1977), we used previous literature analysis as a basis for conceptual model of coordination (FIGURE 15). It describes the relationships between organisational complexity, associated coordination mechanism and organisational performance.

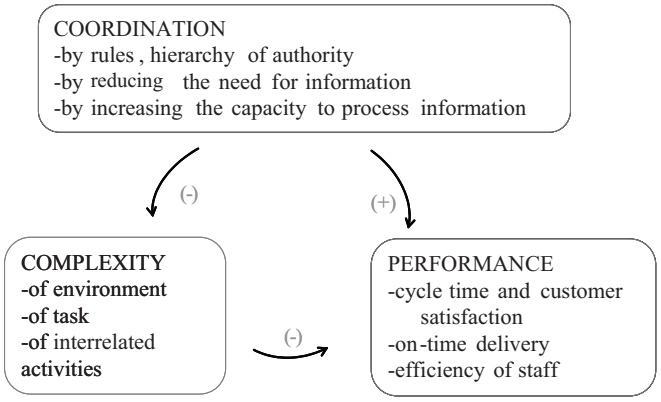

FIGURE 15 A conceptual model of coordination

The proposed model is intended to guide empirical research. This requires that the relevant constructs of complexity, coordination mechanisms and performance can be identified and operationalised using observable indicators (Bensaou & Venkatraman, 1996). Furthermore, we suggest that in order to study the phenomenon, we should follow the changes during a longer period of time.

Galbraith (1977) is well known example of having an organisational imperative perspective on nature of causality (Markus & Robey, 1988). He thinks that people act purposefully to accomplish intended objectives; by using coordination mechanisms the managers can improve information processing capabilities of an organisation, so that it can handle more complexity. However, our model is not that deterministic. Instead, it can be used to study whether the changes in coordination mechanisms are determined by technology (technological imperative), or whether they are results of intendedly rational actions of people aiming at satisfying organisational needs (organisational imperative), or whether the changes emerge from the interaction of people and events (Markus & Robey, 1988).

Also, we augmented Galbraith's framework with a broader definition of complexity: we consider not only uncertainty – as suggested by Galbraith - but also equivocality (Weick, 1979) as sources for increased need for organisational coordination.

As we needed to measure the complexity in real terms, we applied complexity sources widely applied in previous literature (TABLE 7): *task; environment; and organisation of the interrelated tasks* (slightly differing interpretations of these categories can be found e.g. in Daft & Lengel, 1986; Galbraith, 1977; van de Ven et al., 1976; Weick, 1975, 1979; Perrow, 1967; Argote, 1982; Bensaou & Venkatraman, 1996, Lee & Grover, 2000; Gittell 2002).

TABLE 7 Summary of the previous literature on complexity sources

Complexity Sources	***Complexity measures***
Task complexity	Equivocality:
	-Analysability (Daft & Lengel, 1986; Perrow, 1967; Bensaou & Venkatraman, 1996)
	-Diversity of goals associated with number of different products (Galbraith, 1977)
	-Availability of time, money or attention (Weick, 1975)
	Uncertainty:
	-Predictability(Galbraith, 1977)
	-Variety (Daft & Lengel, 1986; Perrow, 1967; van de Ven et al., 1976; Bensaou & Venkatraman, 1996)
	-Difficulty (van de Ven et al., 1976)
Interrelatedness of activities	Equivocality:
	-Differentiation, specialisation (Daft & Lengel, 1986; Galbraith, 1977)
	-Power-dependency (Bensaou & Venkatraman, 1996)
	-Goal compatibility, trust (Bensaou & Venkatraman, 1996)
	Uncertainty:
	-Depth of interdependency (Daft & Lengel, 1986; Bensaou & Venkatraman, 1996)
	-Number of persons (van de Ven et al., 1976)
Environmental complexity	Equivocality:
	-Analysability of cause-effect relationships (Weick and Daft, 1983)
	-Diversity of goals associated with number of different markets, clients (Galbraith, 1977; Flynn & Flynn, 1999; Lee & Grover, 2000)
	Uncertainty:
	-Homogeneity-heterogeneity (Thompson, 1967; Bensaou & Venkatraman, 1996)
	-Organisational intrusiveness (Weick & Daft, 1983, Daft & Lengel, 1986)
	-Stability – dynamism (Thompson, 1967; Bensaou & Venkatraman, 1996; Lee & Grover, 2000)

Goodhue, Wybo and Kirsch (1992) give an example of all three: a manufacturing unit employing a temperamental, thin film manufacturing technology might face complexity in the operation of this highly variable process (complex tasks), complexity from the environment where customer demands were constantly changing (unstable environment), and complexity in dealing with a procurement office that did not always understand the urgency of its requests (interdependency between subunits). In TABLE 7 we have gathered from the previous literature metrics of uncertainty or equivocality related to tasks, environment or interdependencies. Even though we found plenty of different measures and descriptions for them, the following general

conclusion can be drawn: The more obscured the problem or the more conflicts there are, the more complex, in terms of equivocality, the situation is. On the other hand, the more extensive the situation is, measured in number or variety of persons, parties, goals or products, the more complex the situation is, in terms of uncertainty. In the next section we apply our model in a case study.

4.4 Empirical study

Our research process is illustrated in FIGURE 16. It consisted of three phases: A) we focused on depicting changes in complexity during the research period, B) we studied how and what kind of coordination mechanisms was deployed, and C) we looked at the performance data to see whether these measures had effects on performance.

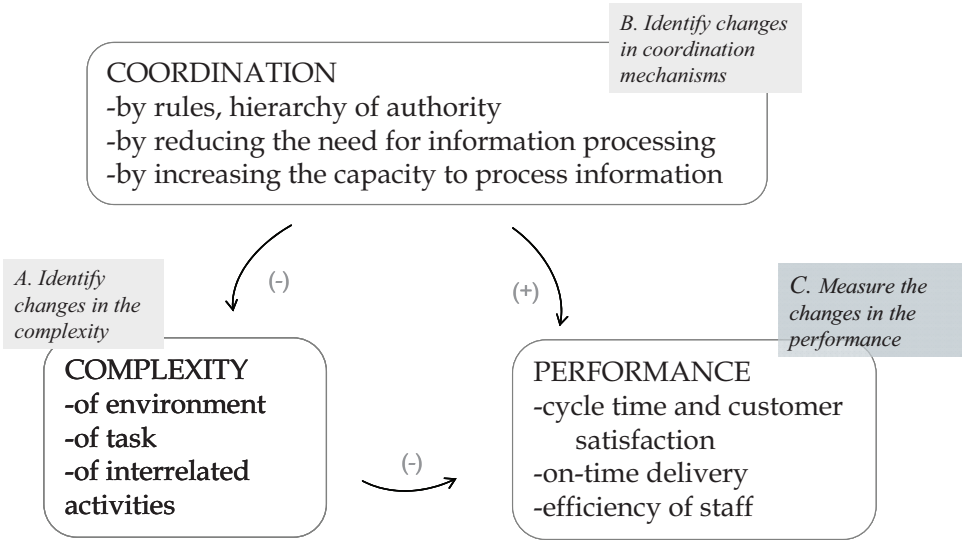

FIGURE 16 Research process of Chapter 4

4.4.1 Changes in Complexity

Our case Company M originated from several local workshops owned by the Finnish state, which merged in the 1940s. For the next approximately 40 years, the company M manufactured a variety of product lines. In the early 1980s, the company M narrowed its product line to focus on specific machines and at the same time broadened its strategic vision by setting the goal of becoming an important global operator. Through rapid internationalisation, mergers, and acquisitions, it achieved that goal over the next decade, exporting

approximately 90% of its turnover[11] (see FIGURE 17). It became the world's largest manufacturer and a world leader in technology in its market.

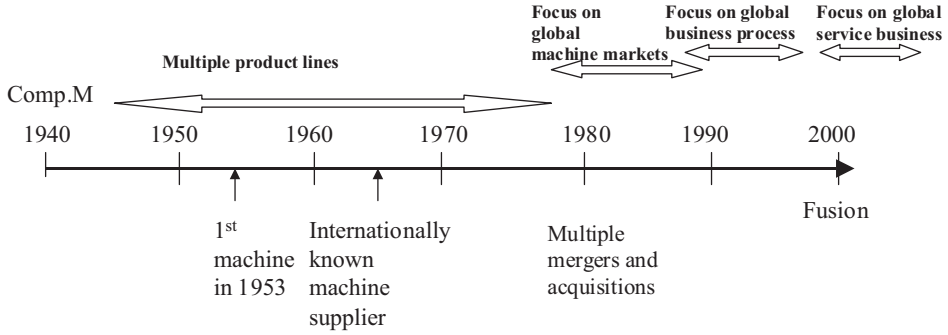

FIGURE 17 History of M

We analysed the changes in complexity of project management in a network of business units of M during 1990-2000. We divided the study period to four phases: I Steady state (1990-1992), II Rationalisation (1992-1997), III High-tech and Complex demand (1997-1999) and IV Company restructuring phase (1999-2000). Steady state –phase was a period of stability, when projects were carried with routine. Phase II was characterised by consolidations and major changes in corporation structure. Launch of a new generation of the main product started phase III that was characterised by global technology leadership combined with tightening time schedules, increasing amount of ICT embedded in the products and more demanding customer cases. The research ends up with Phase IV when the corporation was restructured due to a merger.

4.4.1.1 Phase I - Steady state

Company M provided b-to-b capital goods (machines) to customers throughout the world. Modern machines were huge (over 100 meters in length and several meters wide) and complex (with a similar number of parts as a Boeing 747)[12]. They must meet exceptional operational requirements due to the size and location of the mills and the increased speeds of production,[13] and also the end products had to meet strict criteria within productivity and environmental (energy, water consumption, pollution) guidelines. Because differing electricity systems, raw materials for the end products, and building where each machine was to be installed set limits on its design, Company M could produce nothing

11 Source: the company's www-pages.
12 Source: Interview P19, project manager, 1.5.1999
13 For example, measurements in the range of a thousandth of a millimeter are often required in installing a machine.

to inventory. All production of new machine parts started only after a deal was closed (engineered-to-order)[14]. Projects, which this paper focuses on, took around 20-22 months and are followed by two years warranty period.[15]

Almost all orders in the marketplace were coming from well-known customers, which were decreasing in number but operating globally[16]. Market information manager[17] listings showed how the top 5 customers accounted for approximately 28% of all end products produced in the world, and the top 15 companies accounted for 50%. She explained that the market for machines closely trailed global trends in the end product business, which depended on customer expectations of end product demand. This made the demand for the machines quite *predictable*. Moreover, the low number of competitors had made the markets quite *easy to analyse.*

In Steady state phase the corporation consisted of four separate companies - of which the studied unit was the biggest one - all selling and producing their products quite independently. A typical project concerned 2 or 3 business units and a typical project organisation chart included 23 managerial roles[18].

4.4.1.2 Phase II - Consolidation and rationalisation

This phase was characterised by major changes in corporate structure and dependencies between units. The previous 4 separate companies were merged together. As a result a typical project manager's task increased to cover coordination of work across 7 business units. The number of roles in project organisation chart was increased from 23 to 29[19]. This caused an increase both in uncertainty and equivocality related to dependencies between project members.

Later on to improve efficiency of production the aim was to concentrate on core business, and to outsource production that required less knowledge[20]. The business units within the corporation formed a production web each unit specialising in certain major sections of the machinery. This web like organisation was exercised not only between the business units, but also within the business units. In 1998 there were around fifty separate production units in the corporation. The project managers pointed out that coordination between interrelated units and companies had become one of their major concerns:

> *"When all these production units had own income statements and balance sheets, it made the work of project managers highly complicated. At one point we had 19 separate profit centres within our site alone."* (Interview V5, vice president of projects in 2001)

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14 Source: Interview P2, project manager, 9.6.1997.
15 Source: Interview O7, Manager of master scheduling, 24.4.2001.
16 Source: Interview V3, vice president of Project development, 2.12.2000.
17 Source: Interview O5, Market information Manager, 6.4.2001; and her e-mail on lists of key customers.
18 Source: G11, typical project organisation chart in 1991, 27.4.2001.
19 Source: G11, typical project organisation chart in 1995, 27.4.2001.
20 Source: Interview V7, vice president of purchasing, 2.4.2001.

The rationalisation process was characterised with constant change within the organisation. The interviewees did not know who they should contact, because the units and responsibilities were restructured several times[21]. In addition multiple profit centres' increased equivocality remarkably since their goals were misaligned.

> *"As a result [of separate profit centres] the communication distance grew significantly. If you have to take care of your income and balance, and project manager calls you and asks you to do something for his project, you most probably will think many other aspects before considering the needs of the end customer. Now these separate profit centres no longer exist, but the mentality still remained to some extent." (Interview V5, vice president of projects in 9.3.2001)*

Similarly, according to vice president of purchasing[22] complexity had increased due to huge increase in the use of subcontracting. Before this trend the company itself produced almost everything; in the 70's the organisation used subcontractors only when its own production capacity was temporarily overloaded. Back then they had only few subcontractors (~ 10). In the 80's this strategy was changed and until the mid 90's the number of subcontractors was rapidly rising. In the second half of the 90's the subcontractor base had somewhat stabilised. The case organisation has outsourced permanently both production and engineering activities. Altogether about 50-60% of the activities were outsourced.

4.4.1.3 Phase III - High-tech and complex demand

Even though there were few main suppliers of the product in the world, the competition had forced suppliers to improve their products constantly. More and more automation was embedded into the products to supply customers with more efficient machines. According to the production manager[23], a major change was in 1998 when the company M launched a new generation of its main product. Since then the company M was considered the technology leader in its field and became a leading supplier in its own worldwide segment[24]. The monetary data from the Finance department on the value of the projects gives an impression of the increase in complexity: within one decade the price of new machinery delivery had over doubled[25]. However, the time available for carrying out the project was shortened by several months (- 15%-18%)[26].

> *"There is no doubt that our business is not complex from the point of view of competition - I agree with previous interviewees with that. In the daily work of project managers there are*

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21 Source: Interview P9, project manager, 11.6.1997.
22 Source: Interview V7, Vice president of purchasing, 2.4.2001.
23 Source: Interview O3, General Manager of production, 4.4.2001.
24 Source: Interview O3, General Manager of production, 4.4.2001.
25 Source: Interview V10, Vice president, Finance and Administration, 10.5.2001; G7, Financial data of orders booked and net sales, 15.5.2001.
26 Source: Interview O7, Manager of master scheduling, 24.4.2001.

clearly difficulties due to our complex web-like organisation structure, but also due to complexity of the product. The technological development has led to a situation, where our product has such technical characteristics which make the management of the projects more difficult. This also sets high demands for our customers' capabilities. Their know-how about these more complex products have become very critical for the projects. This leads to a cycle where problems generate all kinds of extra troubles in project schedules, technology and even economic profit." (Interview V9, Vice president of projects, 26.4.2001)

The life cycle of the machine, i.e. the product, was usually 30–40 years. This formed the basis of the long-term customer relationships in this industry. Typically, every ten years some part of the machine had to be renewed due to wear and tear. Another reason was the fast pace of technological evolution[27]: the old machine lines could not compete with the new technology machines which run at extremely high production speeds and with smaller crews.

However, since completely new machine lines were very expensive and the markets of the end products stagnating, through the 1990s, customers increasingly shifted their investment away from new machine lines (particularly in North America and Europe). They preferred renewals where only some sections of the machine line was replaced with a new high-tech module (see FIGURE 18 for orders booked and FIGURE 19 for machine installations).

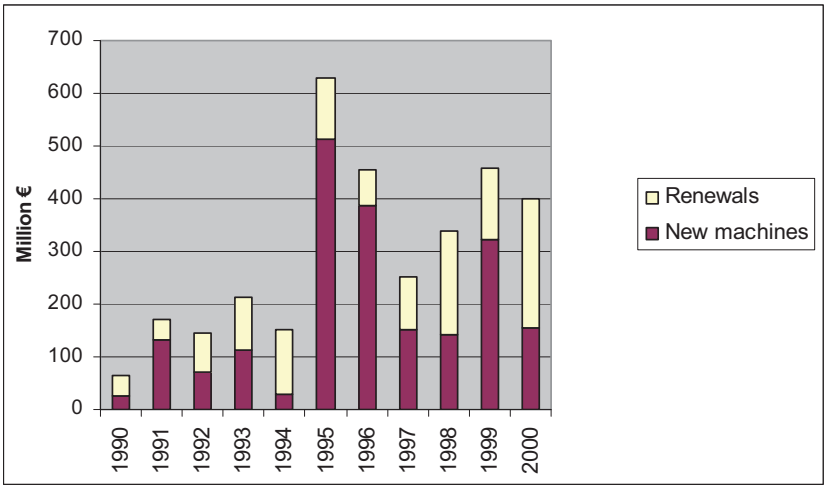

FIGURE 18 Orders Booked in 1990-2000 [28]

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27 Source: Interview V11, Vice president of RTD, 1.7.2002.

28 Source: Authors, based on G7 financial data of orders booked and net sales, 15.5.2001. A renewal was categorized as small if it consisted of 1 or 2 sections of the machine line. Large renewal included 3 or more sections of the machine line.

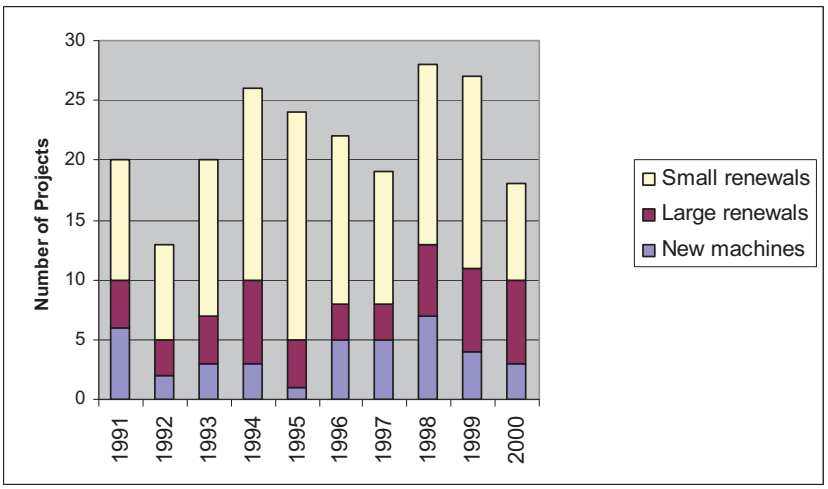

FIGURE 19 Number of machine installations in 1991-2000[29]

Renewal projects were considered more demanding, since their goal to fit new high-tech machinery to customers' often several decades old facilities requires a lot of planning, knowledge and precision. One of the project managers described the added complexity represented by the growing renewal business:

> *"The modernisations of old factories are more demanding. We have to fit the machinery to the existing building and facilities. We are busier on those projects, trying to find space enough for all devices and then replacing them if they do not fit. This requires that I have to participate and communicate a lot." (Interview P24, Project manager, 25.4.2001)*

Moreover, renewals required shorter cycle times (12–16 months), and their delivery processes were extremely stringent, as down times in production had to be minimised[30]. Renewal costs ranged from a few million Euros to tens of millions of Euros[31]. During the 1990s, maintenance and aftermarket services became an important component of Company M's income - approximately 25% of net sales in 2001[32].

This meant that otherwise low environmental complexity had increased due to growing diversity of goals (needs) associated with different client groups.

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29 Source: Authors, based on G6 project data, 4.5.2001 and G7 financial data, 15.5.2001.
30 Source: Interview V8, Vice president of References, 18.4.2001.
31 Source: Interview V10, Vice president, Finance and Administration, 10.5.2001; G7 Financial data of orders booked and net sales, 15.5.2001.
32 Source: Company M's annual report, 2001.

4.4.1.4 Phase IV - Company restructuring period

The fourth phase was characterised with constant structural change. The period started from the merging the company with another Finnish heavy metal industry corporation. This triggered several restructurings within the corporation. The project manager had to orchestrate a very complex project organisation (Organisation chart in 2000 is presented in FIGURE 20).

Thus the complexity due to interrelated activities was increased considerably: for instance a typical project chart consisted of at least 35 managerial roles in ten separate business units[33]. This restructuring not only increased the number of interdependencies between people (having more than tripled from the steady state period), but they caused a period of high equivocality, as people were unsure of future and each others duties and responsibilities. Within the last years of the decade there were so many restructurings that the organisation did not have time enough to recover from the previous as the next one started:

> *"But from the point of complexity, recently the major problem has been that the organisation is changing all the time." (Interview V5, Vice president of projects in 9.3.2001)*

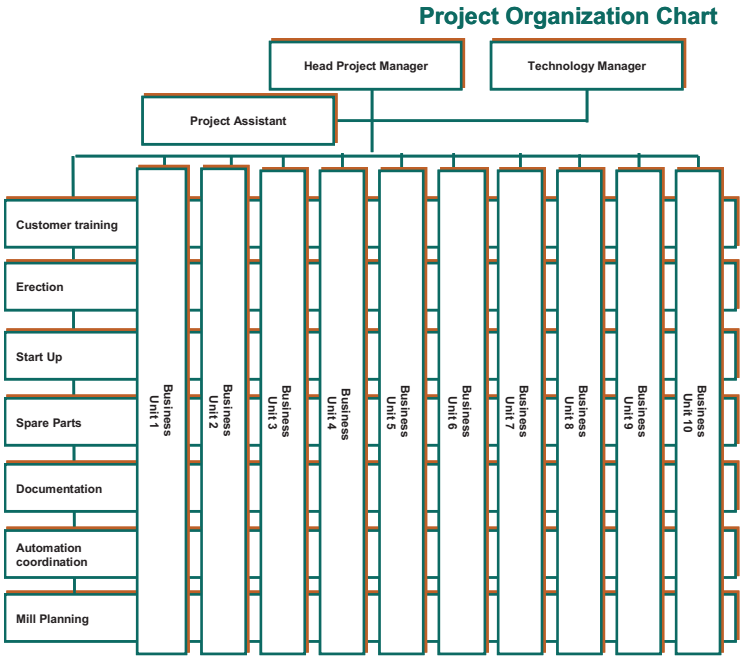

FIGURE 20 Project Organisation Chart Formula (in 2000)

33 Source: G11 Typical project organisation chart in 2000, 27.4.2001.

A new strategy was launched along with the merger. The general manager envisioned this next phase of business evolution as the transformation of a product- and engineering-centred manufacturer into a customer-focused and knowledge-driven company[34]. The key components of this new strategy included the development of know-how and aftermarket services by leveraging the expertise of personnel with advanced information technology solutions. Management regarded these IT solutions as crucial in creating novel, value-adding services based on automation systems and know-how and in expanding its brokering functions—for example, in managing, servicing, and supporting the operation of customers' mills; providing turn key delivery services globally; and brokering the information and knowledge needed to operate and manage customers' mills and other parts of the value chain, such as performance and benchmarking data about different types of mills[35].

4.4.1.5 Summary of Complexity Changes

In the 1990s, the Case Company managed 13 to 29 projects annually, including both new machines and renewals. The value of annual orders booked increased significantly in the second half of the 1990s (FIGURE 18), reflecting an expansion in project scope and size rather than in the number of projects. As a result, the number of interacting parties more than tripled. Dependencies were many, as the company relied heavily on subcontractors. Furthermore, the new product generation raised the product complexity to completely new level. At the same time, the annual share of renewals ranged from 70% to 96%. In the 1990s, on average, 38% of order value came from renewals (with a range from 15% to 80% annually). This trend increased project uncertainties because the project teams had to consider details of customers' existing facilities extraordinarily closely during all phases of very tight project schedules.

In FIGURE 21 we summarise main changes in the total complexity related to project management during the study period. This figure is based on above analysis (more information in Appendix F). With this figure we illustrate the most important peaks and the trends in the complexity.

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34 Source: Annual report of the Company M, 1999.

35 Source: Interview V12, Vice president of care and maintenance, 28.5.2002; Interview V11, Vice president of RTD, 1.7.2002.

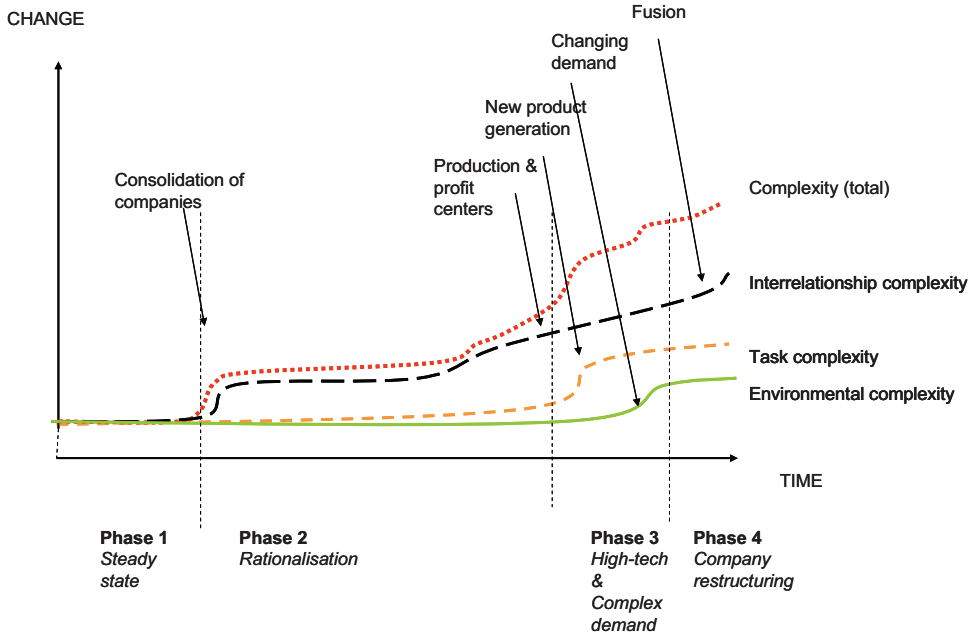

FIGURE 21 Changes in complexity during the research period

From the interviews it became evident that complexity of projects had increased during the study period. The main source for additional complexity was the increasing interdependency of activities. Within the last years of the research period also the increasing complexity of the product and diversifying needs of the customers were adding the complexity of project management.

4.4.2 Adoption of Coordination Mechanisms

Next we will depict the major changes in coordination mechanisms applied by the case department during four phases (see also Appendix G)

4.4.2.1 Phase I - Steady state

Project manager managed a temporal project organisation having representatives from several departments and was responsible for communication with the customer and the company (see tasks of the project in FIGURE 22).

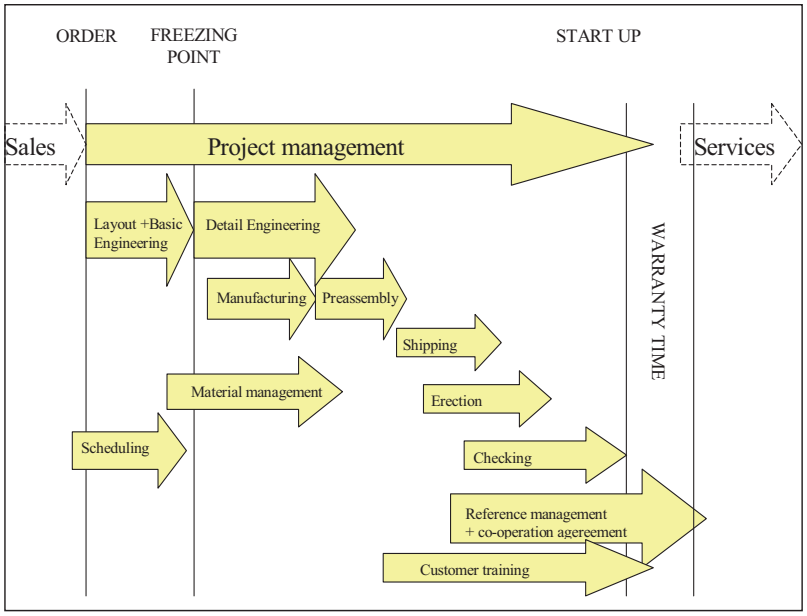

FIGURE 22 Project tasks

Since 1979 the procedure in the project department had been to allocate a project manager to a delivery project as soon as the sales deal is completed by the Sales department, and he stayed responsible until the end of the warranty period, when responsibility for customer relationship was handed over to Service department.

> *"Back then the project manager would walk around production and engineering department and ask after the parts and drawings. He would this way collect all the necessary information and tell the customer if everything is ok." (Interview A3, project assistant, 8.5.2001)*

The company was a typical IBM-mainframe house until the beginning of the 1980's. During that decade the batch processing systems on mainframes were transformed to on-line transaction processing systems. Material requirements planning (MRP) system was introduced in 1988.

> *"This MRP-system has been available to us project managers since its introduction. Someone use it, others don't. It is possible to manage a project without having to use the system". (Interview P24, Project manager, 25.4.2001)*

4.4.2.2 Phase II - Consolidation and rationalisation period

Establishing Project manager groups

It seems that before the mid 90 there were few changes in the structure of the project management. The number of staff in the projects department was increasing towards the end of phase II[36]. There was in 1994 an effort to establish Project manager teams as self-contained groups. They were set up based on knowledge of languages and each group was given an own project secretary. The idea was that the team members could co-operate and temporarily act as a deputy for each other. This didn't work out as well as expected. In practice project secretary was the one who took care of coordination while the project manager was unavailable.

> *"I don't think that we have even thoroughly recognised the possibility of reorganising work within the department. The starting point is that a project must have one single person responsible of customer relationship. He then also orchestrates the work within our organisation." (Interview V4, Vice president of project development, 9.3.2001)*

Investing in PC technology

In the first half of the 90's the company made strategic decision to invest in PC technology (Heikkilä, 1995). The number of PC s rose rapidly (see FIGURE 23).

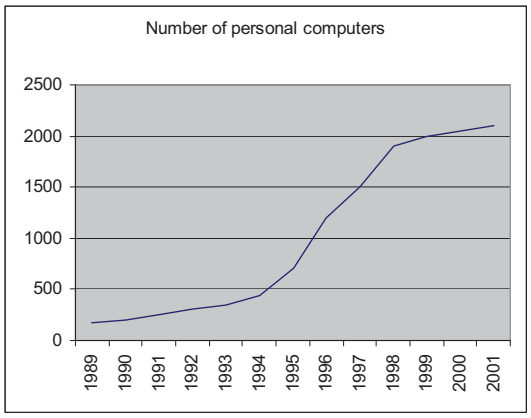

FIGURE 23 Adoption of personal computers in Case organisation

By the end of 1995 all project managers and assistants had an own tabletop computer or lap top (Heilala & Tynys, 1996)[37]. LAN made it possible to share documents over the network by many participants of the projects, and it also

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36 Source: G7 Staff statistics, 27.4.2001. The total number of staff increased from around 130 to 170 and the number of project managers from 15 to 23. The trend was increasing also in later periods. The respective numbers at the end of Phase IV were 200 and 31.

37 Source: G15 Statistics on number of personal computers in M, 8.6.2001.

made possible to work asynchronously. This was perceived as a great benefit to parties who are geographically located in distinct time zones. Project managers felt that projects were easier to control and less coordination was needed (Heikkilä, 1995).

Practically all communication with the customers was by phone and telefax, only few customers could be contacted with e-mail[38].

Strategy to adopt Notes and in-house development of Tasman

In the mid of the 90's the company decided to adopt Lotus Notes. One of the pioneering Lotus Notes applications[39], Tasman, was rolled out in 1985. It was developed from a project carried out with a local university to improve the internal information support of project work. Tasman was developed in close co-operation with the representatives of end-users - the project managers and assistants (Heilala & Tynys, 1996). It was developed as a voluntary tool for project managers and secretaries to manage their own project related documents[40]. The initial goal was to move the documents from a project manager's bookshelves or desk to a virtual workspace, and to use the system to maintain an organisation memory. Project documentation was seen essential in project management as the task is mostly about capturing, processing and disseminating information. In Tasman, each project had an own database with a common folder-structure resembling the way which the paper-based documentation of the delivery process had been maintained. Documents were linked through bookmarks, which also could be sent through e-mails to other participants for rapid sharing and notification of changes in design documents or in any information related to project delivery. Tasman centrally maintained project history. Each document was characterised by its creation time, the author, the type of document, and the set of keywords developed to identify key features of the project delivery. The users could use these criteria to search data from the documents. Also a reporting system for the status of engineering drawings was developed. The developer of Tasman was hired as IT specialist for the department. In 2001, the IS manager commented on the results of the strategy:

> *"I would say that launch of Notes had a tremendous impact, it improved for instance project management" (Interview O9, IS manager, 4.5.2001).*

The consolidation and rationalisation –phase meant that the number of companies and project roles were increased. In line with the increased number of people taking part in the project work, also the Tasman which initially was designed for project managers and assistants evolved to a system which was used by almost all persons involved with projects within the corporation. For

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38 Source: Interview P24, Project manager, 25.4.2001.
39 Source: Interview O9, IS manager, 4.5.2001.
40 Source: Interview O1, the developer of the Tasman, 1.11.1997.

each project a group of users was formed around a common project database. It included project managers, assistants, manager of the project department, engineers and technology managers, erection and start up personnel, service and maintenance engineers, and training personnel. Later on, the system was modified to also allow documents from other departments (engineering, automation, manufacturing, sales) and also from other business units. In a large project the number of users was c.a. 100 to 250 people.[41].

Actually the required improvements to Notes application were initiated by the end users, project managers, since after they got familiar with the tool, they saw its possibilities in coordinating projects involving company people around the world in multiple time zones. The adoption of the system was voluntary for the first adopters, but for later adopters this was no more the case. The project managers expected that all their project workers reported to the system, so that the required info was available at the database[42]. This helped the coordination of work carried out in production web of 7 business units and dozens of internal profit centres.

> *"Tasman (group support system) and e-mail are my main tools. I use them daily for several hours. I really do not need anything else, all information is there. And if the information is not there, I know that we should do something about it immediately." (Interview P24, Project manager, 25.4.2001)*

4.4.2.3 Phase III - High-tech and complex demand

The group technologies were not only for collecting the required information for the project manager, but it was also used as a communication channel between the project workers, whose tasks were highly interrelated. The need to share information was also realised by the management. In 1997 information sharing and communication within the organisation was advanced by providing training and giving all personnel the right to access Lotus Notes work desk and applications[43].

When the customers started an active use of e-mail, based on requests of the project managers, Tasman was added a feature that allowed storing and sending e-mails from a particular projects database. After the improvement all the important information and communication documentation, including the correspondence with the customer, concerning the project was found in one shared platform[44].

> *"Now about 80% of the information between the customer and the company is communicated with e-mail. In addition to this there are project meetings to make sure that all parties agree on this information." (Interview A3, Project assistant, 8.5.2001)*

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41 Source: Interview O11, ICT support for projects, 15.3.2006.
42 Source: Interview P23, Project manager, 25.4.2001.
43 Source: Interview V3, Vice president of project development, 8.12.2000.
44 Source: Interview A3, Project assistant, 8.5.2001.

Thus Tasman was used as an internal coordination tool for managing projects. It acted as a distribution channel for the information customers were providing (see FIGURE 24 of Tasman main page for project KWIPM4 [45]).

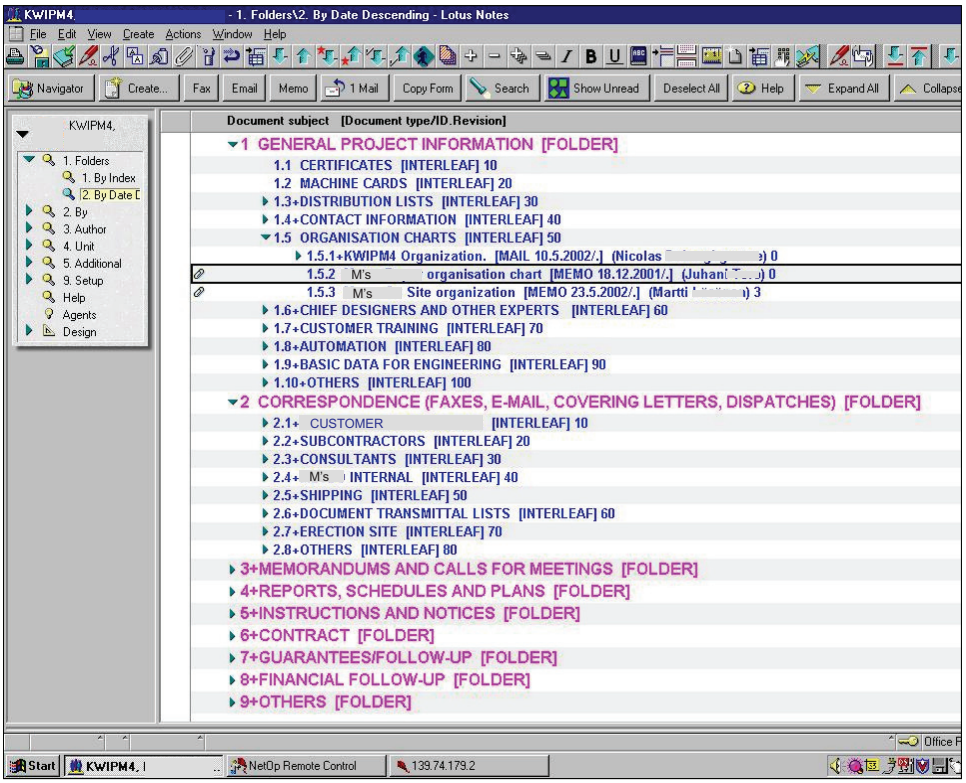

FIGURE 24 Tasman main page for project KWIPM4

The ability to replicate Notes databases provided new possibilities for allowing employees to work remotely. Mobile use of Notes became routine in project management[46]. Development in mobile communication media was seen as an important step in the work of project managers, as it involves a lot of travelling, around 150-200 days a year. However, the customers still did not have an access to Notes due to confidentiality of the data[47].

ICT enabled modifications to division of work

These advances in information technology initiated a gradual change of the work of secretary's from photocopying, posting and faxing to assisting project

45 Source: The developer of Tasman, 24.9.2002.
46 Source: Interview P24, Project manager, 25.4.2001.
47 Source: Interview V3, Vice president of project development, 8.12.2000.

managers in coordination, communication and control tasks[48]. Especially after adoption of e-mail and group support systems the traditional secretary tasks were less needed as the project manager could do the same task electronically by himself[49]. On the other hand, the assistant could help the project manager by handling some routine tasks[50].

> *"During a typical delivery project dozens of drawings and other material are sent to the customer. In the first half of the 90's the project manager controlled the dispatch of required documents. He personally collected the drawings from product engineers and passed the pile of papers to me for posting. With the help of IT (group support system) I can now without help of project manager take care and control that all required drawings are posted in time to the customers." (Interview A3, Project assistant, 8.5.2001)*

4.4.2.4 Phase IV - Company restructuring period

New rules for lateral coordination

The expansion in the user population, initiated some changes in the Notes system for project management. For instance, the project managers wanted to store some confidential information (e.g. financial data) in the system. For this reason it was decided to create user roles with differing levels of access to view and modify data in the system[51].

As the size of the projects grew and they typically affected 10 different business units, an additional lateral coordination person was needed in projects to *coordinate actions across business units*. In the end of 90's the department started to assign an additional head project manager for large multi business unit –projects. In 2000 the corporation officially established this with a main contractor directive, which set up the rules that each project delivery had one business unit as main contractor and one head project manager. Thus the project organisation in many recent projects consisted of a chief project manager and a project manager for each business unit taking part in the delivery[52].

Furthermore, to improve *lateral coordination* a new recommendation for scheduling project meetings was proposed in the end of year 2000[53]. Up till now each project manager decided the number, quality and timing of project meetings largely by himself. It was recognised that more rigorous scheduling of multi-departmental meetings was essential to overcome some internal quality problems[54] related to obtaining and communicating basic customer requirements information and synchronising of actions within the company. This rule was generated based on experiences from previous projects. It

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48 Source: Interview A4, Project assistant, 1.5.2000; Interview O8, Office manager, 3.5.2001.
49 Source: Interview P23, Project manager, 25.4.2001.
50 Source: Interview A3, Project assistant, 8.5.2001.
51 Source: G14, Internal groupware user-training, 10.11.2004.
52 Source: Interview V3, Vice president of project development, 8.12.2000.
53 Source: Interview O7, Manager of master scheduling, 24.4.2001.
54 Source: G10, Internal report on quality costs, 17.4.2001.

intended to make the project organisation more formal and bonding and improve lateral coordination[55]. At the same time, these schedules initiated the need to provide also suitable formats, folders etc. in the Notes.

> *"Especially effort was put on planning the process of project management: when is the right time to start with detailed engineering, so that the purchase department can buy the critical components in time, so that production department receives them in time for production and assembly etc. If these interdependencies are not recognised, the project manager has a lot more work in coordinating and controlling the project" (Interview V5, Vice president of projects in 9.3.2001)*

4.4.2.5 Changing importance of mechanisms in time

The Company M had many years of experience in matrix type of organisation and also had assigned a coordinator person (i.e. project manager) to each of its projects. As the vice president of project development noted, during the research study period 1990-2000, they focused on ICT support of the project business. FIGURE 25 depicts the most important changes in coordination mechanisms in time.

The first years were stable and no new coordination mechanisms were introduced. Then the focus was in providing ICT tools. After a successful adoption of Notes showing the possibilities of the technology in advancing lateral relations, the company started to advocate lateral communication between personnel instead of use of traditional hierarchical channels. This was implemented with ICT and suitable organisational support. And last, the focus of coordination mechanisms was on providing rules for co-operation, because the increased complexity of the product and increasingly equivocal and interdependent networked setting. These rules were also included in ICT tools.

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55 Source: Interview O3, Production manager, 4.4.2001.

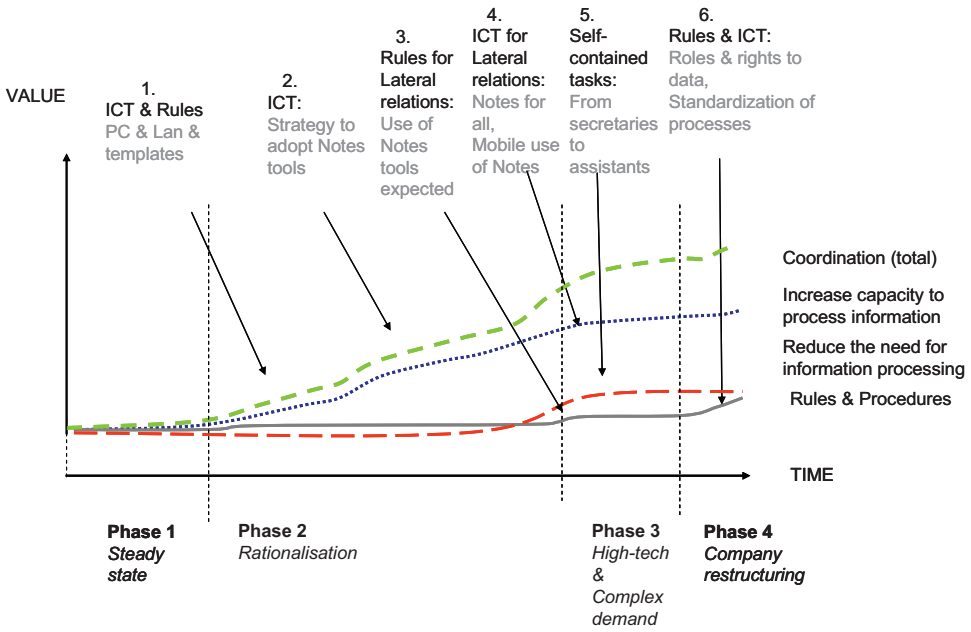

FIGURE 25 Coordination mechanisms applied during the research period

4.4.3 Performance effects

How well did the project management handle the increasing complexity? Galbraith (1977) mentions that if coordination fails creation of slack resources will appear. With slack resources he meant increased resources for production of each output, for instance increased man-hours or relieved time schedules. In the literature measures such as cycle time, lead time, inventory turns, on-time delivery and customer service have been used to measure performance (Flynn & Flynn, 1999). In our case - global project management – the company M provided us data for measuring A) customer service satisfaction, B) cycle times (time schedules) and on-time delivery statistics to depict the quality of output, and C) ratio of the monetary value of projects to the staff resources to describe efficiency of work force (man-years)[56].

A) Cycle time and customer service: M interviewed its key customers after completion of projects between 1992 and 1998. They were asked to identify their level of satisfaction with various phases of the process – sales, project management, assembly, start-up, and training – as well with the equipment,

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56 Source: G7, Estimate on average length of projects, 26.4.2001; G8, reports on customer satisfaction surveys, 9.5.2001; G9, reliability of the deliveries, 9.5.2001; G7, staff statistics 1990-2000, 27.4.2001; G7, financial data of orders booked and net sales 1990-2000, 15.5.2001.

targets, communication, documentation and quality of improvements[57]. Over the study period, customers' answers centred around 3 ("as expected") with the trend toward higher numbers. These process measures were stringent in the sense that satisfaction was measured relative to customer expectations concerning that feature. The Vice president of project development [58] explained that these expectations always increased after good or excellent performance. For this reason M regarded scores of 3 as proof of excellent performance on an absolute scale because the data showed that the company had been able to satisfy increasing customer expectations over time, despite the increased complexity of projects and new coordination requirements.

B) The cycle times and On-time delivery: The cycle times from sales to line start-up shortened by several months over the 1990s (from 20-22 to 17-18 months). This trend indicated better customer service in terms of shortened waiting times and more efficient use of capital. Delivery reliability was not affected by this trend. Annually roughly 16% of projects were late between 1992 and 2000, typically due to customer-related problems such as a construction site that was not cleared. In 1998 and 1999, two project start-ups per year (out of 28) and two project start-ups in 2000 (out of 20) were delayed due to M's operations. These projects were mainly large renewals that had stringent scheduling requirements.

C) Efficiency of Staff: FIGURE 26 shows the ratio of monetary value of orders booked to number of personnel in the project department (2 year moving average). Even though the efficiency has varied somewhat during the research period, the linear trend line (dashed line) it shows that the project management has challenged the trend of increasing complexity.

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57 The scale was 5 ("much better than expected"), 4 ("better than expected"), 3 ("as expected"), 2 ("worse than expected"), and 1 ("much worse than expected").

58 E-mail from Vice president of project development 24.4.2003 concerning the scales and interpretation of the results..

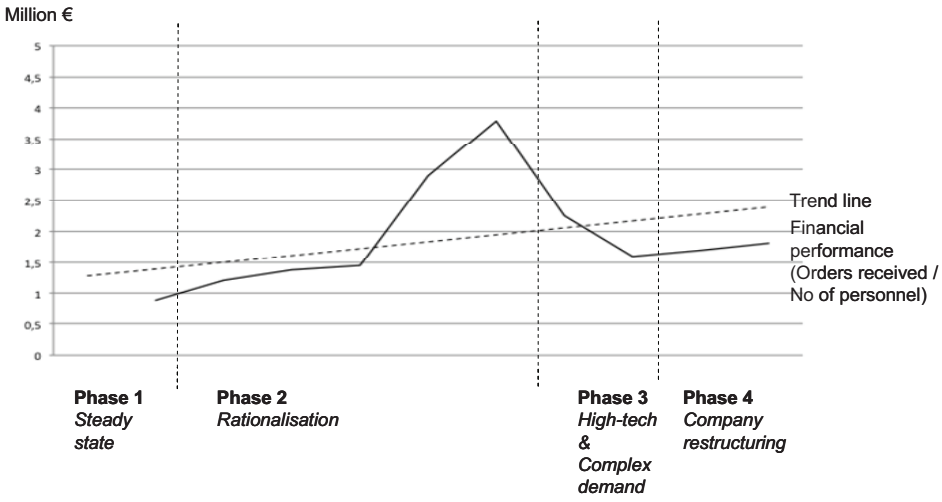

FIGURE 26 Financial performance.

The data shows how the financial efficiency was clearly rising after mid 90's, but phase 3 brought the efficiency down considerably. We cannot provide a clear cut answer on this 'bump'. One possible explanation can be the cyclical market demand. The other potential cause can be found in the on-time delivery statistics: The M had some trouble towards the end of the decade to deliver on-time large renewals, which required fitting of the newest high-tech machinery to customers' often several decades old facilities. This might also explain why the financial performance declined in phase 3: the project management did not have effective mechanisms to cope with the combination of variety in customers' facilities and demand (environmental complexity) and demanding high-tech products (task complexity). However, the financial performance metrics shows that M was recovering from the down turn during the last phase.

As a summary (see FIGURE 27), the case data clearly evidences the quickly rising complexity during the study period. Even though some problems in on-time delivery of large renewals was identified from the data, it should also be quite safe to conclude that M had been able to find suitable coordination mechanisms, since at the end of the period the performance improved from the initial level, even though at the same time the complexity had multiplied.

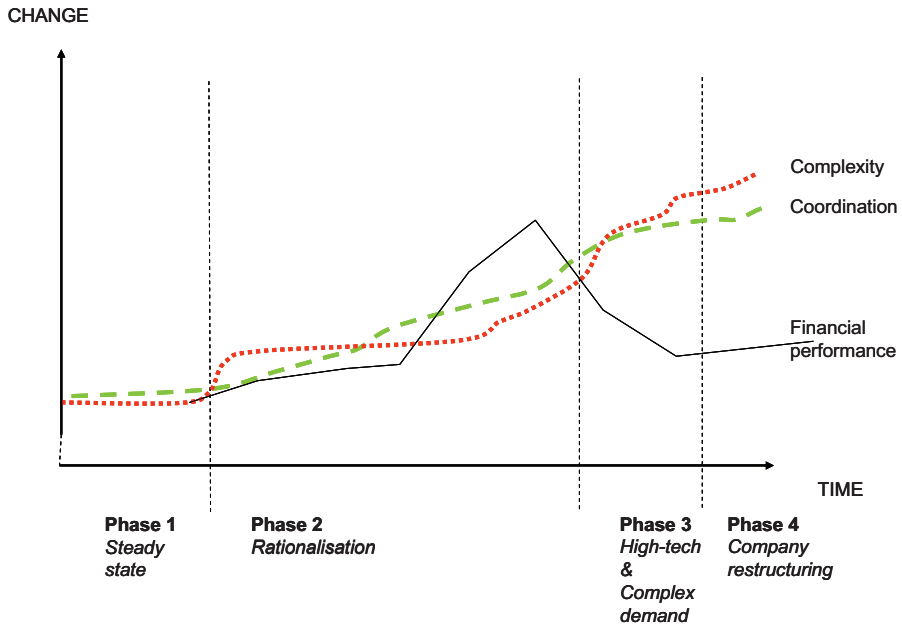

FIGURE 27 Summary of Complexity, Coordination and output

4.5 IT as a coordination mechanism

In the previous section we illustrated the changes in complexity, coordination and performance during the research period. It showed how the complexity had risen significantly during the decade. It also clarified how the organisation had continually improved its set of coordination mechanisms. Next we will explain the interplay between the mechanisms and the effect of gradual development of ICT.

4.5.1 Interplay between coordination mechanisms

There is a rich stream of literature pointing out the importance of interplay between technical and organisational changes. It proposes that organisational context influences the consequences of information technology (Zuboff, 1988) and supports an incremental, continuous vision of technical and organisational change (Robey & Sahay, 1996; Orlikowski, 1996).

We analysed the causal agency of coordinating mechanisms (in the left of FIGURE 28, see also FIGURE 25 showing the evolution of coordination mechanisms in our study). We used categorisation proposed by Markus and Robey (1988) to technological imperative, organisational imperative and emergent perspectives. We examined whether the adoption of certain mechanisms was mainly based on technological imperative, where general

evolution of ICT enables new coordination activities, or on *organisational imperative* for proactive measures to cope with complexity, and last whether change *emerged* unpredictably from the interaction of people and events. We estimated that at first phases the trigger was mainly evolution of ICT and at end of the research period coordination became more organisational driven and managed activity. However, in some situations the following step in coordination emerged from individuals' experiences of previous stages. We found that these changes were sometimes initiated by workers and when found effective given organisational blessing afterward. This supports Brown's (1999) suggestion that informal approaches may need to be implemented before more costly formal mechanisms. Overall, we could recognise all three types of causal agency in changes in coordination.

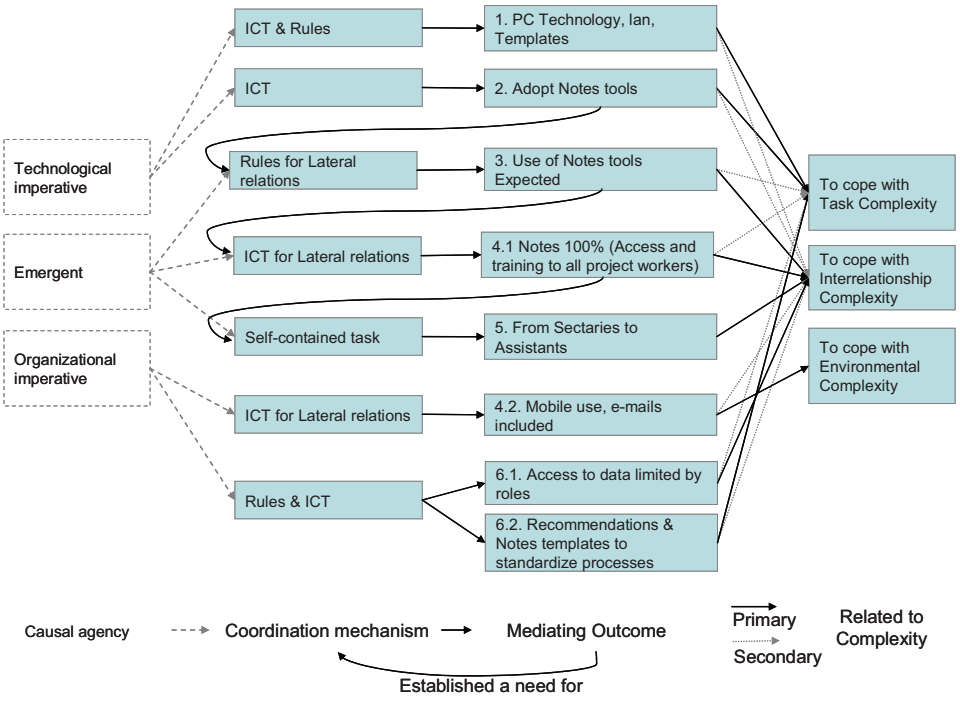

FIGURE 28 Adoption pattern of coordination mechanisms

Furthermore, as suggested by previous literature (Gittell, 2002) our case study shows how in many cases there were multiple coordination mechanisms applied at the same time. Even more interesting, we could detect loops between mechanisms: several times an adoption of a certain mechanisms resulted in a need of change in another mechanism (in FIGURE 28). The introduction of Notes tools for project managers and secretaries (ICT) resulted in a requirement (rule) set by project managers that the whole project group should use the same tool. This evoked a need to modify the tool and to provide organisational support for adoption of the tool (ICT for lateral relations). This in turn provided

a possibility for the change in division of tasks, so that secretaries turned into assistants (self-contained tasks). This finding supports articles pointing out incremental advancement of mechanisms, and interplay between technical and organisational changes. Moreover, it highlights the simultaneous use of multiple coordination mechanisms, including rules, when trying to handle increasing complexity.

Our case shows that in a situation were lateral coordination mechanisms such as matrix organisation, project groups and project managers are already at place, the main advancement in increasing lateral communication even further came from using advanced information and communication technology. Group support systems helped to form groups or teams to solve a mutual problem regardless of place or time.

We also noticed that traditional coordination mechanism of Galbraith's framework, the use of formal rules and procedures and hierarchical power, was continuously at use. This was apparent in latest introductions of new rules for lateral interdepartmental meeting schedules, which again initiated modification rounds of group support systems. Our suggestion is that the relationship of ICT to rules is two fold: on the other hand ICT is often built on some rules of work organisation, division of work, processes etc., but it also generates new coordination needs that often are solved by inventing new rules, standards or procedures. This finding actually challenges the traditional view that routines are less useful in the face of uncertainty due to their narrower bandwidths (Argote, 1982). Instead, it supports Gittell's (2002) notion that routines, along with more interactive mechanisms can be increasingly useful as levels of complexity increase.

4.5.2 Gradual development of ICT

The above findings highlight the importance of development of coordination in small steps. This is apparent also in the development of the groupware for coordination purposes in our case department.

In the first half of the research period the company invested in PCs and LAN. Then it decided to invest in group support systems. One of the pioneering applications was developed in projects department. The success of Tasman as a coordination mechanism seems to be in the way it was developed and used for coordination. Firstly, based on users' or department's requests, the tool was modified in small steps to fit particular organisational situations. Also organisational support was provided, in strategic level by advocating lateral communication and visibility and in practical level by proving extensive training and by permitting or later on regulating personnel's access to all project data. This finding is in line with claim of Kling et al. (1996) that the organisation should be prepared for the greater complexity and organisational impacts caused by the new IT and to provide organisational support to adaptation to these changes.

Secondly, the main Notes tool adopted by the case department was initially designed to support personal project data archives. Later it was

modified to a tool supporting enhancement of lateral relations between project workers located in differing continents and time zones. Even though it was used for controlling the project group, it was also used to improve communication between the members. This made it useful in managing uncertain and equivocal situations.

4.6 Conclusions

Next we will conclude this study by discussing its managerial implications and theoretical contributions.

4.6.1 Managerial implications

The Case study shows how the company had during the study period of ten years constantly altered and adopted new means to coordinate work. Major part of the increased coordination was achieved by increasing the capacity to process information. In all instances these mechanisms involved application of information and communication technology. Also the traditional rules were applied to improve coordination, but often also these instances were related with the use of ICT. The mechanisms that would reduce the need for information processing were applied rarely.

During the past decade the main emphasis was to tackle internal coordination problems. At time of interviews the most frustration by the interviewees was expressed on the difficulties due to the complex web of people having differing capabilities, representing differing roles and differing organisation. And this web was constantly changing, also within the corporation. When the organisation stabilises and new procedures are routinised these problems may be relieved to some extent.

There are many facts indicating that coordination with external parties, such as subcontractors, partners and customers, is of great importance in the future: First, the company is in the business of high asset specific products and the trend of increasing importance of large renewals will make the product even more customised, i.e. asset specific. Second, there are seldom orders from a brand new customer; about 98-99% of orders are from old customers. Third, especially in renewal projects the problem is that the information on customer's facilities and old machines is missing or lacking. This makes the continuous management of customer relationship, co-operation and communication of vital importance. Last, and most important, the strategy introduced by the corporation management expects that the company puts heavy emphasis on development of the business towards after sales service and care. This would require more in-depth relationship with the customers and establishment of a world wide service network. First step toward this goal would be to improve the communication and information sharing with the customers during the delivery project. And then, the next step would be to find ways to enhance this

relationship to even further in the life cycle of the customer sites - for example by finding ways how service relationship could be used to help communication and information gathering about the customers and their sites in the sales and project delivery phases of renewals. Similarly challenging is to coordinate the project so that this information is communicated to all involved internal and external parties in time. At the same time, the company should analyse how the future global business network, providing local service, can be set up and coordinated.

4.6.2 Theoretical contributions

In this paper, we have sought answers to three questions concerning complexity and coordination: a) Can coordination framework based on systemic view of organisation (Galbraith, 1977) be applied to illustrate patterns of changes in complexity and coordination mechanisms? b) How coordination mechanisms evolve and affect each other? c) What kind of a role does ICT have in organisational coordination?

Galbraith in his seminal work (1977) followed thoughts of March and Simon (1958) that organisation can be conceptualised as an information processing system. The underlying axiom is that uncertainty means absence of information, and thus level of uncertainty can be relieved by collecting and processing information. The function of the management is to apply most suitable coordination mechanisms to facilitate collection, processing, exchange and distribution of information (Bensaou & Venkatraman, 1996). Based on previous literature criticising Galbraith's thoughts, we made slight changes to the model. First, following Weick (1975, 1979) we preferred to speak about complexity, which includes both uncertainty and equivocality. And second, based on literature we deduced that environment, task and interrelationship form the main sources for complexity. Third, due to evolution of IT to ICT, we preferred to take into account both vertical information systems and communication technology as coordination mechanism.

We applied our coordination model in a case study to depict interplay of complexity and coordination mechanisms over longer periods of time. By using our model we could illustrate how complexity related to global delivery projects was continuously increasing during the research period. Confirmed by the fact that performance did not decline, the study shows how several coordination mechanisms were successful in handling this increasing complexity. We could also picture the evolution of both complexity and coordination mechanisms. The complexity faced by the case organisation was multiplied during the study period of ten years. It answered to the increased complexity in most instances by improving the information processing capacity. The alternative mechanisms proposed by Galbraith that would reduce the need to process information were rarely applied or even available. This finding can actually hint why 'information overflow' has become an everyday phenomenon in firms: The companies are facing an ever increasing complexity and the means to cope with it seldom reduce the complexity, but handle the complexity by

improving the information processing capabilities of the firm. As a result, there is an increasing need to collect, analyse and interpret new information, leading to an excess of information and number of ways to deliver it.

Our model was used to answer our second research question, to examine the changes between differing coordination mechanisms. As suggested by previous literature (Gittell, 2002) our case study showed how in many situations there were multiple coordination mechanisms applied at the same time. We also detected loops or causal chains between mechanisms, where an adoption of a certain mechanisms resulted in a need of change in another mechanism. Contrary to Galbraith's construct, the case shows how coordination is not necessarily highly determined, organisation driven engagement. In some cases the decision were technology driven and in some cases the changes in coordination mechanisms were emergent and gradual, small adjustments to work methods, tools or routines previously found useful in practice in a smaller setting.

Based on our study we suggest that evolution of information technology to support both supervision and communication has changed ICT role in coordination work significantly. It is no more a separate alternative channel to bureaucracy to transmit information between workers and management, but it, for instance, helps to form informal, distributed groups or teams to solve mutual problems. Similarly it can be a tool to put rules and procedures in practice. Thus we would reconsider its position as an independent coordination mechanism. Rather we would propose that it is the most powerful mean of coordination when it is combined with other organisational mechanisms.

Finally, our study also implies the reason why only few studies had tested Galbraith's model as a whole and why the results of some specific causalities between attributes show conflicting results. The original work of Galbraith is not very clear on the sources of uncertainty, or how can we identify an adoption of coordination mechanism. For instance, to identify the changes in coordination mechanisms the researchers need to collect very context and time specific information. This makes it almost impossible to study the phenomenon with quantitative research methods, but calls for more qualitative and longitudinal approach. As a result we conclude that Galbraith's model is a useful mental construct, which has organisational imperative perspective on coordination. If it is to be used in empirical work it should be more explicit and updated. This article presents one such attempt.

Our findings need to be interpreted with caution. There are some shortcomings in measuring the changes of complexity and coordination. As changes in each attribute were expressed in differing units, a holistic illustration of total complexity and coordination could be given only by using brutal approximations of the importance of each attribute. More over, we were able to value performance with monetary value of orders / number of personnel in the department, which does not take into account actual costs of operations within the department, and is not independent of the environment (business cycles) or actions of other departments (such as sales). Furthermore, the conclusions are

made based on single case study and the case organisation could make autonomous coordination decisions only to some limit. Perhaps the results had been different if we had studied the phenomenon at the corporation level, where coordination decisions can be made autonomously. Furthermore, we were able to only scratch the surface of ICT's role in coordination. Our study provided implications that the case organisation used ICT for lateral relations and was thus able to handle complexity related to inter-relationships. However, it did not make any coordination decisions that would aim at modifying the environment, such as co-optation, or multi company cooperation. Thus we had no possibility to analyse the role of ICT when environmental management actions are taken place. Another appealing research stream would be to look for similar types of ICT based tools for project management, and study their attributes and usage patterns in order to analyse their role in coordination. Thus we believe that follow up studies - case studies, ethnographies, action research, experiments e.g. - replicating or challenging our case study and its findings would be welcomed to accumulate scientific knowledge.

5 ICT FOR COORDINATION

In hierarchically organised enterprises, the main task of management is to coordinate resources that are held in-house (Galbraith, 1977; Snow et. al., 1992). However, in networked operations and outsourcing, the companies are facing a new set of dynamic interfaces with the outer world. Does this mean that required communication increases and coordination requires additional groupware support and GSS systems? Or is it just the other way round – to cope with constantly increasing information over load they are compelled to rely on more standards and rules? Does the network structure guide what kind of ICT support is adopted?

In this paper these questions are analysed with the help of a grid that is applied in a study of two international successful companies M and N, who with their subcontractors have faced the challenges of delivering projects globally for two decades. First we discuss the concepts of coordination and complexity a bit more by forming a conceptual grid of communication and structure in coordination. Then we continue the analysis with relation of network dependencies to coordination needs, and with the ICT for differing network and coordination types. The empirical part of this chapter is based on an intensive case study carried out in 1997-2004 and a comparative case study in 2005-2006 (see Chapter 3 for more information). The aim of our comparative study was to benchmark the tools that the focal companies of networks were using for coordinating global delivery projects. Since both focal companies organised all their customer deals as projects, the information systems supporting the management of projects were considered essential to the efficiency and competence of the companies.

5.1 What is coordination? – The views of economists and organisation scientists

Transaction costs theory claims that organisations should select a governance structure that economises on the sum of production costs and coordination costs (Williamson, 1985). At least in theory it is possible to distinguish coordination tasks from those of actual production tasks (Carstensen, 1996; Shin, 1997). Production includes the physical or other primary processes necessary to create and distribute the goods or services being produced (e.g. see Malone et al., 1987). The coordination actions include all the information processing necessary to coordinate the work of people and machines that perform the primary processes. This involves for instance gathering information, selecting suppliers, negotiating contracts, managerial decision making, planning, control processes and protecting against the risks of opportunistic behaviour (Malone et al., 1987).

Williamson (1985) applied temporal categorisation for these costs, before (*ex ante*) and during or after the transaction (*ex post*). Ex ante refers to the effort of pre-specifying the details of transaction (e.g. agreement) in beforehand of its execution. Ex post relates to the situation where transaction fails and the parties should engage in actions to correct misalignments. Interestingly, his categorisation differentiates the **structuring** the process by pre-specification from **communication** to adjust the actions. This basic differentiation can be perceived also for example in programmed/feedback – coordination typology proposed by March and Simon (1958), and elaborated by van de Ven et al. (1976) and Mintzberg (1979). They suggest that there are two primary means: Coordination can be achieved either with programmed mechanisms, which achieve coordination by specifying tasks and the interfaces among them in advance of the performance of the work; or alternatively by using feedback mechanisms, which facilitate the transfer of information through interaction among participants (TABLE 8).

TABLE 8 Coordination typologies

Coordination	***Williamson, 1985***	***March and Simon, 1958***	***Thompson, 1967***	***Galbraith 1977***	***Mintzberg, 1979, 1983***
By structure	Ex ante	Programmed mechanisms	Planning, schedules, rules, standardisation	Rules, hierarchy, computing technology	Standardisation of work processes, of worker skills and of work output
By communication	Ex post	Feedback mechanisms	Mutual adjustment	Lateral relations	Mutual adjustment, direct supervision

Examples of programmed mechanisms are rules, standards and plans (Thompson, 1967, Mintzberg 1979, 1983; Galbraith 1977), and examples of feedback mechanisms are direct supervision, lateral relations and mutual adjustment (Thompson, 1967; Galbraith 1977; Mintzberg 1979, 1983).

By combining the above two elements of coordination mechanisms we can form a two dimensional grid of communication and structure (similar approach can be found for instance in Katzy, Sung & Serrano, 2004):

One axis represents the communication element of coordination. The organisation can apply coordination mechanisms having different level of communication characteristics. For instance Daft and Lengel (1986) presented a classification of communication based on their capacity to process rich information[59]. Communications that can support transmission of multiple channels are considered rich, whereas lean media has few channels to communicate meaning, e.g. they cannot convey physical gestures or facial expressions. Examples of lean media are numeric and written documents. Still, documents can be very effective for well understood situations. Face-to-face communication facilitating immediate feed-back and providing multiple cues for instance via body language and tone of voice is an example of rich communication media (Daft & Lengel, 1986).

The other axis represents the level of structure of coordination mechanisms. With it we refer to the depth of specification of regulative instructions. Highly structured coordination means that tasks and the interfaces among them are specified in advance of the performance of the work. When coordination is relying on small set of basic regulations, its level of structure is low. Examples of low-structure methods are simple, independent guidance or practices. They provide general outline for separate actions without defining their interactions. Process descriptions, which follow for instance Capability Maturity Model (CMM(I)) or other similar frameworks, are examples of high-structure regulation methods, which not only govern the carrying out the tasks and their interaction but also aim at improving these processes.

5.2 Complexity – the reason for coordination

Economics and organisational design literature argues that coordination is most often related to increasing complexity. Complexity makes it difficult to predict future outcomes due to information incompleteness (Galbraith, 1977; Argote, 1982). Galbraith's proposition is that the greater the uncertainty, the greater the amount of information that has to be processed between decision makers during task execution. He followed the idea from that uncertainty means

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[59] The media richness theory has evoked a vast line of research and critisism (see e.g. Ngwenyama & Lee, 1997).

absence of information and defined it as "*the difference between the amount of information required to perform the task and the amount of information already possessed by the organization*" (Galbraith, 1977 p. 37 see FIGURE 29). An organisation performs better in complex situations by collecting and processing more information more efficiently.

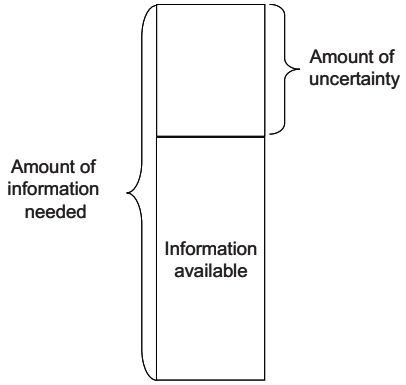

FIGURE 29 Uncertainty as defined by Galbraith (1977)

The organisational literature (Weick, 1975, 1979; Daft & Lengel, 1986) also suggests another reason for organisational information processing – to reduce equivocality. Situations marked by equivocality are ambiguous and thus subject to multiple interpretations (Weick, 1979; Daft & Lengel, 1986). According to Weick (1979, p. 6) "*the basic materials on which organizations operate are informational inputs that are ambiguous, uncertain, equivocal…The activities of organizing are directed toward the establishment of a workable level of certainty*". Weick suggests that to relieve equivocality members of organisations spend considerable time negotiating an acceptable version of what is going on.

We see that definitions of uncertainty and equivocality complement each other, and are both related to managing information. The idea behind Galbraith's uncertainty definition is that the level of uncertainty can be relieved simply by collecting and analysing information whereas Weick's (1979) and Daft and Lengel's (1986) equivocality refers to ambiguous situations with multiple interpretations that could be relieved by increased interaction between parties involved. Reflecting uncertainty and equivocality to our characterisation of coordination, it seems that for equivocal situations it would be appropriate to use coordination mechanisms with rich communication media, since they can facilitate the discussions between members while they are resolving ambiguous matters. On the other hand, high-structure coordination methods seem to be most beneficial when the matters are uncertain, but can be resolved by gathering and analysing more information (Daft & Lengel, 1986; Stacey, 2007).

In FIGURE 30 we draw a conclusion that coordination by structuring helps to cope with uncertainty.

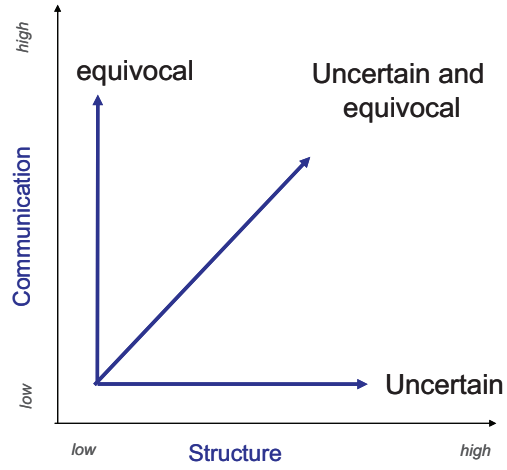

FIGURE 30 The suitability of communication and structure based coordination to equivocal and uncertain contexts

The more uncertain (lacking information) the situation is the more emphasis should be put on proper structuring of the process and instructing the parties involved. But, when the situation is equivocal (subject to multiple interpretations) the emphasis should be put on communicative coordination allowing discussion, sharing of views and compromising. Most complex the situation comes, when it is both highly equivocal and highly uncertain at the same time. This situation calls for coordination mechanism, which uses a combination of communicative and structural means.

5.3 Four archetypes of coordination and ICT systems

From the point of coordination – which we defined as *management of dependencies between activities* - one obvious point of interest is the relation between dependency and complexity. Thompson (1967) proposed a classification of dependencies into three basic categories: pooled, sequential and reciprocal dependencies.

In FIGURE 31 we depict how these dependency types are related with the levels of structure and communication richness in coordination, and what kind of ICT support it requires.

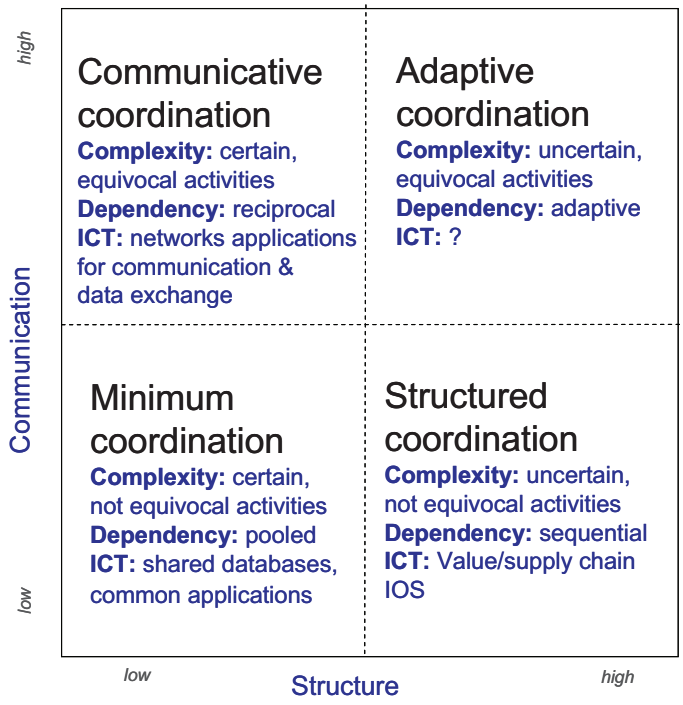

FIGURE 31 Coordination archetypes

Minimum coordination - This cell depicts coordination archetype, which typically rely on simple written or informal rules that require little communication between parties. This means that certain rules and routines are developed to coordinate the actions of units. An assumption behind is that we are able to develop a set of rules that are in line with each other. This practically requires a limited number of differing situations, which in turn are rather stable and recurring (Thompson, 1967). According to Thompson (1967) the simplest case of dependency between units is *pooled dependency*, where the units share or produce the same resource but are otherwise independent. Pooled dependency can usually be handled with simple rules and standards. According to Kumar and van Dissel (1996) pooled dependency is best supported with *pooled information resource systems*. It is about sharing of common IS/IT resources, such as common databases, common communication networks, and common applications (Chi & Holsapple, 2005).

Structured coordination - means that dependent activities are given a procedure and time schedule according to which their actions can be managed. Coordination is achieved by following detailed process definitions. This archetype requires lots of effort in before hand, but should reduce the amount of exceptions while working. Structured coordination is appropriate where systematic analysis and measurement of processes provide enough explicit information to reduce uncertainty. Structured coordination is suitable for

sequential dependency (Thompson, 1967), in which the output of one unit is the input for another unit. Suitable ICT support includes value/supply chain IOS that aim to institutionalise structured coordination between organisation (Kumar & van Dissel, 1996). They include formal (EDI-based) orders, order tracking (e.g. with the help of Radio frequency identification), and database look-up of adjacent partners in the chain etc.

Communicative coordination - means adjustment of work during action. New information is transferred between partners while they are carrying out the work. Few rules govern the work, but rest of the unresolved issues are coordinated by e.g. face-to-face meetings and numerous phone calls. This archetype is very flexible facilitating information transfer and mutual understanding between interdependent parties. Answers are obtained through subjective opinions rather than from objective data. Communicative coordination is suitable for situation where events are equivocal and poorly understood. As Thompson (1967) mentions this mutual adjustment is not only considered as vertical feed-back within the hierarchy, but can also reach over the boundaries of the firm. Communicative coordination fits the requirements of reciprocal dependency, in which the units are feeding their work back and forth among themselves. According to Kumar and Van Dissel (1996) the ICT support for communicative coordination could include data and application sharing such as desk-top sharing technologies, CAD/CASE data interchange and repositories, discussion databases, synchronous and asynchronous, time and place independent CSCW tools, and video-conferences.

Adaptive coordination - applies both rich communication and highly specified processes. Rich communication with relevant parties across borders provides new information and this information is used to adapt the processes to fit to the situation at hand. It facilitates active learning and innovation but also constantly questions the prevailing processes. Direct supervision can be an example of learning coordination if the interaction between the parties is truly reciprocal, and results in changes in coordination structures. Adaptive coordination is needed, to our mind, to coordinate reciprocal dependency where the processes are adapted to the situation based on the new information that is received during the execution. This dependency, which we call adaptive dependency, means that in addition to feeding the work back and forth between the actors during the execution of the task, also the coordination structures are modified based on the new knowledge. It is suitable to changing equivocal situations which challenge current processes. This kind of dependencies might be required in future business networks such as characterised by van Heck and Vervest (2007): business is conducted across a rapidly formed network with anyone, anywhere, anytime despite different business processes and computer systems. These future smart business networks have "*the ability to 'rapidly pick, plug, and play' business processes to configure rapidly to meet a specific objective, for example, to react to a customer order or an unexpected situation (such as dealing with emergencies)*" (van Heck & Vervest, 2007 p. 33). They suggest that suitable ICT systems could probably be based on the service-oriented architecture which resolves the problem of information

silos by loose coupling of underlying systems. Still, as recent articles by Gonzalez (2008) and Gonzalez and Bharosa (2009) on coordination in crisis response evidence, people tend to prefer well-known and simpler technologies rather than sophisticated tools.

In the following FIGURE 32 coordination archetypes are combined with more practical assessments by Katzy et al. (2004) on the typical functionalities that are available from existing tools at market currently for managing cross unit projects. The functionalities were collected by Katzy et al. from 23 commercial "*virtual collaboration tools, project management tools, groupware and distributed work management tools*" (Katzy et al., 2004, p. 5).

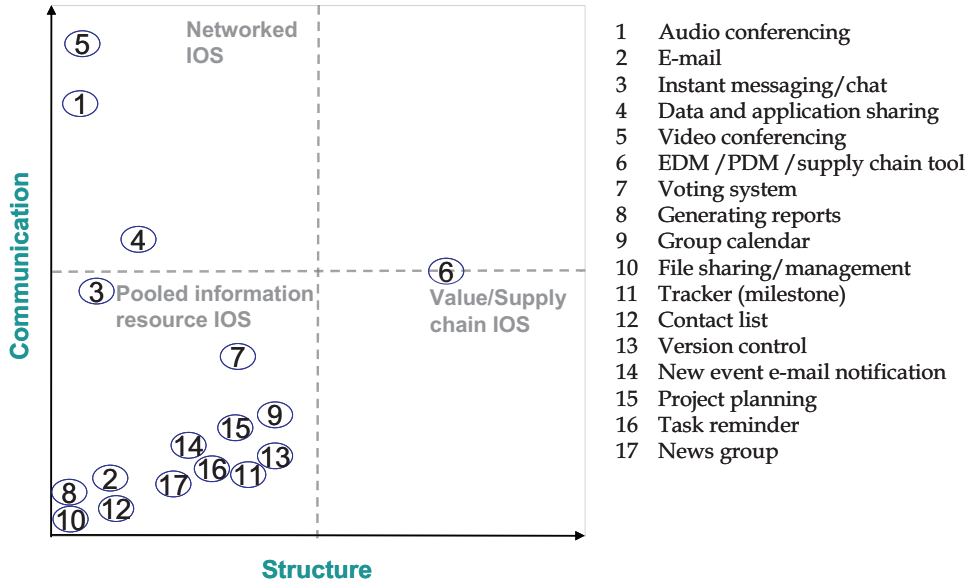

FIGURE 32 Functionalities of ICT systems for managing cross unit projects (Katzy et al., 2004, p. 5)

It is easy to visualise from the figure that most of the functionalities available in commercial ICT tools for virtual project or distributed project management tools are concentrated in supporting minimum coordination (the lower left quarter). In this type the typical network is pooled dependency, which can be aided with pooled information resources IOSs.

The ICT support for communicative coordination is mainly audio & videoconferencing. Value chain IOS such as Electronic data processing (EDP), Product Data Management (PDM) or other supply chain tools can be of help when higher level of specification in advance (structured coordination) is needed.

Next we will turn to analysis of the ICT systems adopted by two of our case networks: N and M

5.4 ICT tools for Coordination: Cases M and N

Following the technique of theoretical sampling (Eisenhardt, 1989; Orlikowski, 1993), we selected two cases for their similarities as well as for their dissimilarities. Special attention was paid to theoretical relevance and purpose of the comparison. Here, the relevance of the sampling was ensured by keeping the substantive area addressed similar – the networked business and use of ICT to coordinate networked actions.

Both Cases, M and N, were about global networks designing, manufacturing and delivering high-technology products to global b-to-b markets. Both were also in project based business, i.e. all customer deals were organised as delivery projects. From the discussions with the representatives of the focal companies we had the knowledge that both focal companies had build and implemented their own project management system particularly designed for their purposes, and seemed to be quite satisfied with them. Both had mandated the use of these systems in all projects. In addition, the project management systems were compatible across the two organizations in that they both covered all the phases of the project delivery. What made the comparison interesting was that the two systems seemed to deviate from each other in their qualities. In the comparative case study we aimed to examine whether the network structure, which also seemed to differentiate the cases, had an effect on what kind of ICT support functionalities were implemented.

To take advantage of the comparative research design, the data was analysed systematically and discussed together with the participants to reveal the differences in perceptions on network coordination and respective implementations of information systems.

5.4.1.1 Case M

As described in previous chapters, M had faced an extensive increase in complexity related to its global projects. During the previous decade, M had steadily improved its capabilities to coordinate the delivery projects. M's project activities were highly interlinked and carried out simultaneously at several of its business units. Thus for one customer order there are several subprojects. The multiple projects are coordinated by having project managers in each business unit and one primary project manager who coordinates all these subprojects (FIGURE 33, where units of M are represented with $M_1 \ldots M_x$). The dependencies between the subprojects were reciprocal, since the units were feeding their work back and forth among themselves (see FIGURE 34).

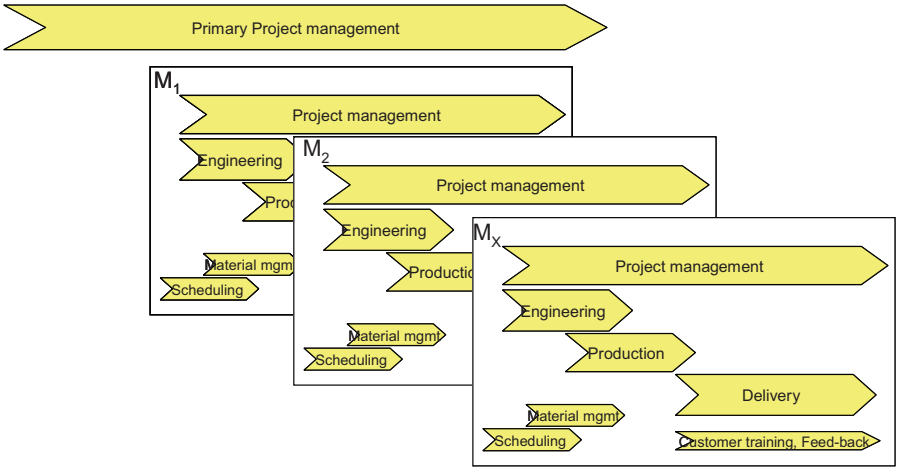

FIGURE 33 The project organisation within M

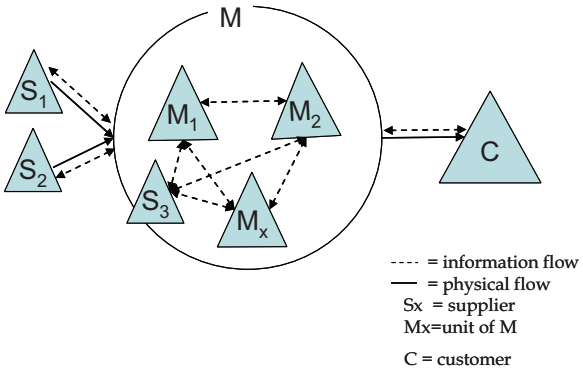

FIGURE 34 The organisation of M's network

In coordination of projects M relied on tailored Lotus Notes -based applications, which tracked discussions and e-mail threads, helped in keeping diaries, and facilitated the sharing of formal documents within the corporation. It was supported by videoconferencing and interoperable wireless phones at sites and co-locations[60]. This way M had established a culture that appreciated and encouraged the sharing of information. Reflecting this to our theoretical framework, we notice that *M focused on communicative coordination methods, which is the suggested method for coordinating reciprocal dependencies M had between its units* (FIGURE 34).

60 Source: Interview O11, ICT support for projects, 23.3.2006.

However, M relied also heavily on subcontractors, for instance in engineering phase well over half of work was carried out by subcontractors[61]. The information sharing principle did not fully apply to its business network; M's network, according to interviews[62], seemed to have the characteristics of an aggregation type of a business network (Tapscott, Ticoll & Lowy, 2000): M was an aggregator that operated and led the functions and activities of the network in a hierarchical fashion. Instead of operating as a collaborative network, the suppliers in reality operated as separate members in the aggregator's supply-web. M had "one-to-one" dyadic relationship with each of its suppliers (see FIGURE 34). As a result the collaboration in this aggregation network was done through M as an intermediary. M controlled the dyadic relationships with its subcontractors, letting only accredited partners to enter directly the customer's site. This way M could ensure quality, guarantee delivery dates, and handle most socio-technical issues by itself. On the other hand there was a price to pay: a substantial amount of control was required for operating the network.

Although many of the suppliers were kept in a role where they were one actor in a pooled interdependency, some of the workers from core partner companies were during the project factually sitting in the facilities of the company M and were considered equal to own employees of M in respect to participation in the project and access to ICT system (as in FIGURE 34 the supplier S_3).

With the stagnating demand, M's strategic vision required further value-add on its delivery process, in deeper co-operation with fewer, more competent global contractors. M needed to find ways to manage and share information better not only internally across business units but in close relationships with its customers and subcontractors/suppliers in a growingly complex and dynamic environment. The development of ICT-applications continued, because they will play a critical role in coordinating business unit-subcontractor activities in the future.

Instead of opening their internal groupware systems for contractors, M decided to take into active use data warehouse systems. They helped especially in delivery and sharing of formal documents where version control is of great importance during the life span of the product[63].

Internally, M improved coordination between business units by enforcing a common project management scheduling framework and by clarifying responsibilities between business units during deliveries. The internal project groupware was augmented with sophisticated training materials and videos. Also all e-mail messages concerning a specific project could be stored in the groupware and were, thus, visible to the whole project group. M also put effort in management reporting covering the summaries of the status of milestones on

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61 Source: Interview V6, Vice president of engineering, 30.3.2001.

62 Source: Interview V3, Vice president of project development, 8.12.2000; Interview P23, Project manager, 25.4.2001; Interview M7, Purchasing manager, 15.2.2002.

63 Source: Interview P23, Project manager, 25.4.2001.

whole project portfolio. Similarly they aimed more structured processes by building project planning tools and templates on standard MS Project[64].

To summarise, the network of M seemed to be a combination *of reciprocal and pooled interdependencies* (FIGURE 35). M's approach in using ICT to support their global deliveries was to emphasise open, internal communication with features supporting shared communication and problem solving among the business units and preferred subcontractors all over the world. On the other hand, in case of other suppliers pooled information resource systems were utilised.

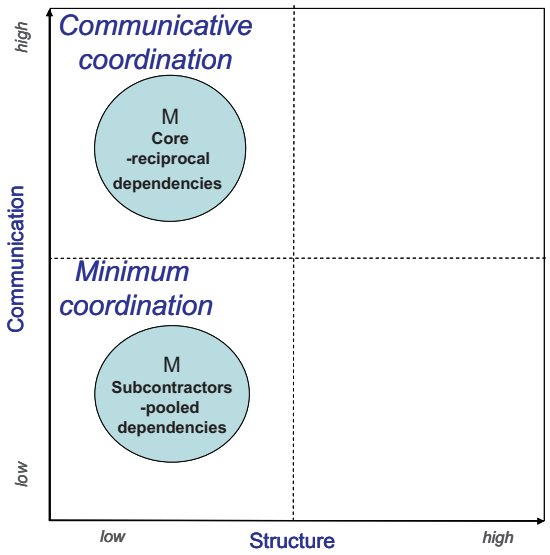

FIGURE 35 Analysis of M's network

5.4.1.2 Case N

Company N was one of the largest telecommunications hardware, software and services company in the world. N together with its network operated on global business-to-business markets. In 2005, it employed more than 18 000 people in manufacturing, research & development and sales offices located all over the world.

The products were complex technology goods which require high competence in design and manufacturing, but also in erecting and starting up the technology at customer's sites.

N outsourced well over 90% of project tasks. The total supplier network consisted of altogether thousands of subcontractors and suppliers. N saw that the most efficient way to carry out the delivery projects was to use as much as

64 Source: Workshop WX, 12.9.2006.

possible the subcontractors located in the same country as the customer. For this reason, all project networks were unique. The number of subcontractors in a project varied from ten to hundreds companies depending on the nature of the project, its geographical distribution, and the location itself, e.g. level and quality of basic infrastructure and services available in the country of the customer.

The company N had an internationally well-known brand and it wanted to make sure that use of numerous subcontractors would not harm it. For this reason it considered high level project management and supply network management as its core capabilities:

> *"This kind of big project business is very much about management of subcontractor networks and of handovers between the supplier companies, as well as management of scopes and changes"* (Interview V14, Head of project management services, in 2006)

The above means that the main coordination effort of N was to assign, schedule and control performance of contractor network. Especially critical were the handovers, i.e. the moments when one contractor was finishing his task and the contractor for the next tasks in the process should start his work. The other important coordination task was change management, i.e. in case of exceptions to replan and inform relevant participants about changed project delivery details. Furthermore, the amount of suppliers was being adjusted all the way through the project; N used simulation tools to analyse optimal timing for the entry and exit of each supplier to the project network. [65]

In response to the intense competition in the markets, N recognised the need to centralise logistics and project management functions for more efficient and timely processes. This was considered vital because of the vast contractor base and hundreds of simultaneous projects going on worldwide, and also to meet the quality requirements to avoid rework[66].

N utilised rigid work break down structure to divide the project into clear separate tasks that were carried out in sequence (FIGURE 36). These tasks were accomplished by various subcontractors each working separately in a clear sequence. Subcontractors did not communicate with each other[67], instead all handovers between the tasks were coordinated by N.

Also the communication towards the customers was solely taken care by the N. The interviewees explained that this was important in maintaining the brand. In addition, since - especially in more mature markets - some of the N's subcontractor companies were actually N's competitors, the subcontractors were not allowed to communicate with the customers.

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65 Source: Meeting ICT4, 23.2.2006.
66 Source: Meeting ICT1, 1.10.2005.
67 Source: Interview O16, ERP-manager, 23.3.2006; Interview V14, Vice president of project management., 24.3.2006.

Against this backdrop we can picture the network of N as having sequential interdependencies, where the coordination was expected to rely on pre-definition of the interaction and processes.

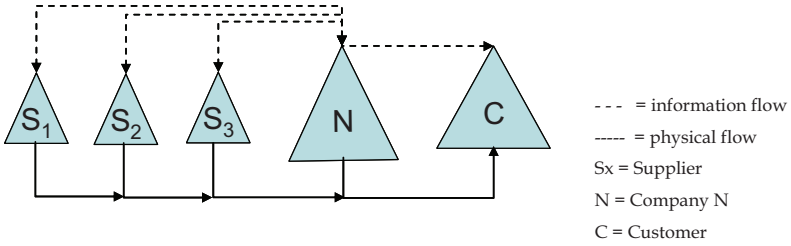

FIGURE 36 The organisation of N's network

N introduced more rigid process standards and embedded them in the portal based software[68].

> *"In the handover situations N is the coordinator, that is the construction company does not phone to the electricians and ask them to go there (to the customer site/s), instead it updates the information to the system when it has completed its own task."*(Interview O12, Project management process owner in 2006).

Well defined process made it easier to split work in work packages following the work breakdown structure. It also made control and change management easier, because the process becomes self-guiding if an appropriate incentive scheme was applied. It was critical that the contractors updated the progress of their work tasks, and this was ensured by paying them only after the contractor updated the status of the project in the database. This way the next contractors could plan their resources in a timelier manner[69].

The quality of the subcontractors was ensured with a multistage process, where they were gradually getting in tighter relationship with the principal. Most of the data on the progress of the subcontractor accumulated in the system including the evaluation reports and to-do's for improvements[70].

The system was designed as simple as possible to use. It was meant to be used primarily on the Net with minimal requirements, i.e., standard browser on a PC, by all vendors and contractors. The system had to take into account that tasks were carried out in various time zones, so it was expected to be up and running 24/7 all year round. Also, the languages, symbols and letters supported by the system had to be carefully selected so that the system provided sufficient support for the various users, but still remained maintainable and the input data usable. Internally these requirements had required quite an extensive redefinition of processes and integration with the

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68 Source: Meeting ICT1, 1.10.2005.
69 Source: Meeting ICT4, 25.2.2006.
70 Source: Interview O13, ICT manager of projects, 23.3.2006.

ERP and other back-office systems, high-availability services, multilingual support and shifting responsibilities between finances and delivery processes management[71].

To summarise, N's supply chain consisted of *sequential dependencies* (Thompson, 1967), in which the output of one unit was the input for another unit. N's role was to coordinate the activities of the whole network. As expected, N applied *Structured coordination*, where coordination was achieved by following detailed process definitions (see FIGURE 37).

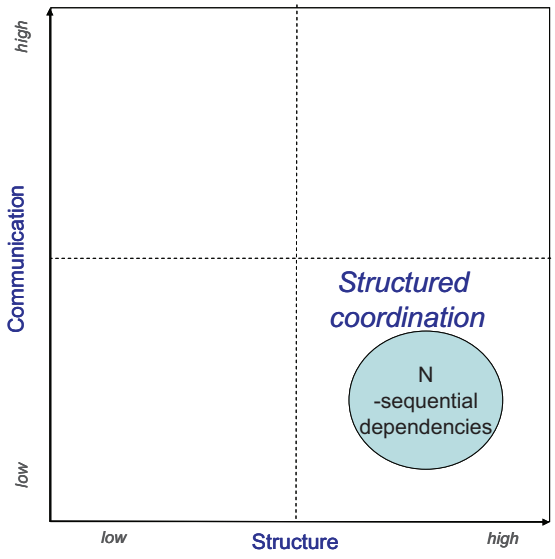

FIGURE 37 Analysis of N's network

Next let's have a closer look at what kind of ICT functionalities the case networks had adopted to support the work of project coordination.

5.5 Sets of ICT functionalities in enabling global deliveries

The functionalities of the ICT-systems that supported global delivery services in our two cases are depicted below in FIGURE 38. The data was gathered in two rounds: first by utilising the model in devising a questionnaire to M's and N's responsible teams asking the functionalities, their users and purposes (see Appendix H for the questionnaire building on Katzy et al., 2004; Kazi & Hannus, 2002; Zigurs & Buckland, 1998. More details can be found in Riipinen,

71 Source: Interview O16, ERP-manager, 23.3.2006; Interview O13, ICT manager of projects, 23.3.2006.

2007) and secondly, from the interviews (Kortteinen & Mäkinen, 2006; Vigman, 2006; Riipinen, 2007) and in the meetings with the informants. The questionnaire was first presented and discussed with the informants in a joint workshop[72]. The informants returned the filled questionnaire a week later by e-mail. The final analysis of the functionalities and interpretation of their positions within the framework was done by the research group on the basis of the above mentioned data, added with the knowledge of the systems from the previous studies and the observations in the user-training courses and ICT-system demonstrations.

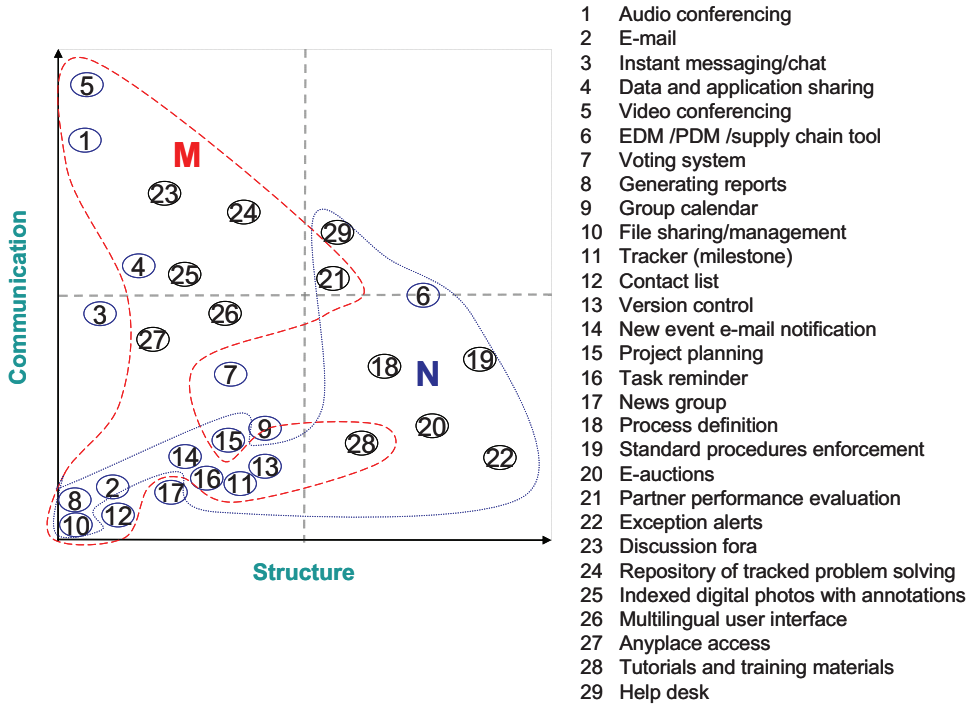

FIGURE 38 ICT Functionalities adopted by the case companies

In FIGURE 38 the functionalities used in M are circled in dashed line, and N respectively in dotted line. It is remarkable how different functionalities had been implemented, although it seems that there were also many core functionalities common to both cases. The commonalities included e-mail, reporting, file sharing/management, milestone tracking, version control, e-mail notification to all parties, task reminders and as new features partner performance evaluation and tutorials and training materials.

Excluded functionalities (that were regarded by the companies not so important in executing the project delivery services) were chat/instant

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messaging and voting system. The latter was clearly not so important in the execution stage, where the responsibilities are well defined and decision making rights allocated. The former was somewhat surprising, but we think this was due to the nature of the operations - people were on the field in different time zones carrying out their tasks and, thus, were not able to respond immediately, or did not have time to spend waiting for replies on the net. This was probably indicated by the introduction of new, automated functionality 22, Exception Alert, which was a directed messaging service to the limited set of users (like error or status codes).

Looking into the ICT systems of M, we noticed it has emphasised *communication richness* kind of functionalities for the activities between the business units and core contractors. Additional functionalities to Katzy et al.'s list they had implemented in the set of coordination tools are discussion forums open to all users (23); solutions repository, including the trace (24); annotated digital photos indices to examine real world pictures of problems and their solutions (25); and tutorials (28). These were typically used in video/audio conferences as shared material during the sessions to pinpoint, discuss and resolve problems. For non-core subcontractors the company used pooled information resource IOSs, as was proposed in the literature.

A different approach was visible in the case of N: their strategy can be characterised as Structured coordination. Also N's choices are in line with the literature, i.e. sequential dependency was matched with methods emphasising predefinition of tasks. In Case N the delivery processes were backed up by additional functionalities such as defining the specific delivery processes from work breakdown structure (18); enforcing them via the information system e.g. by designing the payments to take place automatically only after the updates by the contractors on the project status information had been approved by N in the system (19); evaluating the contractors performance on a regular basis (21); alerting of exceptions in the process (22); and enforcing in this tightly controlled way that the global standard was adopted to each project.

It seems that both these companies had been able to innovate successful ICT-support for their global networked delivery services, although their approaches differed greatly. This was also concluded by the representatives of M and N in a joint benchmarking workshop at the end of the project[73].

5.6 Discussion

Our cases indicate that both approaches adopted by the case organisations can be profitable also in the global distributed setting with thousands of

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73 Workshop WX, 12.9.2006.

contractors. The application of ICT has made it feasible at larger scale, but what can we say about the future directions?

In both cases the development towards the present state had started more than ten years ago, when the first wave of global deliveries realised (see e.g., Jarvenpaa & Tuomi, 1995; Applegate et al., 2004; Collin & Lorenzin, 2006). Both M and N were also proud of their systems. Still, they were keen to learn what kind of solutions the other had made. For this reason we arranged a discussion session between the main responsible persons of project development and of ICT development from both companies. Here the representatives shared their views and analysed the possible next steps they could take.

If - remembering our previous analysis on the constantly increasing complexity - we assume that the complexity faced by the companies is going to increase in the future also, how will the companies react (see FIGURE 39)? Will N stay as sequential network and increase the pre-definition of processes even further? Should M expand communicative coordination to cover all its subcontractors? Or will the companies move to the upper right quadrant where they add their systems with high-communication and high-structured features, features that yet not are available in commercial project systems.

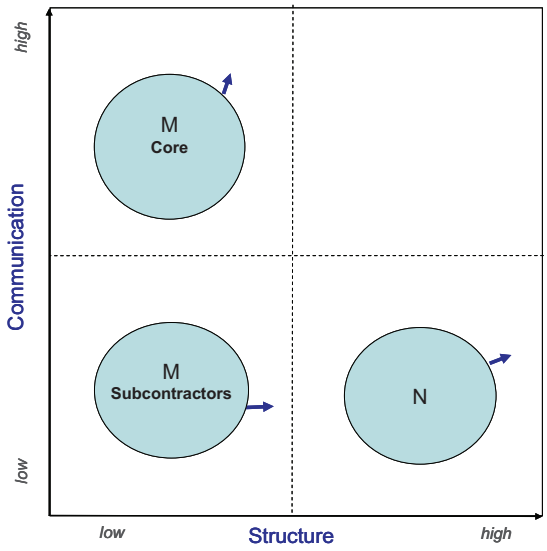

FIGURE 39 Future direction: Where to go from here?

In the discussions, both M and N admitted that they would benefit if they had some features that the other company had adopted: M was interested to have more structured and defined processes, at least in some instances, and N, in turn, admitted the benefits of free communication. However, neither was willing to cut down their current features in order to give more room for the other. On the other hand, to move to the upper right quadrant in FIGURE 39 would mean a major effort from the companies and investment in totally new developments and in integration of ICT. For that reason, it is most probable that

they will continue in the path they have selected, but perhaps include a few features of the other type. What comes to M's network of non-core subcontractors, M was reluctant to open its Core systems to all subcontractors. Instead, it might move the ICT support for non-core subcontractor network towards more pre-defined systems.

An alternative way for the companies to cope with increasing complexity is to restructure their networks, so that they would have fewer interfaces with the outer world they have to coordinate with. This alternative would mean finding new partners that would take part of the coordination responsibility. This provides attractive opportunities for global service providers and system integrators.

5.7 Conclusion

In this article we analysed the concept of coordination. We draw a theoretical dichotomy from the early days of organisation science with rules, standards and plans providing high level of structure versus relying on direct supervision and mutual adjustment providing means for rich communication. This communication vs. structure coordination grid was then related to the concepts of equivocality and uncertainty. Making use of our theoretical grid we also identified four coordination strategies and their ICT support.

This grid, even though being very simple, adds our understanding on ICT's role in coordination: Our study supports Kumar and Van Dissel (1996) argument about the correlation between network strategy and IT: Today, the network strategies of the companies, revealed in established network arrangements, determine the desired combination of ICT support for coordination. This was apparent in our empirical finding that the focal companies had, based on their contrasting network structures, developed highly sophisticated ICT systems, which provided appropriate type of support for the coordination of their current global operations. Thus ICT cannot be considered as a separate coordination mechanisms but is highly related to the strategies and structures of the organisation.

Another special character of the grid is the classification of coordination mechanisms: instead of grouping the coordination mechanisms to those that reduce the need for information processing, and to those that increase the capacity to process information (as in Galbraith's framework) we prefer to group the coordination mechanisms based on their support for communication and support for structured tasks and processes. This categorisation seems more fruitful in describing coordination of organisational activities in today's knowledge economy where the amounts, as well as the sources of knowledge are huge and increasing. The strategy to reduce the need for information processing is seldom valid. Instead, by characterising the mechanisms with their ability to support communicative or structured coordination, we can

better recognise that equivocality and uncertainty require differing characteristics from the coordination mechanisms.

Based on our analysis we can draw a theoretical conclusion that there seems to be a relationship between the type of complexity (uncertainty, equivocality), the network type (pooled, sequential, reciprocal) and the ICT functionalities adopted (pooled IS, supply chain IOS, Networked). There is no one right combination of ICT functionalities for all business networks, but it is always dependent on the level of complexity dimensions and the network structure.

There are many issues in this chapter that would be worth of more in depth examination. For instance, in our study, the ICT systems and functionalities were positioned in the framework on the basis of subjective assessments of the informants and the researchers. One issue calling for more precise examination is the recognition of functionalities of the ICT system: A tool providing a clever combination of several functionalities may provide better support for coordination that these functionalities separately. Thus, if we in our analysis divide the whole into parts (functionalities) we perhaps loose some essential aspects of the ICT system, such as relative importance of the functions and their co-existence.

Moreover, in order to improve framework's usability, especially in cross study comparisons, explicit measures for levels of pre-definition and richness communication would be valuable. In this task the vast literature on media richness theory (e.g. Ngwenyama & Lee, 1997) and media synchronity theory (e.g. Dennis et al., 2008) provides a good starting point.

PART II: COORDINATION OF COMPLEX OPERATIONS -ORCHESTRATION OF EMERGING COLLABORATIVE BUSINESS

6 RESEARCH DESIGN OF PART II

Part II of this thesis includes empirical data and the insight collected during an action research study in a consortium of companies, researchers, and research funders. The aim was to look into possibilities for creating a business network which offers joint ICT-supported business-to-business service. The researchers' role in the consortium was to aid the process in communicating the needs and intentions of the parties to each other, and to help in forming an acceptable joint operation model. This chapter describes the background and the context of this study and the research design in a more detail. It starts with the description of the strategic intentions of the companies and the researchers. This is followed by research design and data collection.

6.1 Strategic intentions

It was company M that made the first move towards negotiations for establishing this consortium. FIGURE 40 below is our interpretation of the changes of Company M on its way to the present situation. The figure depicts the changes in M's core competence, mode of co-operation and business network topology alongside the evolution of its IS-architecture as they have emerged to support this evolution. The change in the core competence can be divided in the three major eras during the last two decades. In the beginning Company M sold, manufactured, and delivered capital (b-to-b) goods as components under the supervision of customer representatives (i.e., project consultants) around the world. Automation and IT companies separately supplied the computerised information systems, which were needed to operate, diagnose and maintain production and processes on customers' sites.

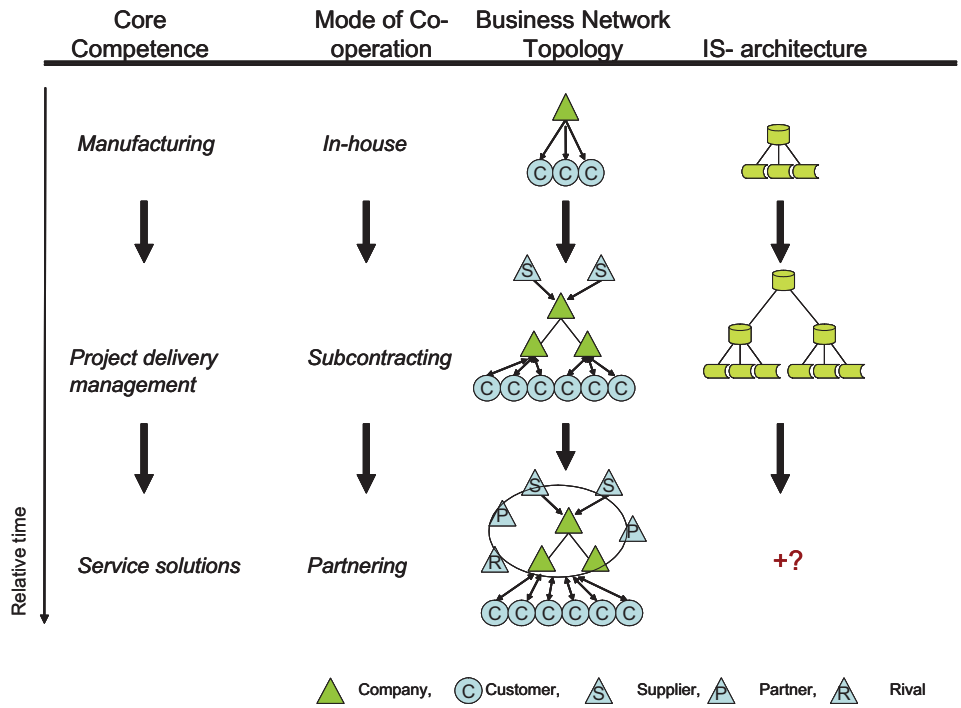

FIGURE 40 Evolution of core competences, mode of co-operation, business network topology and IS-architecture of Company M

The shift from production towards customer orientation started with delivery project management. As the degree of integration of the separate components grew at the customers end, it became feasible and necessary to coordinate the delivery and design stages of the individual components more closely with partners before and during the delivery. This means that the final equipment, including automation and supporting ICT systems, were supplied to customers in close co-operation with subcontractors. Company M took the role of a coordinator in the delivery project. The extreme cases were turnkey projects where the company took the main contractor role for the whole project with all components including automation and ICT systems configuration. The industrial and technical evolution (especially the growth of complexity) has thus changed the core competence of the industry from manufacturing to project delivery management.

The next step in the evolution of Company M's core competence was stated in its business strategy: it was expected to move towards customer oriented service. The final outcome of this development might mean that operation and maintenance of the customers' equipment are outsourced to an alliance of Company M with its partners. There were requirements to increase profitability and meet the tighter quality standards set out by the customers' clients, and environmental restrictions by the authorities. The possibilities

emerged along with the advances in ICT, remote diagnostics, control and coordination systems; as well as the constant pressure to cut costs.

This development has had implications for the information systems of Company M. In the early stages the ICT-architecture was rather simple (in relative terms): functional application software, the purpose of which was primarily to coordinate the intra-company product design, and planning of production. In the second stage the architecture was enhanced with distributed work support and document management, especially in terms of creating a knowledge database on the installed machines around the world. The last phase would require a lot of synchronisation with clients, partners, and even from competitors information systems, to meet the needs of profitable, high-quality service offerings.

There were initially several potential partners to the network, but the ones that remained through the end were companies B and C. Company B, a software house, had been moving towards more customer centric strategy. Until the time of the study it had acquired the needed additional industry specific knowledge primarily by company acquisitions. Company C primarily searched new markets for their value-added infrastructure services, both by expanding the existing clientele and by providing new services to and with the companies of the network. The company shared some of the clientele, and are partially competitors in some product groups.

In summary, in order to carry on with the espoused strategies, all three companies were likely to need capabilities, knowledge and innovations from outside their own competence. This development was paced by the growing tendency of the clients to outsource parts of their business, and on the increasing use of networks for creating, storing and accessing knowledge to share and appropriate information that could not be produced internally. As stated by Powell (1990, p. 316):"*By enchancing the spread of information, they sustain the conditions for further innovation by bringing together different logics and novel combinations of information.*" In worldwide business, it also meant expansion of the network so that there were local companies working together with global companies.

The aim of the research consortium was to study what kind of products and services the companies could offer jointly for their customers, and what kind of organisation this would mean from the point of e.g. financing, structures, ICT, and customer relationship management. The partners acknowledged the riskiness of the project, put in words by one of them when we discussed the strategic aims of the business network initiative: "*Here we have the safe possibility to learn from experiences of failures*"[74]

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74 Source: Workshop, 27.1.2003.

6.1.1 Strategic intentions of the research and the formation of consortium

Where as the companies aimed at defining both processes and the product of more in-depth co-operation, we researchers described our stand as dualistic: on one hand we acted as the facilitators of practical setting up of the network and its business concept, and on the other hand we had theoretical interest on studying how co-operation in business networks is developed, especially how the net of separate independent companies is created, coordinated and how it can be supported with ICT.

FIGURE 41 below pictures the consortium formation. It included several members from companies and a researcher group from a university. In addition a local business incubator company took actively part in the consortium activities. Also, a representative of national funding agency for technology and innovation was monitoring the work of the consortium.

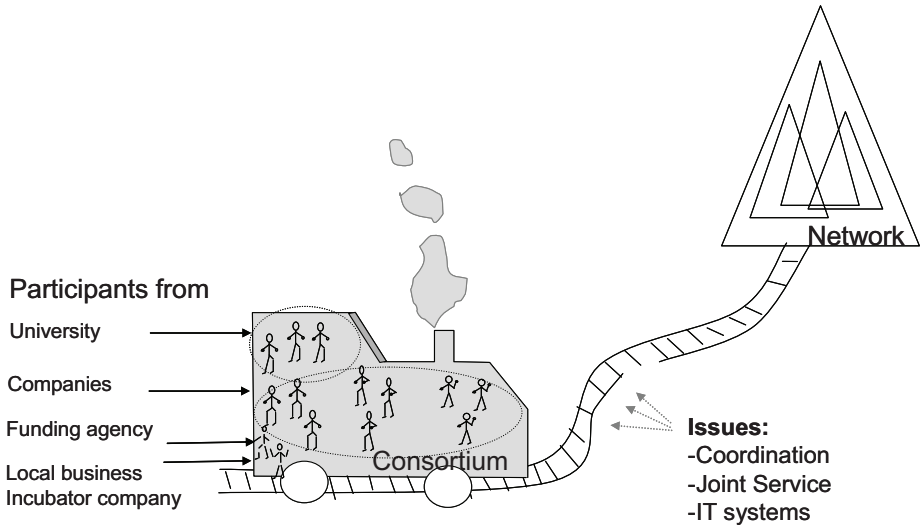

FIGURE 41 The research team formation

The researchers worked as a team, making all the decisions over the issues to be studied, methodologies and data collection methods together with the practitioners. My own research interests focused on coordination of complex operations. Previously I studied the phenomenon in the contexts of a network consisting of several business units of a corporation, and a network of subcontractors. In this research project I had the opportunity to continue the line of study, but now advancing to a context of a collaborative business network consisting of independent companies aiming at higher level of collaboration (see also Appendix A).

The objective of my research in Part II was to increase the understanding on coordination in business networks both in practice and in theory. The main concern was related to the generation of new concepts and development of

theoretical models, instead of confirmation of existing theory. Relying on abduction this research project aimed at "*fruitful cross-fertilisation where new combinations are developed through a mixture of established theoretical models and new concepts derived from the confrontation with reality*" (Dubois & Gadde, 2002 p. 559). As suggested by pragmatist abduction, the researchers, by constantly going back and forth from one type of research activity to another and between empirical observations and theory, are able to expand the understanding of both theory and empirical phenomena (Dubois & Gadde, 2002). Abductive reasoning has especially recently been applied in Scandinavian IS research concerning coordination and network relationships (e.g. Lakemond, Berggren & van Weele, 2006; Salo, 2006; Fredriksson, 2006; Niemelä, 2003).

6.2 Action Research Design

Action research, building on pragmatist philosophy (Baskerville & Myers, 2004), is an established research method in social sciences, and has lately also increased in importance in IS research (Lau 1997; see e.g. a special issue on action research in MIS Quarterly 28(3), 2004).

Susman and Evered (1978) contend that action research is future oriented, collaborative, involves change, generates theory grounded in action, and is situational (Reason & Torbert, 2001). It provides an avenue to improve the practical relevance of IS research (Baskerville & Myers, 2004). Whereas researchers relying on other research methods seek to study organisational phenomena but not to change them, the action researcher is simultaneously studying the phenomenon and creating organisational change (Baskerville & Myers, 2004). Often action research has the four major characteristics (Baskerville, 1999, p. 6):

1. Action research aims at increased understanding of certain phenomenon or social situation, with emphasis on its complex and multivariate nature.
2. Action research simultaneously assists in practical problem solving and expands scientific knowledge.
3. Action research is performed collaboratively and enhances the competences of the respective actors.
4. Action research is primarily applicable for the understanding of change processes in social contexts.

Baskerville and Wood-Harper (1996) note that action research is one of the few valid research approaches that researchers can legitimately employ to study new or changed methodologies and coordination of activities. Here we have a new situation, introduction of the networked co-operation. We cannot study new techniques or coordination mechanisms without intervening in some way in the 'real world' of the practitioners. Since, action research builds on the idea of intervention, we consider it as a valid research approach for the Part II.

Action research refers to several forms of research approaches (Reason, 1994). For instance, Baskerville and Wood-Harper (1998) recognise action research streams within IS discipline. One influential stream evolves from work by Argyris and Schön (1978) and another arises from soft systems methodology by Checkland (1981, 2000), where systems science and action research are combined together. Both seem to build on pragmatism: Argyris and Schön (1996) state that in fundamental sense their view on organisational inquiry originates from Dewey, one of the originators of pragmatism. Similarly, even though Checkland himself does not directly refer to pragmatism, his views are found very close to the views of Peirce (Barton, 1999).

Our approach resembles Soft systems methodology by Checkland (Checkland & Scholes, 1990; Winter & Checkland, 2000) a great deal. In the following picture (FIGURE 42) our research process is depicted with the help of the process model presented by Checkland and Scholes (1990). It is a two-stream, iterative process: The cultural analysis -stream consists of analysis of the intervention, of the social system and of the political system. The logic stream, in turn, consists of the comparison between relevant systems, models and the situation. This is followed by determination of changes and actions.

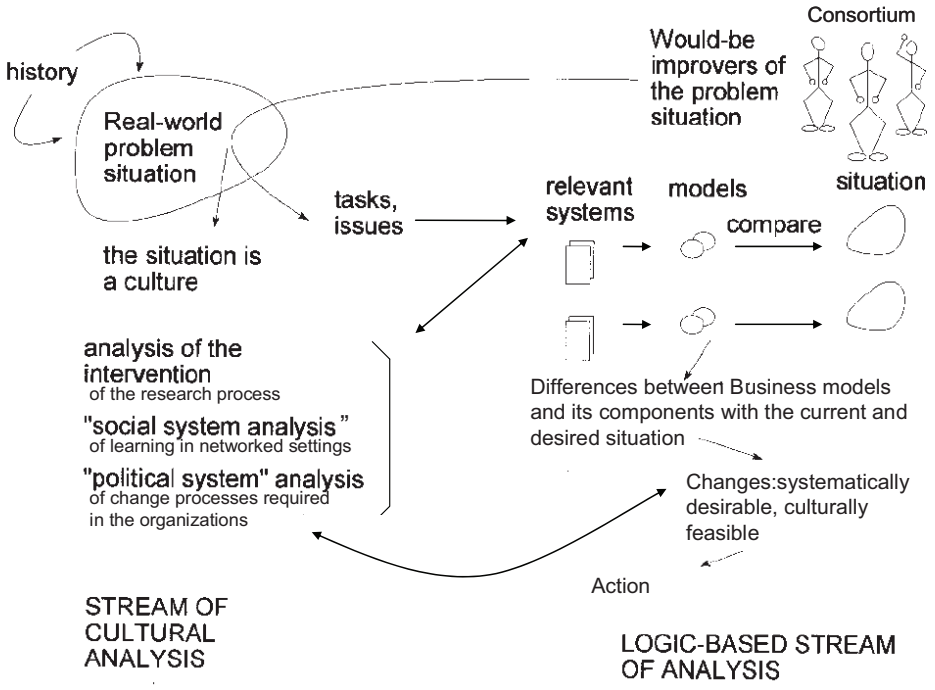

FIGURE 42 Research process of Part II (Checkland & Scholes, 1990)

Our research was carried out by a consortium consisting of practitioners and researchers. The problem was to find ways to establish a business network

where independent companies would work closely together with the goal of providing global customer-oriented service. The business model issues were analysed with a logic-based approach. Various models, their pros and cons were discussed within the consortium. The aim was to use these models to construct and agree on a model for the future joint business model.

At the same time the research team conducted cultural analysis of the co-operation. We studied the process of joint learning and information sharing within the network. We also analysed the change processes needed within the network and inside the organisations if the joint network was to be politically acceptable. And, thirdly, we analysed the process of the research collaboration in the consortium. These analyses form the chapters of Part II.

In FIGURE 43 the research process is depicted with more concrete terms.

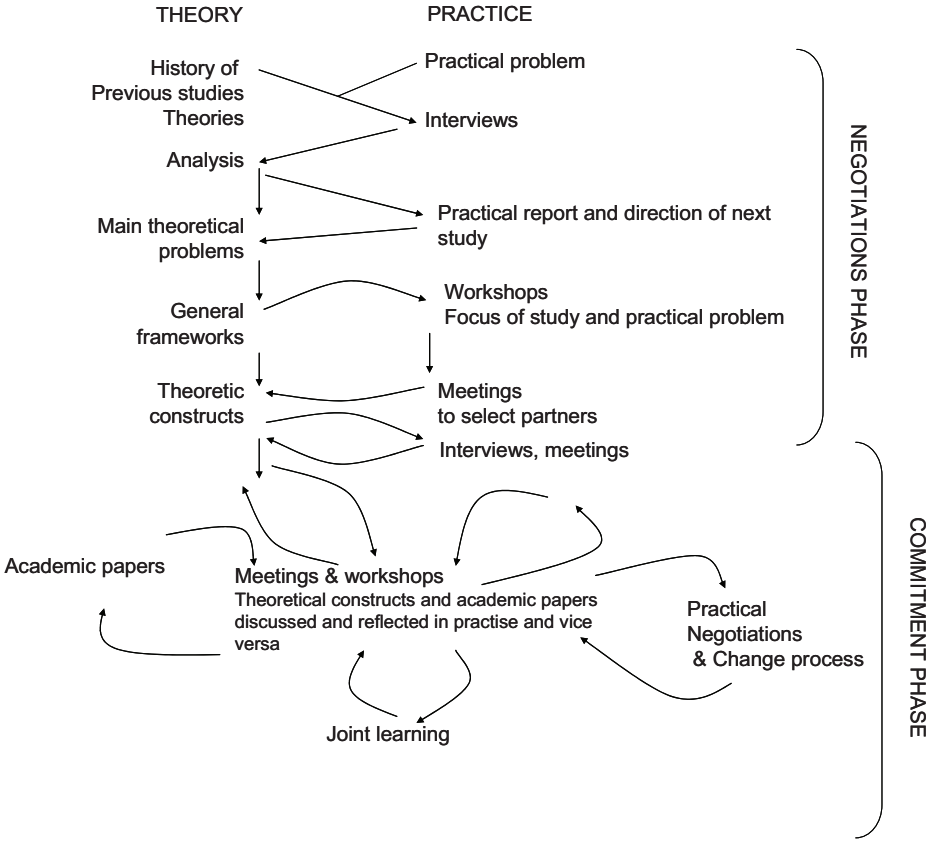

FIGURE 43 Research activities in Part II

The starting point was a practical problem. Since our research process was based on abduction and action research, problem identification initiated an iterative process where theory was matched with findings and insights from the real life. The data was gathered mainly by interviews, workshops and meetings (see also Appendix B). The aim of this iterative process was to understand an

evolving phenomenon and to develop new theories. The process included two phases: negotiations and commitment phases, which are next described in more detail.

6.2.1 Negotiations phase

We approached the practical problem by combining the previous contextual and scientific knowledge we had on the topic into an initial framework for conducting several interviews. This empirical information was analysed and a suggestion for the general direction of the future cooperation and study was presented to the companies involved. At this point also the practical problem was redefined and first versions of theoretical research questions were formulated.

The research continued with workshops and meetings between practitioners and researchers. In these workshops the aim was to co-operatively reach an in-depth understanding on the practical problem. After this period the companies agreed on who should continue in the process. The very first task in the formation of a network concerned communication and understanding the ambitions of the potential parties and selection of 'right' or suitable combination of capabilities and resources. During the first months totally 11 parties took part in negotiations (FIGURE 44).

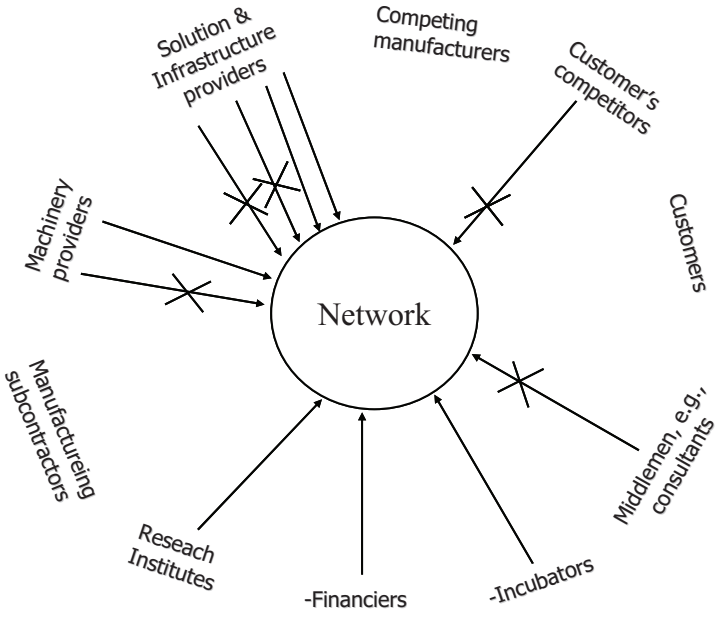

FIGURE 44 Companies participating in the negotiation phase

All potential partners had to make their own decisions as to whether or not to engage in the network, and then to decide which business units should be involved. In this first phase one company decided to drop out due to financial reasons: It was motivated to join the network, but estimated that it did not have enough resources to take part in such an endeavour. One dropped out since the aim of the network did not motivate them enough. A third company was dropped out, because it was regarded as too strong competitor to the rest of the partners. Also the fourth drop out was due to competitive reasons and finally the customers were closed out from the consortium, since the companies feared that their participation might have directed the effort too much towards their special needs. After this round the size of the consortium was settled to 3 companies, added with researchers and a local business incubator company. A research funding institute (Tekes, the Finnish Funding Agency for Technology and Innovation) participated in the funding of the research work. Companies were represented by senior managers backed up with expert teams.

6.2.2 Commitment phase

When strategic intentions were aligned to a sufficient degree, the network started discussions over the joint business. The co-operation intensified remarkably. Face-to-face meetings and workshops remained as the main means of collaboration. In these sessions both researchers and the practitioners presented their thoughts, frameworks and theories in an aim to reach an increased understanding on each others views, and on the potential solution for the practical problem. At the same time, the theoretical constructs initiated from the previous literature were presented and modified to reflect the findings and insights from the practice. These activities were accompanied in the practical side with business negotiations and change management activities, and in theoretical side with preparing and presentation of academic papers.

Finally, the network was to come up with a first proposal of a jointly defined business model. This proposal of business model served then as a basis for the companies to evaluate the efficiency and equity of the deal proposed. In our case the negotiations were ended at this point, thus we did not finalise the business model nor did we continue to the executions phase.

6.3 Data collection

For this study the empirical data and insight came from meetings, workshops and interviews. These were added with phone meetings and e-mail discussions. The data (in TABLE 9) was documented mainly in memos. Interview sessions were recorded and transcribed, and were also checked by the interviewees.

TABLE 9 Data for Part II

	Year	02	03	04	08	Total
Data collection method	Meetings	7	363	20		63
	Workshops	1	4	5		10
	Interview sessions	18	5	18	1	42
	Other		1	2		3
	Total	26	46	45	1	118
Documentation method	Memos	11	76	47		134
	Audiotapes	18	5	11	1	35
	Transcripts	18	5	8	1	32

The interview data includes 42 in-depth interview sessions each taking about 2 hours (FIGURE 45 shows the number and company of the interviewees). The main focus of interviews carried out in 2002 was global service needs of M. Later interviews concerned the participating companies' views on networked business models. We also intervieved one representative of a partner company, as well as several customer representatives.

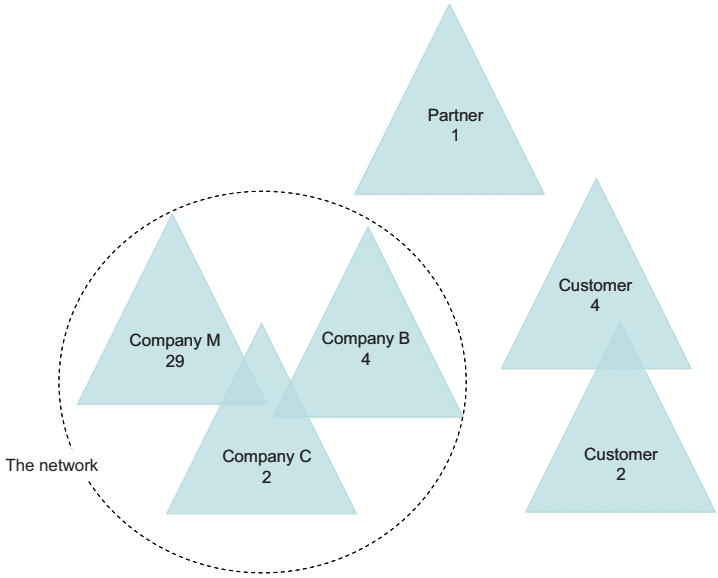

FIGURE 45 Interviewees of Part II

We had altogether 10 several hours' long workshops with the companies (in TABLE 10). In total the process took considerable time and effort from the companies (see

FIGURE 46). Based on our records the parties spent more than 560 hours in negotiating and 1060 hours in commitment activities related to network generation. In total this amounts to more than 1600 hours in joint activities, such as joint workshops, face-to-face discussions and meetings. The figures do not include any internal meetings of the companies, nor preparations or travelling to the consortium meetings. One can thus assume the actual amount of hours spent to be easily in excess of these figures, for instance using the 80:20 rule, as much as 8000 hours (approx. 4,5 man years).

TABLE 10 Workshops in Part II

	Participants		*Duration*	*Man-hours*
Workshops	***People***	***Organisations***	***Hours***	***Total***
30.10.2002	11	6	2	22
27.1.2003	16	8	3	48
18.2.2003	12	6	3	36
19.3.2003	12	7	2,5	30
12.12.2003	13	6	9,5	123,5
19.3.2004	9	5	4	36
20.4.2004	8	6	4	32
24.5.2004	12	6	6,5	78
9.6.2004	14	7	11	128
6.9.2004	9	5	10	90
SUM			55,5	623,5

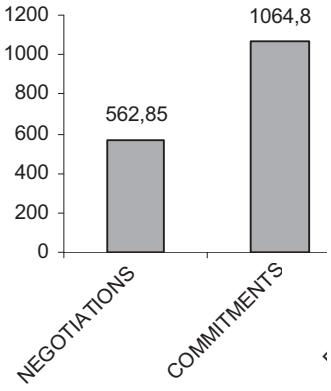

FIGURE 46 Man hours spent in negotiation and commitment phases

6.4 Analysis and limitations of the research method

In abductive action research, literature plays quite a special role: *"The researcher's objective is to discover new things – other variables and other relationships. Even during this process, the researcher must consider phenomena in the light of a theoretical framework. The researcher should not be unnecessarily constrained by having to adhere to previously developed theory. Theory is important, but it is developed over time."* (Dubois & Gadde, 2002, 559)

The challenge in abductive action research is that the researchers collect vast amount of information. The research issue is redirected several times during the process. Thus, the researcher ends up with piles of documented data. Although these pieces of raw data were important for the learning of the researchers, they can obscure the reader's understanding. Furthermore, in this thesis we can not present the empirical data as such due to confidentiality reasons: we had to respect the privacy of the participants as well as confidentiality of the business plans of the companies. For the above reasons we rarely have direct references to empirical data in our text.

Action research is among the more qualitative and interpretative approaches. The close involvement is good for in-depth access to issues and data. It enables participation in action, rather than merely accessing opinions as is in the case in an interview-only study (Walsham, 2006).

However, there are some limitations and problems. In action research the researcher may become socialised to the views of the people in the field and loses the benefit of a fresh outlook of the situation (Walsham, 2006). Furthermore, since action research is often financed by the clients, both ethical and professional problems often arise. For example, Baskerville (1999) reminds, that practitioners may be expecting consulting-type of performance if the researchers don't explain their research orientation clearly (Baskerville, 1999). In this research project the consortium was created after writing a research plan. Founding on this plan, the research was funded jointly by the business companies, the business incubator company and Tekes (Finnish funding agency for technology and innovation). A contract was signed by the members stating among others the publicity of the results and obligations of the research project to develop general knowledge about related theories.

Without doubt, action research is very context-bound making generalisations difficult. Despite these problems, action research is seen to respond the needs for relevance in information systems and management research (Baskerville, 1999). Here it is used in an attempt to understand and to model coordination of collaborative operations in business networks.

7 TRUSTING NETWORKS - AN INTRODUCTION TO COORDINATION IN NETWORKS

In this conceptual chapter we characterise business networks and their coordination mechanism found in the literature. We look into the coordination of emerging collaborative business network, rather than on restructuring processes within single organisation or within a supplier chain (e.g. Hammer, 1990). We describe the phases of collaborative network development, where the point is to show the criteria which the coordination of networks is based on. We continue by depicting how these criteria can be evaluated and agreed on in the negotiations over joint business model.

7.1 Rationale of Networks

Ultimately, the motivation for organisations to join a network is the attainment of goals that are unachievable by the organisations independently (as postulated by van de Ven, 1976). The firms may enter alliances in order to gain fast access to new technologies or new markets, or they may try to shape competition, or gain legitimacy (Powell, 1990; Nielsen, 2002). Business networks are considered especially useful for the exchange of qualities or commodities whose value is difficult to evaluate, like know-how, technological capability, a particular method or style of production, or a spirit of innovation and experimentation (Powell, 1990). This is further leveraged due to technological complexity of new innovations (Hagedoorn and Duysters, 2002). The above implies that knowledge-related capabilities are of central concern in the formation of networks.

Traditionally the firms approach collaboration from an exploitation view; they seek additional knowledge from other companies operating in similar or the same domain. The aim is to find matching knowledge-related capabilities that can be transferred, incorporated and appropriated in the assimilating firm

(Nielsen, 2002; March, 1991). In this view, it is crucial that there is some similarity between the co-operating firms, for instance similarity of goals, services, staff skills, and clients (van de Ven, 1976), so that they can absorb the innovation within a reasonable timeframe (Cohen & Levinthal, 1990). This timeframe can be further shortened by improving the absorptive capacity within a firm by accumulating capacity in particular areas (ibid., p. 136).

An alternative motivation to form a business network may be to explore an external problem or opportunity in the overlapping domains of organisations (van de Ven, 1976). In such cases the need emerges out of awareness, for example, of changing need priorities, resource distribution channels, or power relationships in the environment (van de Ven, 1976). This explorative view challenges the traditional exploitative view especially in knowledge intensive environments (Nielsen, 2002; March, 1991). Whereas the traditional exploitative view is concerned with increasing productivity through standardisation, systematic cost reduction, and incremental improvement of existing technologies, skills and capabilities, exploration, in turn, is about finding new opportunities for wealth creation through building new capabilities and innovation. Nielsen (2002) pictures explorative networks as networks where new knowledge can be created among the participants as a synergy (and not simply the sum). We would expect these networks to be more stable: they aim at achieving long-term goals, for example, by forming longer-lasting relationships (Hoogeweegen et al., 1999). However, as these explorative networks are concerned with new, innovative matters, they are facing more complexity in their tasks and outcomes. In line with real-life observations of business process re-engineering projects, many risky explorative networks may fail in achieving their objectives and break up after only a short trial period (see e.g. Sivadas & Dwyer, 2000).

7.2 What are networks?

In literature the terms business network, business net, strategic net and value net generally refer to intentionally formed nets where an actor can, at least to a reasonable extent, influence and control the behaviour of others in a business network (Svahn, 2004). The value activities carried out by differing economic players are linked to each other through different flows such as material, information, financial resources and relationships (Parolini, 1999). It is also acknowledged that the same actor can participate in several business networks.
Managers often perceive management of supply network as a phenomenon driven by the development of ICT (Håkansson & Persson, 2004), where the efficiency of sequential dependencies between the companies is the major driver for economies. On the other hand, when innovation and agility is pursued, they aim for solutions supporting collaboration and learning in the reciprocal interdependencies (Håkansson & Persson, 2004).

The difference of business networks to supply chains, industries and dyads is illustrated by Delporte-Vermeiren (2003) with an example of a business network, involving a large number of actors (e.g. A1, B1, C1) contributing to the filling of several customer orders (FIGURE 47). The starting point for the formation of the business network is actual customer demand. Members of one particular network are the actors working together to fill several orders for the same customers. In the example, the business network contains nine actors. Seven of the nine are activated and are involved in the process of filling orders 1 to 4. Actors B3 and C2 are part of the network but are not activated in the current process of filling orders 1 to 4. Two actors (A2 and B1) are involved in different supply chains to fill order 2 and order 3, respectively.

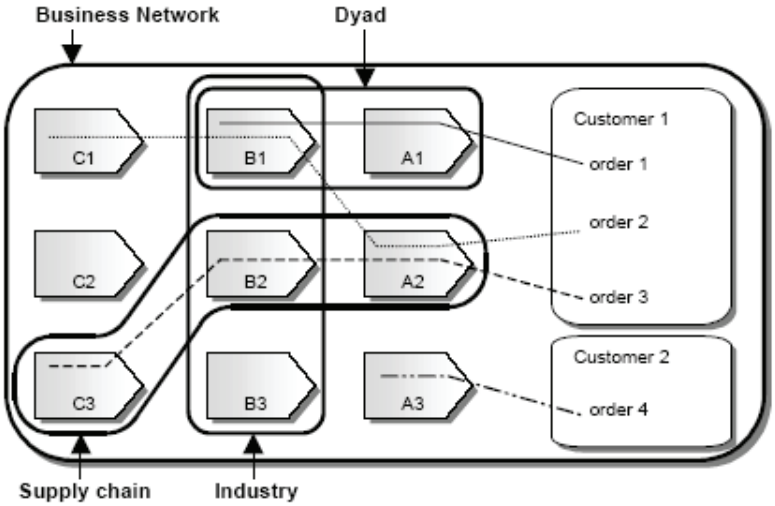

FIGURE 47 Topography of Business network vs. supply chain, dyad and industry (Delporte-Vermeiren, 2003, p. 12)

Håkansson and Ford (2002) discuss the significance of links, or threads, between the actors in the network. They point that the content of the threads is the result of investments by both of the counterparts. The greater the investments the more substantial will be the content. They see that the total network is actually formed by investments and the life of a node is the result of the interplay between internal investments and investments in the threads. The stronger the threads, i.e. the more content there is within them, the more important they will be in giving life to the node, but also in restricting the freedom of the node. This means that the actors have to make decisions over which relations they are willing to invest in and commit to.

In Part II of this thesis we focus especially on collaborative business networks which we define as

> *"a group of participating businesses that agree to cooperate in some novel, knowledge enhancing ways and to depend on each other to some extent, in an aim to reach business objectives, perceived by each participant as fair play, and sustainable over time as a network".*

With this definition we want to point out the attitude of the network towards sharing information and knowledge. The collaborative network is distinguished from mere supply chain by its emphasis on learning: The network aims at structures and ICT that support awareness, adaptiveness and capabilities to learn. These are seen as decisive features of competent and sustainable network (see e.g. Ren et al., 2008 and Kinnula, 2006) in information society.

7.3 Hierarchies, markets and networks

Powell (1990) presented a summary of key differences among markets, hierarchies and networks. His claim was that networks cannot be regarded as just a combination of markets and hierarchies measured in a continuum with discrete market transaction located at one end and the highly centralised firm at the other. He finds intermediate notion as overly static, and not particularly helpful in explaining many forms of collaboration.

According to Powell (1990) networks are 'lighter on their feet' than hierarchies. In networks, transactions occur neither through discrete exchanges nor administrative fiat, but through networks of independent parties engaged in reciprocal, preferential, mutually supportive actions. Also the relationships between units take considerable effort to establish and sustain constraining partner's ability to adapt to changing circumstances. As networks evolve, it becomes more economically sensible to exercise voice rather than exit. (Powell, 1990).

Trust is claimed to be the generic coordination mechanisms in networks (Adler, 2001; Powell, 1990; Lorenzoni and Baden-Fuller, 1995; Ring & van de Ven, 1994; Kautonen & Kohtamäki, 2006). Adler (2001) distinguishes three sources of trust: calculative form of trust via a sober assessment of the costs and benefits, familiarity through repeated interaction, and values and norms that engender trustworthy behaviour. He also distinguished three mechanisms by which trust is generated: by direct interpersonal contact, by reputation through a network of other trusted parties, or by our understanding of the way institutions shape the other actor's values and behaviour. Specifically in the context of networks Ruuskanen (2003) talks about systemic trust where an actor considering participating in the networks must be convinced that the network's co-operation model is possible and sensible. The mechanisms are primarily complements rather than substitutes: They tend to build on each other. However, a willingness to rely on trust in dealing with partners is a more probabilistic decision than a simple act of faith; that is, it involves judgments on the reliability of both people and organisations, and that such judgments are subjected to continuous updating in the course of the collaborative endeavour

(Mayer, Davis, Schoorman, 1995; Ariño, de la Torre & Ring, 2001; Zolin et al., 2004; Jarvenpaa, Knoll & Leider, 1998; Berki, Isomäki & Salminen, 2007). Also Kumar, van Dissel & Bielli, (1998) conclude that trust-related concepts (responsibly, benevolence, fair play and altruism) supplement the previous theoretical perspectives in IS literature. In this perspective called 'trust-based rationalism' trust, social capital and collaborative relationships form the key concepts.

Compared to pure hierarchy and market mechanisms, social coordination mechanisms such as trust is claimed to make an enlarged scope of knowledge generation and sharing possible.

> *"Trust can dramatically reduce both transaction costs – replacing contracts with handshakes – and agency risks – replacing the fear of shirking and misrepresentation with mutual confidence… Also, insofar as knowledge takes a tacit form, trust is an essential precondition for effective knowledge transfer. Therefore, as knowledge management becomes an increasingly important performance determinant, I hypothesize that trust becomes an increasingly attractive mechanism to economic agents". (Adler, 2001 p. 219-220)*

Also according to Powell (1990) and Ring and van de Ven (1994) trust, defined as confidence in another's goodwill' (Ring & van de Ven, 1992), reduces complexity more quickly and economically than authority or bargaining. Möller et al. (2005) point out in their article on strategic business nets, that if the net is aiming to become more than traditional supplier net, it needs to have the ability to create trusting relationships and to identify the roles, capabilities and goals of other important actors, and to modify one's strategy to match the network situation.

It should be remembered, though, that all the three theoretical coordination mechanisms – prices, authority and trust – are ideal types; in reality coordination is achieved with a combination of hierarchical, market and social coordination mechanisms (FIGURE 48) (Grandori, 1997; Kohtamäki, Vesalainen, Varamäki & Vuorinen, 2006). For example, Grandori and Soda (1995) reviewed the literature on coordination mechanisms in network research and find that many of the basic mechanisms applied within hierarchy (Galbraith, 1977) were also adjusted to network settings, such as routines, rules and procedures; inter-firm authorities (e.g. clusters of local firms accepting the leadership of a central firm) and third parties. In hierarchy the fundamental mechanism of coordination involves close personal surveillance and direction of subordinates by superiors. The information necessary for task completion is contained in rules; these may be rules concerning processes to be completed or rules which specify standards of output or quality (Ouchi, 1979). Information systems can act as a control mechanism to monitor the partners: they can ensure greater predictability, efficiency or calculability of performance (Gallivan & Depledge, 2003). In networks, a firm's control over the purchasing volumes allocated to each of its suppliers, and the target costing process can also be used as a form of authority (Kohtamäki & Kautonen, 2008; Kulmala, 2003; Kulmala et

al., 2002). Furthermore, level of details in contracts and contractual sanctions illustrate the use of hierarchical mechanisms (Kohtamäki & Kautonen, 2008).

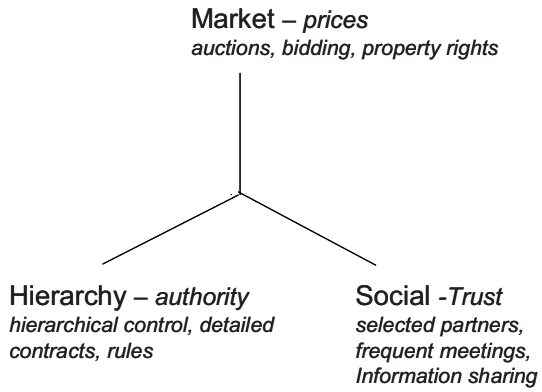

FIGURE 48 Three generic coordination mechanisms

On the hand, also internal competition is sometimes applied within networks (Holland & Lockett, 1997; Mitronen & Möller, 2003), for instance by using e-auctions and property rights (Grandori & Soda, 1995). Frequency of bidding, number of competitors, supplier switching time and the supplier's position in comparison to competitors reflect the use of price mechanisms in network setting (Kohtamäki & Kautonen, 2008).

Social coordination mechanisms build on social norms, social control and carefully selecting partners on the basis of some predictors of future cooperation behaviour (Grandori & Soda, 1995). The routinisation of know-how, accepted rules of fair behaviour and shared values act as objective-aligning mechanisms (Grandori, 1997). Frequency and nature of meetings and contacts, personal chemistry and quality of social relationships characterise the social governance in networks (Kohtamäki & Kautonen, 2008). Similarly coordination through intense processes of information exchange and problem solving characterise social coordination (Grandori, 1997). Group problem solving and co-operation is often supported by committees, task forces, user groups and consultation (Grandori & Soda, 1995; Mitronen & Möller, 2003). Group support systems and other ICT can help to share knowledge, disseminate values and reinforce sense of shared mission between firms (Gallivan & Depledge, 2003).

To sum up, there are several types of coordination mechanisms applicable also for networks and the task of the network partners is to recognise, adopt and update the suitable ones for their situation. Ideally, we should find a balanced combination of coordination mechanisms, where the positive contribution of each mechanism is maximised, while their negative effects are minimised. According to Kohtamäki and Kautonen (2008) each mechanism has a different role in maximising the performance of the relationship: the role of market mechanism is to force the partner to maintain continuous development

in order to keep up with the competitors; the use of hierarchical mechanism aims to steer the partner's efforts to match the core company's requirements; and social mechanism facilitates information sharing and learning within the network allowing improved process development and, consequently, performance (Kohtamäki & Kautonen, 2008). Unfortunately, the literature is silent about how the suitable coordination mechanisms can be selected.

7.4 Coordinators and network participants

The literature is rather vague regarding to a question of who coordinates the network. For instance, Lorenzoni and Baden-Fuller (1995) claim that "*those networks that are not guided strategically by a 'center' are unable to meet the demanding challenges of today's markets*" (p. 146). They see that the role of the central firm is to create visions, manage brand images, create an atmosphere of trust and reciprocity, and to develop mechanisms for attracting and selecting partners. However, Håkansson and Ford (2002), in turn, point out the paradox related to management of a network: The more companies try to control the network and manage their relationships, the less effective and innovative will be the network. If a company acquires full control over the network, the positive effects of networked form are lost. Vervest, van Liere and Dunn (2008) write that collaborative networks "*typically do not have one single authority that regulates actor behaviour*" (2008, p. 27). Also van Heck and Vervest (2007) claim that smart networks orchestrate their operations with distributed coordination, instead of hierarchical and central coordination. Parolini (1999) simply asserts that networks can be either coordinated by one party or by multiple parties. Based on the above discussion, it seems that a network needs a core, preferably formed by several firms, which take the responsibility of orchestrating the business network. These core firms develop and share the coordination responsibility in some way and develop mechanisms to attract, select and motivate the rest of the network.

Bouwman (2003a) has recognised three levels of participants in business nets: Structural, contributing and support partners. Structural partners provide essential and non-substitutable assets to the value web. They play a direct and core role in making the customer value assumption and in creating the business model. Thus, it would be most probable that the structural partners would also be responsible for the network coordination. Rodon et al. (2005) lists four functions of these business network orchestrators: to define the objectives and designate the network partners, to define and defence the expected performance standards for business network members, to nurture and develop the physical and intellectual assets, including the competences of partner companies, and to solicit voluntary participation and to reward performance. Also, a function that concerns the management of the ICT infrastructure that supports the interactions between the members is of central concern, even

though it can be performed by any member of the network or even by a third party (Christiaanse, 2005).

Contributing partners, in turn, provide goods and/or services to meet requirements that are specific to the value web, but otherwise they play no direct role. If the assets they provide are substituted, the value assumption and the business model could still stand.

And last, support partners provide generic goods and services to the network, without which the value web would not be viable, but which otherwise could be used in connection with a wide variety of value assumptions and business models.

Our suggestion is that networks could be depicted as having several layers in respect to intensity of the relationships, collaboration and commitment to cooperation. We illustrate this with FIGURE 49, where the focus of the network is to provide value to the customers (in the centre). The collaborative network consists of structural partner companies (inter rim, in the FIGURE 49), added with long term subcontractors, and with dynamic pool of local or case-dependent suppliers (outer rim).

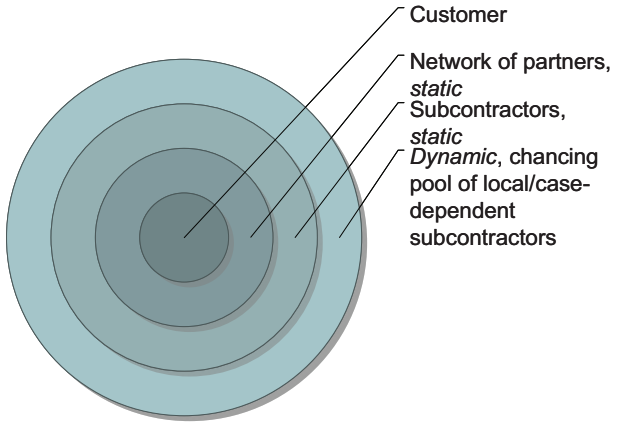

FIGURE 49 An example of intensity layers of an imaginary business network

This would mean that the core companies create the business model and coordinate the network operations. The subcontractors of the next level are carefully selected (following the move to the middle hypothesis by Clemons et al., 1993) and long term contracts are valued. The outer rim is formed by a dynamic pool of subcontractors, from which support partners are picked up to fulfil specific needs of the current project or case and where more arms-length market mechanisms are expected to be applied.

Next, let's have a closer look on the creation of the network and the business modelling process.

7.5 Business model: a conceptual device for collaborative network coordination

Previous literature has mainly focused on networks as given contexts for the organisations within them (Beugelsdijk et al., 2003). There are only few studies on the initial formation of the network or creation of the joint business (Lapiedra et al., 2004; Busquets, 2005, 2006). However, several researchers (Powell, 1990; Grandori, 1997) have pointed out that the coordination and network building is a dynamic process. Decisions over coordination are made in differing phases, and they are also adjusted during the cooperative relationship. Next we will try to describe how the process of network building is coordinated with business modelling. The reasoning builds on the work by Ring and van de Ven (1994) on developmental process of networks.

The process consists of repetitive sequence of negotiation, commitment, and execution phases, each of which is assessed in terms of efficiency and equity (FIGURE 50).

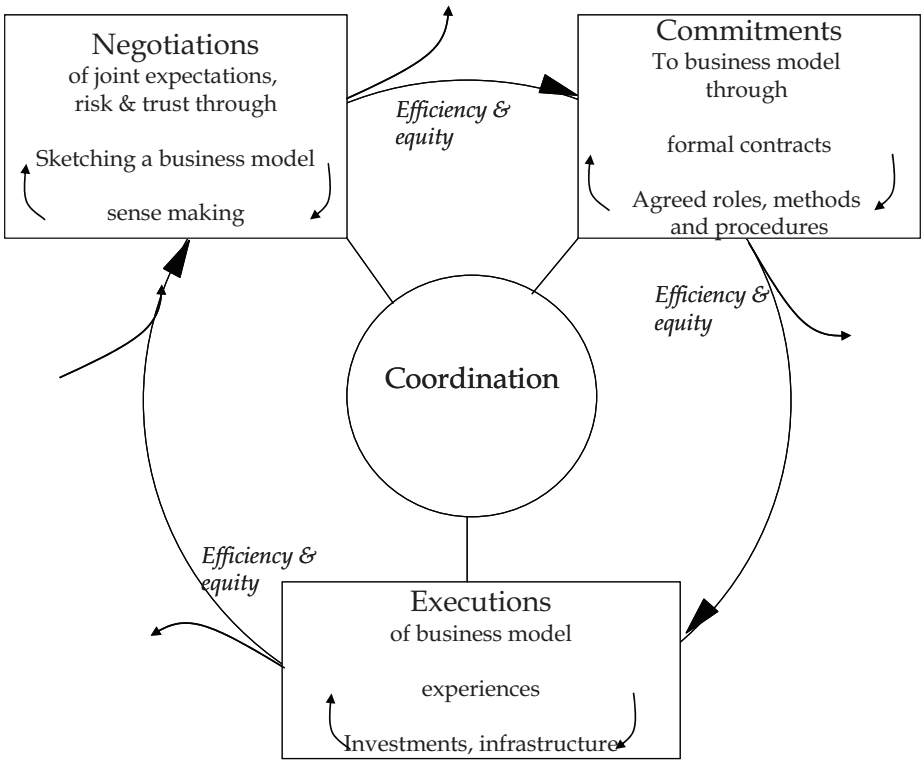

FIGURE 50 Development process of a cooperative network (inspired by Ring and Van de Ven, 1994)

Ring and van de Ven (1994) point out the importance of equity in addition to traditional efficiency as criteria for assessing cooperative networks. With equity they mean 'fair deal', which does not require that inputs or outcomes are always divided equally between the parties, but all parties receive benefits proportional to their investment (some call it experience of reasonableness, e.g. Kohtamäki et al., 2006). We find this principle of fairness to be a distinctive character of collaborative networks. The partners are allowed to question the fairness of the deal from their point of view and either continue in the network or if not satisfied, step out or renegotiate the terms of the co-operation, including coordination. That is, cooperation emerges out of mutual interests and behaviour is based on coordination that can not be decided by only one single party.

In the **negotiations phase** the parties develop *joint expectations about their motivations*, *perceived uncertainties* of a business deal that they are exploring to undertake jointly. In this phase "*parties select, approach, or avoid alternative parties"* for the network (Ring & van de Ven, 1994, p. 97). They also bargain over possible terms and procedures of a potential relationship. At the same time the parties are undergoing a sense making process (Weick, 1975; 1979), that lead otherwise independent parties to enter into negotiations with another (Ring & van de Ven, 1994). This phase of bargaining and sense making provides opportunities to assess uncertainty associated with the deal, the nature of each other's role, and other's trustworthiness, and possible efficiency and equity of the deal.

In the **commitment phase**, the wills of the parties meet when they reach an agreement on business model that clarifies "*the roles and obligations in respect to customers and products*, *sharing of costs and benefits*, *organisation and rules"* for future action in the relationship (Ring & van de Ven, 1994, p. 98). At this point coordination mechanisms for execution of the relationship are established. Also in this phase a series of interactions is needed to enable the parties to reach lawful mutual consent. Many of the details are informally agreed, but often also layers are called upon to write a legal agreement on key commitments.

In the final **execution stage**, the commitments and coordination mechanisms are carried into effect. Working together according to the business model, agreed on in the previous phases, helps to reduce uncertainty and makes interactions among parties more predictable. However, with time, changing environment, as well as misunderstandings, conflicts and changing expectations among parties are bound to arise requiring that the cycle is restarted again (Ring & van de Ven, 1994). Similarly, partners may leave and new parties may enter the network and the phases are, to some limited extent, replayed.

The above process model modified from Ring and van de Ven (1994) points out that the core parties forming a network engage in a simultaneous bargaining and sense making process where the aim is to reach a joint understanding and commitment on a business model defining major aspects of

the cooperative transaction, such as participants and their roles, financial matters, infrastructure, product / service and customer relationship.

Business networks are formed by independent companies, which all have their own strategies. In order to motivate them to take part in the network they should find a network strategy that is acceptable for the participating companies. This network strategy is in turn made explicit by business model. Each component of the business model, especially the revenue sharing and roles of each participant is considered. The new business model must therefore, in sufficient detail, describe the value created to the customer and the income generated to each participant. In addition, each partner's role in producing the output has to be clear. These aspects of the business model, financials, infrastructure, product and customer relationship are exactly the ones that should be made explicit during the negotiation process (Ring & van de Ven, 1994) in order to make possible for the potential partners to estimate the efficiency and fairness of the deal.

The process of developing a joint business model can be an esoteric exercise of intellect and imagination. In business networks the driver to the co-operation should ultimately be the customer need. This means that the procedure should start from an articulated opportunity to fulfil some customer need. However, the dirty details of the real world have to be taken into account if the business model is ever to be implemented, especially in a cost-efficient manner. This means that a business model should have the general characteristics of a good model: it should describe the ontology and means for sensitivity analysis for the designers. Moreover, the development activities should put at least equal attention to the organisational change issues. No matter how clever business model we design, it won't function if the parties involved are not committed, are not able to share information, or the business processes are not suited to co-operation.

Reflecting the above theories and our experiences in the light of soft systems methodology (Checkland & Scholes, 1990; Winter & Checkland, 2000, please have a look at FIGURE 43), we came up with a description of the business modelling procedure (FIGURE 51). It consists of two parallel processes: 1) the actual systematic analysis of business model and its components, and 2) the organisational change management process.

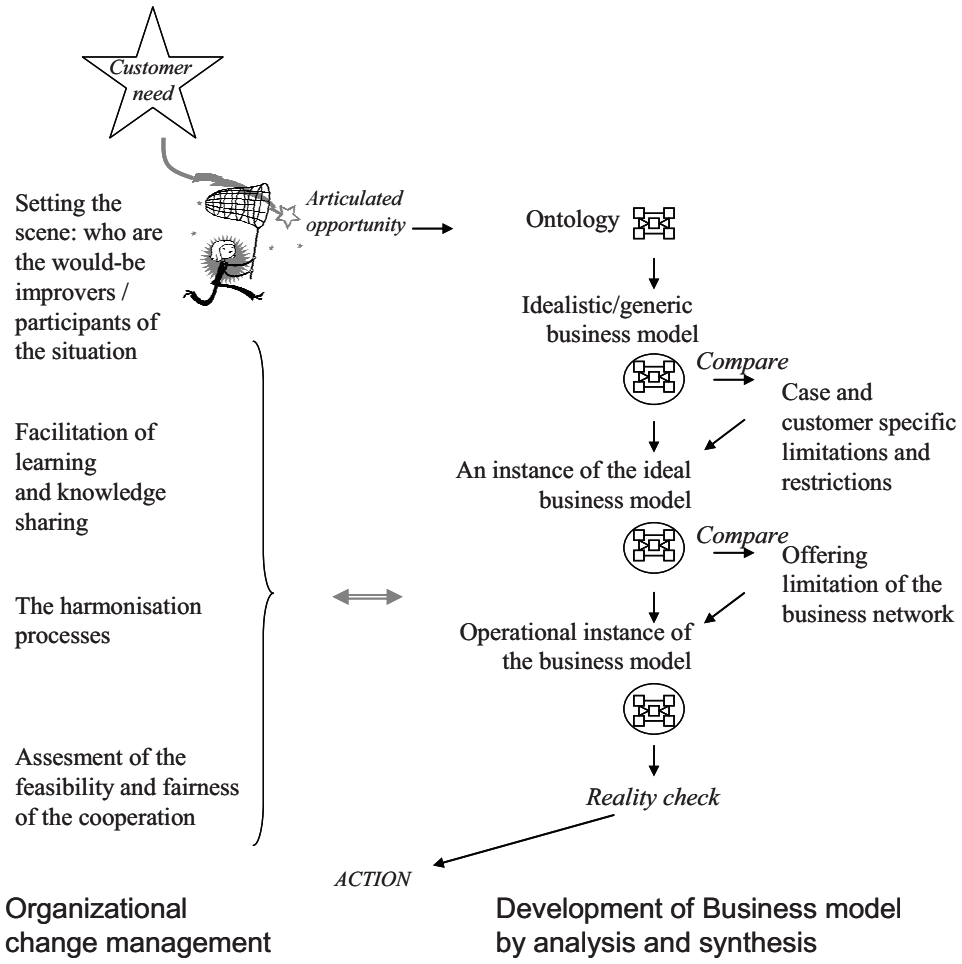

FIGURE 51 The coordination procedure of collaborative business network

The systematic analysis of business model starts from an ontology. Ontology is an explicit simplified conceptualisation of the objects, concepts, and other entities that are assumed to exist in some area of interest – in this case joint business models -and the relationships that hold among them. The ontology is used to design an idealistic or generic business model for the business network. Then, demand-side restrictions are to be recognised. These determine the instance of the ideal business model that is applicable to the specific market. The next step is to consider supply-side restrictions which may affect the possibilities for the network to offer specific products or services as planned. As a result an operational instance of the business model is designed. The last step of the analysis is the reality check of the concept: the business model should be critically analysed and feed back to the previous stages should occur

accordingly (Heikkilä, et al., 2005c). Only after passing this reality check can the collaborative network start sales negotiations with potential customers.

All this work toward realisation of joint business should be supported with a process of change management, which escorts the partners to harmonise the network strategy, and to synchronise its operations. In contrary to systematic analysis of the business model, there is no clear sequence of change management activities. Rather, they all run constantly affecting each other; perhaps only the emphasis between the activities is changed during the process. In our empirical study we recognised four activity categories:

1. First, an important task is to decide and agree who are the participants in the development process. These parties should also come up with an articulation of the opportunity that they aspire to be attained by the business network.
2. Elemental is also assessment of the feasibility and fairness of the co-operation. This is because network is sustainable only if it is seen beneficial by its participants.
3. The facilitation of learning and knowledge sharing between the partners is essential especially if innovative new ideas are wished for (we concentrate on learning aspects of networks in chapter 10).
4. Last, but not least, change management is also about the adjustments between strategy, processes and business model. These harmonisation actions are needed if separate organisations are engaged in a co-operation (harmonisation is discussed in chapter 8.)

As suggested by the FIGURE 51 the organisational change management activities interact with the systematic analysis of business models. Thus the evolving organisational state has an influence on the advancement and details of business model analysis, and vice versa.

We believe that in this process trust and coordination mechanisms are established, in forms varying from social control to information systems, and from boundary spanner roles to incentives, formal rules and market mechanisms. And the role of business model in this process is to provide a framework for the negotiations between the structural partners to cover all the key aspects of the joint business and help them to evaluate it's efficiency and fairness. This is in line with previous findings (Tomkins, 2001) that ''*the major value of contracting may lie in it being a device to set down goals and methods to enable mutual planning, rather than being primarily and ex-post control device*'' (Tomkins, 2001, p. 177). Later on, the constructed business model helps the further negotiation rounds with the contributing and supporting partners.

7.6 Discussion

In Part I of this thesis we applied Galbraith's coordination framework (1977) to describe the combination of coordination mechanisms. We discovered that it

was a useful tool in the context of traditional organisation, where the authority structure is clear and managers can choose which coordination mechanisms are the most suitable ones. The reason for coordinating actions was to react to increasing complexity and the aim was to fit information processing capabilities of the company with the complexity it was facing in its operations. That is, the aim was to keep the system stable.

In collaborative networks interaction takes place between organisations that are pursuing their own goals and acting purposefully to explore new business prospects. The partners are aware of the increasing risk and complexity related to networking. The coordinator is not determined based on authority as in Galbraith's model, but via negotiations between the core companies forming the network. The aim is to combine the capabilities and competences of several partners in a collaborative business effort. The appropriateness (or success) is measured by equity of the deal to each of the parties (see also TABLE 11).

TABLE 11 Stylised comparison of views on coordination

	Information processing view on coordination	***Collaborative network view on coordination***
Context	Within a hierarchy	Between organisations
	Cybernetic systems	Open systems
Coordinator	Manager based on authority	Agreed in negotiations
Mechanism	Hierarchical authority	Process of business modelling
Aim	Sustain balance between internal & external complexity and information processing capacity	To combine competences and knowledge (innovatively)
Metrics for success	Efficiency of the organisation	Efficiency and fairness of the deal to each partner

Against this backdrop, we propose an alternative device for coordination: business model process. The focal companies should explicitly formulate a business model for the network which defines not only the customer value and how it is to be provided, but also acts as a conceptual device that guides the selection of coordination mechanisms.

The reasoning for considering the business model as a coordination framework for business networks derives from the proposition that trust is the principal coordination mechanism in networks. We advocate that the three sources of trust (values and norms that engender trustworthy behaviour; assessment of the costs and benefits; familiarity through repeated interaction, Adler, 2001) are engendered in the process of business modelling. In addition, the model sets jointly agreed basis for a balanced set of coordination mechanisms for execution phase:

1. As Osterwalder (2004) points out, business models help to capture, visualise, understand, communicate and share the business logic in coordinated manner. The business model acts as a dynamic boundary

object helping the parties to understand each other's motives and goals, and to agree on joint goals for the cooperation. This alignment process is essential, since aligned values and norms signal trustworthy behaviour that leads to confidence (Adler, 2001).

2. Business model contributes to coordination by trust by facilitating assessment of the costs and benefits. Since participation to a network is always voluntary, the potential partners should have some means to estimate the consequences of the cooperation. Concretely, business model can improve measuring, observing and comparing the business logic (Osterwalder, 2004). An explicit business model makes the evaluation of the fairness and risks associated with the deal possible and, thus, provides basis for the decision whether to join or not.
3. Business model supports the trust (or distrust) that comes from the familiarity through repeated interaction. In networks, we would point out the importance of the actual process of business modelling: we see that trust is established during the business model creation process.
4. An important contribution of business models is in improving the management and the alignment of strategy, business organisation and technology (Osterwalder, 2004). The model provides means to analyse and agree on the roles and levels of partners in the network as well as on investments in information and communication technology. As suggested in the literature, collaborative business networks should have distributed coordination power. Practically by the agreement on the business model the core partners jointly settle the general coordination rules and procedures as well as ICT systems for the cooperation. Evidently, the coordination of business networks in practice is added with mechanism having hierarchical or market characteristics as well.

The business modelling approach has certain disadvantages and drawbacks: First of all, it is applicable only in the context of networks, which have business aims. The purpose of the network is expected to concentrate on providing products or services to customers. This means that business modelling process does not fit e.g. to coordination of social networks, where drivers of collaboration differ from the ones we assumed (efficiency and fairness). Second, the business modelling process does not fit to business networks that aim at traditional supply chain type of operations where the companies are not ready to exchange knowledge and commit to in depth collaboration. And third, the process is time consuming. Thus, in situations where rapid set up of the network's coordination mechanisms is essential, the whole business modelling process is too burdensome to carry out. If these rapid needs come up regularly, one possible resolution would be to build some sort of meta level business model and process, which are then modified further in each occasion.

7.7 Conclusions

In this paper we present a conceptual coordination framework for emerging collaborative business networks. It draws attention to the dual procedure consisting of organisational change and more analytic creation of business model. Our framework outlines the organisational change management that should be carried out in parallel to the sketching of components of a business model (in the sense of Osterwalder & Pigneur, 2002).

We propose that business modelling can be of help when used as a framework by the core network parties in creating trust and determining the suitable portfolio of coordination mechanisms for their collaborative network. We suggest that when the parties are engaged into negotiations over the aspects of joint business model, they are also engaging in a process of sense making and learning, where the trust is generated by direct interpersonal contacts, by understanding other parties' values and behaviour, and by calculations. In this process business model and its creation serves as a boundary object that facilitates communication between negotiating parties.

During the business modelling the negotiating parties come to an understanding over the general framework of network coordination: how is the coordination responsibility shared between the parties, in which areas of the business model the network or part of the network can rely on hand shakes, and in which areas more formal contracts or use of market mechanism are needed.

The collaboration of the network requires mutual interests and the decisions over coordination can not be dictated by one ruling party. Instead they are based on trust established during the process of business modelling between the members, as well as on the shared knowledge of each others' capabilities, and roles in the joint effort.

The business modelling framework may be useful in directing and framing their future collaboration. For instance, we can immediately raise questions such as: Is there any recommended ways to carry out the harmonisation cycles pointed out in the framework? How should we manage knowledge in business networks? How they can be supported with ICT?

8 SPANNING BOUNDARIES, CONSCRIPTING BUSINESS MODELS[75]

The trend, prevalent also in Finland, of outsourcing and concentrating on core competences has made Finnish enterprises increasingly interdependent in terms of abilities and expertise (Powell, 2000; Dyer & Singh, 1998; Soekijad & Andriessen, 2003). On the other hand, however, inter-organisational cooperation in which companies combine their knowledge and know-how in new ways is fertile ground for innovation (Nooteboom 2000). It is, therefore, of little surprise that the importance of business networks as a source of business expertise has grown in recent years (Tsupari et al., 2001, 2004).

Mutual learning within a network presents considerable challenges, and this is no more so than in a network comprised of businesses with different histories and competencies and conflicting goals. In contrast to at the intra-organisational level, these goals cannot be changed by simple boardroom decision. A network company has a right, and even a duty, to withdraw from cooperation if dissatisfied, for example, with the level of expected investment or the sharing of risks and profits. It takes time for the parties to learn to trust each other, to work together and also to be ready to implement changes to their own operations and practices as and when cooperation requires it. In practice, this involves learning on multiple levels: cooperation requires changes within the network, within the individual company, and within bilateral relationships between companies. (Heikkilä et al., 2005a)

The network's companies are thus faced with a challenge: how to create an innovative business model which spans inter-organisational boundaries? In literature, this type of cross-boundary learning is considered to require the use

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75 This chapter is written based on previously published Heikkilä J., Heikkilä M. and Lehmonen J. (2004) Joint Development of Novel Business Models; and Heikkilä M. and Heikkilä J. (2006). Liiketoimintamalli yritysverkoston kehittämisen välineenä.

of "boundary objects" (Star & Griesemer, 1989) to facilitate the spanning of boundaries between communities (communities of practise, Brown & Duguid, 1991; 2000, communities of knowing, Boland & Tenkasi, 1995). A boundary object facilitates mutual exchange of knowledge between different parties. Star and Griesemer (1989) describe four types of boundary object: the standardised form, the common repository (e.g. library), the coincident boundary and the ideal type. An ideal type is an abstract description or scheme of fundamental concepts which is adaptable to different situations for the purpose of describing concrete details about different parties. Ideal types are models which can be used to facilitate the exchange of ideas between cooperation partners.

Carlile (2002, 2004) in turn presents three levels which affect the usefulness of a tool or method in joint problem-solving across knowledge boundaries. These three levels of Carlile (2004, p. 558) (FIGURE 52) also describe the relative complexity of the boundary and the methods suggested by Carlile have resemblance to the coordination methods by Galbraith (1977):

1. At the syntactic level, a boundary object can be a common language that individuals can use to transfer knowledge. A common vocabulary is sufficient in situations in which the differences and dependences between the parties are already well known. Boundary objects at this level include, for example, rules, taxonomies and databases (Karsten, Lyytinen, Hurskainen & Koskelainen, 2001).
2. At the second, semantic, level the boundary situation is unclear to the parties. Here, the function of the boundary object is to help clarify unclear dependencies and differences of interpretation, the goal being to achieve common understanding. This solution can, according to Carlile (2004), be achieved through cross-boundary relationships, teams and contact persons.
3. The third, knowledge transformation level by Carlile, brings an interesting political level into discussion of boundary objects. In Galbraith's model the political process is not considered, because it assumed that mechanisms were selected by simple managerial decisions. In Carlile's model the aim of transformation level boundary object is to help individuals to jointly transform their knowledge. According to Carlile it becomes necessary when the interests of the parties are divergent, thus obstructing the sharing and assessment of knowledge. In such circumstances the most effective boundary objects are prototypes and other boundary objects that the parties can jointly modify. Henderson (1991) emphasises the importance of the development process of boundary objects. During this process, the parties typically create numerous draft sketches on the basis of which the final boundary object is gradually formed. Before reaching final completion, the boundary objects thus serve as tools that conscript participation (conscription devices, Henderson, 1991) in the common description process. By discussing and developing the boundary objects, the parties strive to create common understanding and to find acceptable compromises through negotiation.

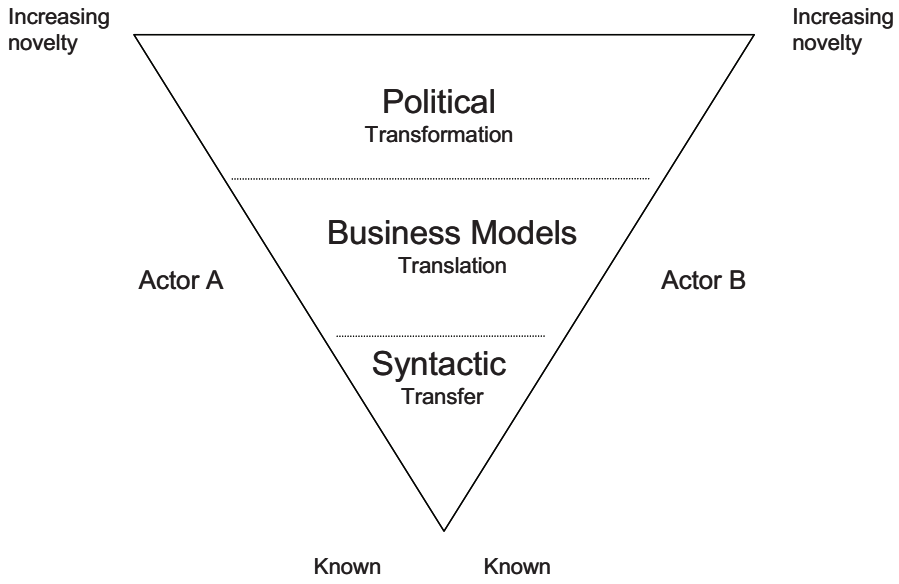

FIGURE 52 Carlile's (2004) classification of boundaries, boundary spanners and boundary objects

In this article, we present our observations in an action research study of the development process of a joint business model for a network comprising three business companies. We analyse the progress of the process in terms of the boundary object concept and, in the light of Carlile's theory, identify the organisational change processes needed and the knowledge boundaries that are to be crossed during the process of business modelling.

In this article, we present our observations of the development process of a joint business model by a network of three public companies. We depict the progress of the process in terms of using the boundary object concept, and analyse the reasons for the termination of the project in the light of Carlile's theory. The main contribution of this article comes from a unique research effort that analyses the match of boundary spanning levels with boundary tools in business network setting.

The empirical context illustrates the multiple challenges related to boundary spanning in joint business network collaboration. These boundaries are especially challenging in the early phases of network establishment, when enterprises with differing backgrounds, values, capabilities and goals try to negotiate and agree on rules for joint business. We identified several boundary spanning activities, which were initiated by the network business model planning process.

Finally, our study shows how a cross-boundary team conscripting a blueprint of a business model created common understanding on principles of joint business. The blueprint of business model acted as a conscription device (Henderson, 1991) between the participants involved in semantic boundary

spanning. It helped the inter-organisational translation process by providing a construct that the participants could discuss and create draft sketches and evaluate the fairness of the collaboration rules.

8.1 Planning the common network business model

The studied network companies M, B and C were already familiar with each other prior to the project through long-term bilateral business partnerships. The companies had, however, identified a need to cooperate more closely and to cost-effectively combine their expertise in order to better serve their global customers. Although the need for cooperation was recognised by the companies, they had not previously engaged in any active sharing of inter-organisational knowledge, and so boundary-spanning work communities had hardly been established. The different backgrounds, histories and operating environments of the network companies made it impossible to directly combine their knowledge as a whole. The significance of the knowledge and expertise of each network company had to be evaluated with respect to the development of the common business model (cf. Andersen & Christensen 2000). An example of the problems arising from the dissimilarity of the network organisations was the companies' different policies regarding the confidentiality of information. In addition, legislation regarding the publication of information on stock exchange listed companies restricted the dissemination of information between the companies. The parties' strict observance of non-disclosure agreements, terms of copyright, right of use of produced materials, and patent rights to inventions, meant that the draft network partnership agreement alone was circulated and debated within the companies' legal departments for a full year before being finally drawn up.

Our network project began with a series of workshops involving the representatives of the companies considering network membership. During the workshops[76], we outlined the parties' initial concepts of what the project was fundamentally setting out to achieve and what each party felt they were able to contribute to the network. After selection of the member companies, at least three persons, including at least one senior management representative, were appointed from each company as network project representatives[77]. In essence the team was delegated the responsibility to test and develop novel, joint business models. The goal of the project was to reach a common understanding between the members regarding the essential nature of the network business model. Furthermore, it was to come up with a common proposal as to what form the network business model should take in order for its member

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76 Workshops W1, 30.10.2002; W14, 27.1.2003; W19, 18.2.2003.
77 In workshop W27, 19.3.2003 and preceeding mail and phone conversations.

companies to be able to jointly offer a commercially viable service[78]. FIGURE 53 below illustrates the business logic triangle of networks. The underlying big triangle represents the business network's strategy, business model and processes (in a corresponding manner to FIGURE 5. Osterwalder & Pigneur, 2002) to meet the customer demand. It is constructed by adjusting the companies' own business logic triangles M, B, and C (in FIGURE 53 depicted as three grey triangles) with the network level business model (e.g., Gemünden, Ritter & Heyedebreck, 1996).

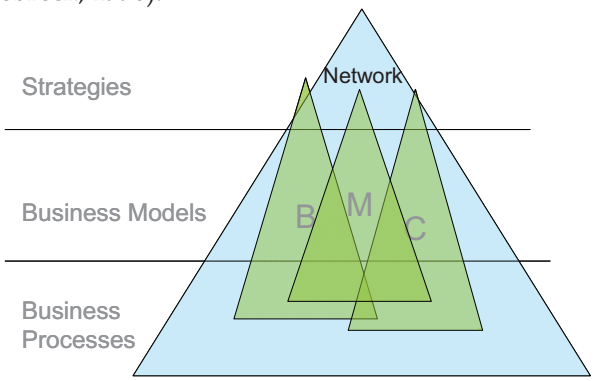

FIGURE 53 The business triangles of the network and of the partners

Designing the business model components

During the workshops[79], it was agreed that a network business model based on the companies' existing operations models would be unfeasible, as the models would restrict the network's innovativeness and profitabillty.

Upon proposal by the researchers, planning of the business model was commenced using business model ontologies (FIGURE 54). As an ideal-type boundary object, the conceptual model presented particularly by Faber et al. (2003) appealed initially to the network members, but was later rejected as being too closely tied to the sale of digital products for mass consumer market[80]. Instead, a somewhat modified version of the Osterwalder and Pigneur (2002) model was used as the starting boundary object of the network. In our own ontology[81], we emphasised the importance of the customer as the centre of all operations and singled-out technology as a core component, because the technological superiority was considered one of the core competences and the origin of competitive edge for the consortium.

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78 Source: Diary notes of 16.4.2003; memos of meetings E31, 7.4.2003; E32, 16.4.2003 and E28, 29.3.2003.
79 Workshops W19, 18.2.2003 and W27, 19.3.2003.
80 Workshop W120, 20.4.2004.
81 Workshop W132, 24.5.2004.

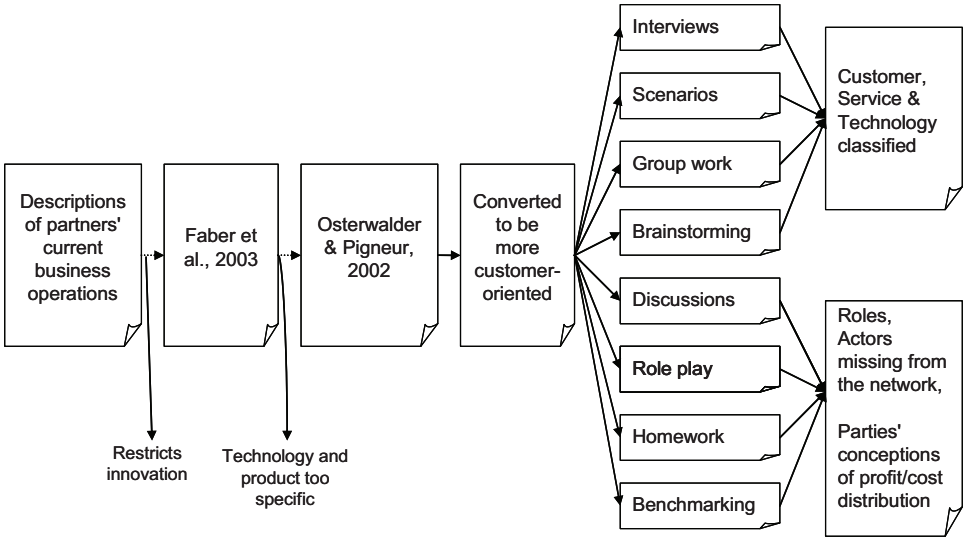

FIGURE 54 Boundary objects and working methods utilised in the network development process

The business model ontology was exploited in the network planning as a tool assisting the negotiations between the members. The partners studied each component of the ontological model both separately and collectively as a whole.

The next step was to sketch a *generic* product/service concept, which was used to discuss what the customers are offered and how they are served, as well as a concept of the customer relationship, the network organisation, the financing (e.g. sharing of costs and profits) and of the technology used. After being compared on one hand against the restrictions related to the customer, juridical, geographical, technical issues and on the other hand against the limitations of the current network, the knowledge would be eventually crystallised as a concrete operative business model(s) (FIGURE 55), the viability of which could then be tested within the network and with a pilot customer prior to its broader application (please refer back to FIGURE 51 where the process of business model analysis is depicted).

In analysis of potential services and customer relationships the aim was to identify suitable customer segments for the business operations being developed. The company representatives, assisted by the researchers, sketched out mini scenarios (Mercer, 1995) which were used to estimate future market developments and the effects of these developments on the customers' needs[82]. Group work and think-tank sessions proved the most effective means of knowledge transfer regarding the use of technology for the network's service provision.

82 Meeting E110, 13.-16.3.2004.

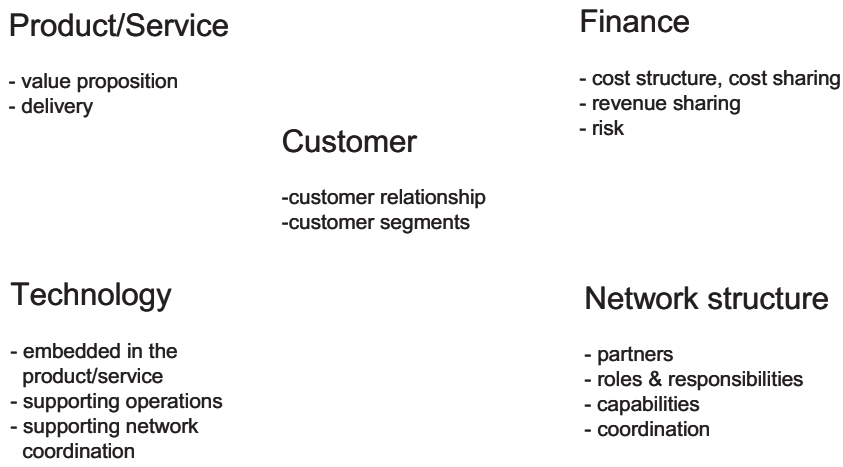

FIGURE 55 Core components of the network business model

The service offering was rather difficult to sketch out by the participants. The partners were looking for analogies from other business sectors. Sometimes they consulted their own staff and took the current offering in an aim to point out where the value from co-operation comes. The discussions were dwelling between need for strategic changes to slight adjustments to the current offerings, which would require no big changes to the processes of the companies. Also the interviews within the companies relieved considerably large scale in opinions of what was considered as suitable joint service offering.

The result was a classification of potential customers within a chosen geographical area according to their cooperative ability and level of production technology. Hence, although the consortium planned to start the modelling from potential technological innovations, they soon abandoned it and restarted from the differing customer needs. The consortium was able to reach a consensus where each customer category required differentiated service, technology, local support and pricing.

The network organisation, i.e. principally the different parties' roles, was initially outlined on the basis of bilateral discussions between the researchers and each company. As confidence later developed, the roles and responsibilities and the need, pros and cons of differing legal organisation forms were also discussed in joint meetings involving the entire network. Role-plays (Torvinen & Jalonen, 2000) proved useful in concretising abstract ideas and in clarifying role-specific problems[83]. We also requested the companies to consider specific cooperation-related problems, and to bring their justified standpoints regarding these to the negotiating table at the next joint meeting. Confidential talks in company dyads were also going on throughout the process. To us it appeared a

83 Source: W27, Workshop, 19.3.2004.

necessary, but not sufficient, means to iron-out obstacles to bilateral cooperation between the companies.

Options for financing were approached by first means of interviews[84]. On the basis of the interviews with company representatives, the researchers then compiled a summary of the representatives' views regarding the grounds for the allocation of costs and revenues as the basis of the network meeting discussions[85]. Benchmarking other industries served as the means avoid sticking to the present financial arrangements in the new business models[86]. The inclusion of financing as part of the service offering was considered a key competitive factor, but it was also recognised that the consortium was not prepared to provide sufficient funding to augment the offering beyond the present financial arrangements.

The participants were very motivated to the extent that the consortium had one company representative conducting interviews at the overseas customer sites on behalf of the consortium.

In order to keep the business model development as a whole under control we held frequent network meetings. In addition, numerous confidential one-on-one discussions served as a direct channel of feedback and, in particular, as a means of strengthening commitment and mutual confidence. Furthermore, the network representatives negotiated through out the process within their own companies. Sometimes, also the researchers were asked to participate or to provide back up information for these internal meetings.

8.2 Harmonisations initiated to achieve the network business model

As described in the previous section, the design of joint business model was carried out through various workshops, meetings, and confidential discussions, at multiple levels. When analysing the process, the researchers identified three iterative change and learning processes which were initiated by the network business model planning process (illustrated in FIGURE 56.). In addition we recognised that the network should also be able to analyse and articulate the possible need for new knowledge, partners, infrastructure etc.

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84 Interviews C2, 20.4 ; M2, 29.4. and B1, 30.4.2004.
85 E128, Steering group meeting, 3.5.2004.
86 Source: E142, Meeting 24.8.2004; W145, workshop 6.-7.9.2004.

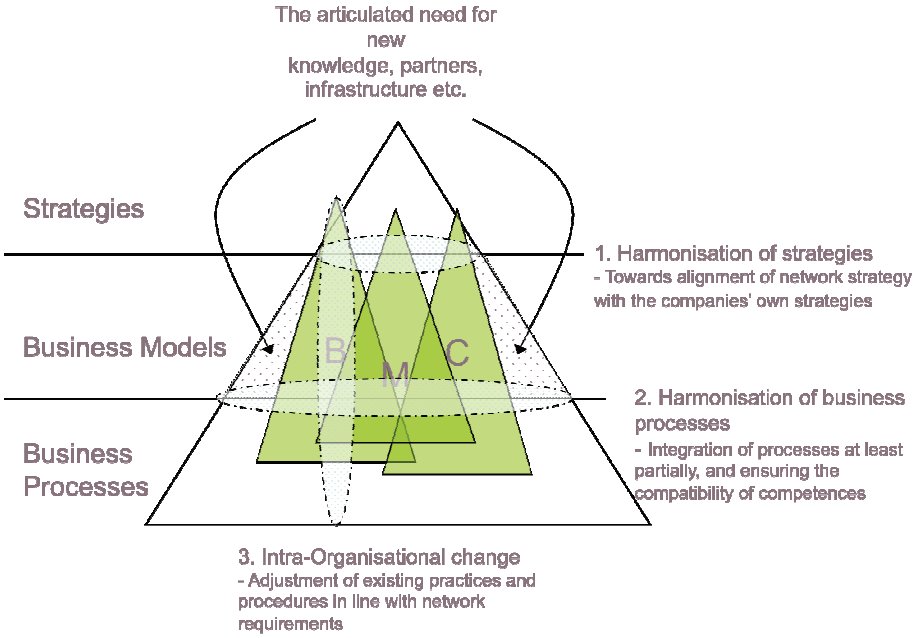

FIGURE 56 Changes required in the development of a common business model

Harmonising the strategies: It was seen necessary that the joint business model was compatible with the strategies of all participants – no company will enter in the collaborative network if its aims conflict with the company's own strategies. In our case, the core team in several workshops and other cross-boundary discussions assessed and interpreted the individual strategies of each other member company and sought a suitable common strategically adjusted goal for the network. The interpretation was backed with a number of methods ranging from interviews to group discussions and scenario building. Thus, in order to harmonise the strategies, the function of the business modelling procedure was to help to clarify the differences of interpretations and clarify dependencies through cross boundary relations, teams and contact persons.

However, the process also relied heavily on creation of blueprint sketches, which were discussed and modified together between the parties. These business model sketches developed gradually towards the final boundary object, and hence served as conscription devices (Henderson, 1991). This finding implies that the strategy harmonisation process involved political level negotiation due to divergent interests, and required boundary objects that the parties can jointly modify.

Harmonising the processes: Second, in order for the network business model to be adapted to the activities of the member companies in practice, it was to be adjusted at the detailed, *syntactic level* (Carlile, 2004), which required boundary objects such as *rules, taxonomies and databases*. This was apparent in our case, which started to focus more on practical business processes to

implement the business model. The harmonisation work began by presentations of current processes of each company and the changes required, if collaboration was to be fruitful. Later on some process designs were suggested to be jointly drafted towards common process definitions.

Adjustment between the joint business model and mutual processes was seen a necessity. As the companies even operated on different principles (or production types), there was an evident need to align at least some of the processes and ensure data compatibility. The members looked at the kinds of processes they already had and how the network could, by combining these processes, produce the desired outcome (this is depicted in FIGURE 56 by letting individual business triangles to overlap on the processes-business model level. The overlap should cover the whole interface at process and business model level in forms of agreed rules, procedures and databases, for interoperability reasons). The focal company's as-delivered design database of the facility was considered to be a good starting point for designing joint processes for the common offerings.

Intra-organisational changes: Third recognised adjustment was changing intra-organisational ways of working and resources: Our case evidenced that internal change management within a participating company is essential, if a partner hopes to gain approval for the cooperation by its staff members, and to incorporate the network operations to its other internal processes. As the joint business offering formed only part of partners' operations, it had to be harmonised with the business models and processes applied for producing other products and services. Thus, the company representatives of our study were engaged for considerable periods in negotiations and lobbying at different levels within their own organisations. The internal adaptation was regarded necessary in order for the network's operations to be able to be accepted by each company and to be adapted to the company's own processes. They are reflected in individual business models to ensure the strategic fitting, absorption of innovations, and change management (e.g. in the sense of Takeishi's internal coordination of inter-firm cooperation, 2001).

Among the consortium parties, this third change process proved highly challenging. The task of the key persons appointed to the network project from each company was, firstly, to appoint suitable persons from their organisation to innovative, networked development tasks and, secondly, to function as a communication channel between the network and their own organisation. However, resistance to change within the companies was strong, and this slowed the progress of the network development team's proposals. Thus, in our case, the most demanding knowledge transformation boundary was found within each company. In line with Carlile's (2004) suggestion to the use prototypes in these kinds of situations, the company representatives felt that if we carried out some practical *pilots* of the joint service with selected customers, they had it easier to explain and show the benefits of co-operation within their own companies.

The articulation of needs for additional capabilities: The business modelling reveals if the current network is missing some resources, know-how or actors. If so, the network should take actions to incorporate these in to the network. In our consortium the customer focus posed a need for additional capability from external companies that parties still perceived primarily as competitors, not collaborators. The observed capability gap and competitors services appearing on the customer's preferred agenda restarted negotiations over offering, network structure and financial arrangements.

8.3 Assessment of the viability of the joint model

The business model sketches were continuously used by the partners to assess the feasibility and fairness of the joint endeavour. The discussion over the business model brought up financing and ownership of information as the most problematic issues within the planned cooperation including[87]:

- The creation of a common product concept and, brand, for the network.
- The right of ownership of information concerning customer relationships and installations.
- In particular, the calculation and allocation of business costs and revenues within the network. Some of the companies strove for a partnership network in which costs and revenues would be shared equally among all parties. In contrast, others viewed that the majority of costs and revenues should fall to only one of the companies.
- The partners disagreed on the valuation of past investments such as background intellectual property and the joint use of facilities of the parties.

On the other hand, the project had continuous customer contact on the overseas market and we made a number of interviews with the site, production and technology management on the offering created with the blueprint business model[88]. After initial doubts, they were eventually most willing to continue with the consortium to implement the offering in a few of their plants.

After 30 months from the initiation of the discussions, the consortium ran out of time. Even though the partner organisations saw many benefits along the period of joint business development, and the trial customer started to warm up, the partners considered the still unresolved issues mentioned above to outweigh the benefits. Solving these problems would have required continuation of negotiations, most likely with a bunch of lawyers and, possibly, inclusion of new partners. Capacity of the companies to participate in the network cooperation waned, in some cases dramatically: one company

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87 Source W143, Meetings 24.8.2004; W145, workshop 6.-7.9.2004.
88 Source: Interviews CU1-CU5, in 2004.

modified its business strategy such that the development of a core service dedicated for use by the network was discontinued. The weakened financial situation of another company led to extensive staff reductions, and felt obliged to discontinue participation in this joint development project. As consequence, the development of the joint business venture was terminated by joint decision. Despite the readiness by the customer to start a pilot, no joint service was finalised for wide scale market launch.

8.4 Discussion

The joint business model development process served as a means of showcasing and transferring the parties' knowledge within the network. By discussing and developing different draft plans for each component of the business model and the connections between these components, the companies were attracted to reconsider their own background assumptions and to share their business concerns with the other parties. The model thus served as a tool for clarifying mutual dependencies and differences of interpretation between individual members.

In this chapter, we listed harmonisation needs that were seen essential for the companies to be able to assess how closely the network model align with their strategies (strategy harmonisation), practical processes (process harmonisation), and to what extent they are prepared to change in order to achieve cooperation (intra-organisational change). Next, we reflect upon the three first harmonisation processes with boundary activities coined by Carlile (2004) (FIGURE 57).

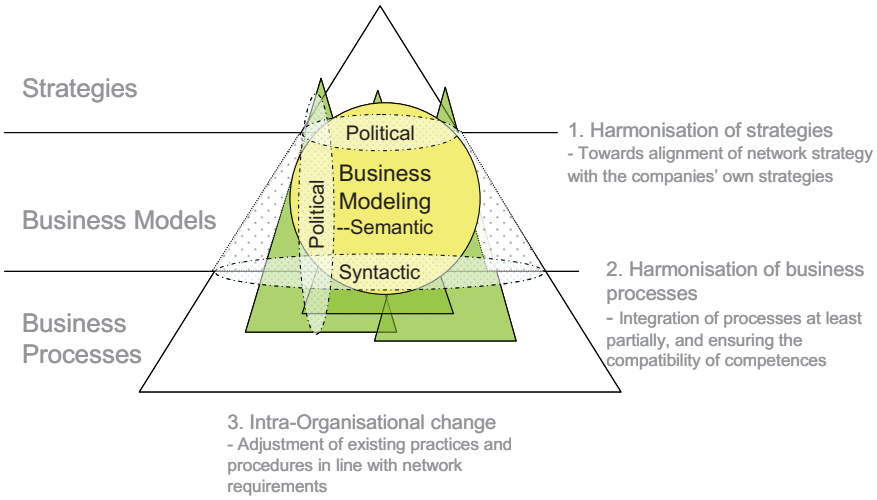

FIGURE 57 Types of boundaries in the development of a common business model

- We noticed that both in strategic and intra-organisational harmonisation, the parties were involved in political level knowledge transformation. This was done by sketching and jointly developing various blueprints on the details of the business model; the business model ontology concepts served as such as first boundary objects of the network, on the basis of which future business activities were discussed. Thus the business model was utilised as political level conscription device (Henderson, 1991).
- The harmonisation of business service and delivery processes required syntactic level boundary objects, utilising joint databases about the customer site information and early standardisation efforts for exchanging information, communication and co-operations as predicted by Carlile's theory.
- However, we also recognised specific needs for improvement in the boundary objects used: First, the business modelling should be carried out further towards more detailed boundary objects in order to being capable to advance the harmonisation of processes. This would require that business model was converted to formal architecture and process models. Second, the participants felt that practical *pilots* were needed in political transformation process, since through pilots or proof-of-concepts it would be easier to explain the effects of the collaboration within their own companies. We think both of the above-mentioned observations give good grounds to support Carlile's theoretical model.
- Even though the literature in this chapter is more focused on knowledge exchange between boundaries, the mechanisms listed are very similar to the coordination mechanisms proposed by management literature. The rules and procedures (Galbraith, 1977) are means to coordinate collaboration at syntactic level, and lateral coordination mechanisms (Galbraith, 1977) are suitable for semantic knowledge transfer (Carlile, 2004). The boundary object literature, however, adds one important point that is missing from coordination mechanisms literature: the highest level of knowledge boundaries is political, that is faced especially by the networks, where the interests of the parties are divergent, thus impeding the sharing and assessment of knowledge. In such circumstances the most effective tool is a dynamic boundary object which is during a development process designed by the negotiating parties via numerous draft sketches towards a commonly accepted boundary object. In our case network the business modelling was utilised as a conscripting device.

8.5 Summary

This paper reports an action research study where companies, which had engaged in bilateral relations for a number of years, attempted to establish a joint business venture. For this purpose, a consortium was established with the

aim of creating mutual understanding regarding the future joint business and to come up with a common proposal as to what form the network business model should take in order for its member companies to be able to jointly offer a commercially viable service. During the process we applied joint business modelling and analysed its role during the development with the concepts of boundary objects (Star & Griesemer, 1989), conscription devices (Henderson, 1991) and how they are postulated to be used during a co-operative effort (Carlile, 2004). Our research confirms the implications of Carlile's theory (2004) and also gives some practical advice for managing such consortia.

As companies increasingly outsource non-core functions as external business components, the number of inter-organisational, changeable interfaces is increasing. Previous to this trend, syntactic level tools, i.e. rules and databases, were sufficient for the exchange of knowledge between parties, because these were held within the same organisation. With the proliferation of subcontracting, and as operating conditions change, cross-boundary cooperation will require more semantic level knowledge transfer tools for the clarification of meaning and differences of interpretation. When the goal is to establish joint operations and to combine knowledge between actors, cooperation becomes still more complex. The individual actor is thus obliged to find the means and the will to change. What may originally have been intended as a flexible extension of resources may in fact require substantial investment, planning and negotiation in order to align the strategies and business processes of the partner companies.

Our study shows how joint business modelling enabled the potential partners of a business network to identify deficiencies in their financing expertise, and risks related to conflicting incentives. The business model also revealed a need for additional expertise and highlighted how the planned joint operations deviated from the member companies' existing operations models. Upon realisation of the extent of the risk and changes involved, the companies were not willing to implement the pragmatic or syntactic level changes needed to move towards a common operations model.

Second, our study also showcased that negotiations over business model entail substantial amount of knowledge sharing over several knowledge boundaries. The business modelling process seems to cover all the knowledge boundaries each requiring special boundary objects (Carlile, 2004). The business modelling process started from static boundary objects, such as theoretical ontology, building on which the partners developed in collaboration dynamic sketches and at the same time aimed at more practical prototypes, trials and pilots. All these were regarded as necessary to support the semantic, syntactic and political levels in joint collaboration across differing knowledge boundaries.

Third, the analysis points out the rising importance of political knowledge transfer in coordination of networks. Both the need for harmonisation of network strategy and the need for intra-organisational changes within each participating company entail substantial amount of political knowledge

transformation. Simple managerial decision is not sufficient, but conscription devices, are required to help the parties to negotiate the details of the network collaboration. In our empirical case, the business model process acted as a framework that guided the selection of specific boundary objects and methods during the process. And the business model itself was utilised as a conscription device, which was jointly modified towards acceptable description of networks operations and coordination.

Fourth, the study also showed the challenge of bridging political level knowledge boundaries. Even though jointly sketched business model descriptions are suitable for negotiation and agreement within small groups, their suitability in large scale is questionable. Not all can participate in sketching. Thus, the outcomes of the conscription process should be far more concrete than suggested in the business model literature, and for somewhat unanticipated reason: The concrete performance indicators can give the others more explicit information to make their own estimates of the value, risks and fairness of the endeavour.

And last, this study showed how the analysis of the business model made the risks related to the new joint offering clear to all parties. It saved a lot of money that would have been wasted if the companies had started the endeavour without thorough analysis. Soon the network would have run into the problems we were now able to recognise in before hand through business modelling approach.

This study has many shortcomings and limitations. It is based on one empirical case, albeit an extensive one (we were following intensely the progress more than two years), and thus, it does not provide proper grounds for generalisations beyond the case itself. Furthermore, the three harmonisation needs pointed out in the paper were recognised by the researchers during the study from the daily activities of the network. We do not have exact data on for instance how much time the partners spend in these harmonisation activities, or measures on their importance. This would require a new, very carefully designed study and full research co-operation of the partners. Moreover, in our case, the reluctance of the partners towards intra-organisational harmonisation can be pointed as one major issue leading to end of negotiations. Perhaps, in case of smaller, non-public companies, the processes would have been more straightforward due to flatter and smaller hierarchies, and due to less legislation, which inhibits transparency. And last, as we researchers were part of the team, we affected the way the network selected and utilised the boundary objects. We do not know, for instance, if left alone, the network would still had carried out the business modelling process in the same way as they now did.

9 COORDINATING AND BOUNDARY SPANNING ROLES OF BUSINESS NETWORKS[89]

In hierarchically organised enterprises the main task of management is to coordinate resources that are held in-house (Snow, Miles and Coleman, 1992). In many network organisations, however, it should be the task of certain managers to operate across hierarchical boundaries, creating and assembling resources controlled by outside parties. These boundary spanners are vital for the companies' resource expansion and knowledge acquisition, e.g., of each others' cultures and procedures. They are also at the heart of 'smart' networking (Vervest et al., 2005), as their tasks are directly linked with the key features of smart networking, namely awareness, adaptability and learning capabilities (ibid.) of the community of networked businesses.

But who are the coordinators across boundaries in inter-organisational activities? Organisational literature has identified a number of roles related to boundary spanning activities (Thompson, 1967; Snow et al., 1992): gatekeepers (coined by Allen & Cohen, 1969) are the persons seeking and mediating new information outside the organisational boundaries and assimilating it into their organisation. Their communication and absorption capabilities set natural limits on the extent of stimulus from outside the company. In addition, the roles of champion, project leader, project sponsor and innovator have been found to be of importance in introducing innovations to organisations.

The depth of co-operation increases across the boundaries as a consequence of collaborative networked operations. Does this mean that the number of boundary persons should therefore increase in proportion to the number of firms, relationships, or complexity of the network? Can smarter, more modern ICT compensate the need for more persons in boundary roles, or

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89 This chapter is modified from Heikkilä J., Heikkilä M. and Pekkola S. (2008). "Coordinating and boundary spanning roles of business networks".

does it actually require more? So far, our understanding of the importance of innovators in a networked business is limited.

We address these questions with two case studies, Network of independent companies and Network of subcontractors. We begin by briefly introducing the different roles of boundary spanners as we use them in our study. We describe the cases to gain a holistic understanding of different coordination issues and analyse the absence and presence of roles in each context. Finally, we compare the cases in the absence/presence of the roles and draw conclusions and recommendations for further research in the governance of the networks and their smart ICT.

9.1 Boundary spanning roles

The boundary spanning (Adams, 1976) roles necessary for successful introduction of an innovation has been an ongoing topic in organisational and IS-literature. Early literature regarding gatekeepers (Allen & Cohen, 1969) illustrates the roles of seeking and mediating new information outside the organisational boundaries and assimilating it into the organisation. Gatekeepers boost the innovative capacity of an organisation by expanding its resource base, by assimilating information from research, literature, fellows, colleagues, etc. On the other hand, an innovator is depicted as a person who seeks to satisfy market needs by thinking of new ideas, developing solutions to problems and identifying opportunities. Where gatekeepers tend to explore information objectively and critically, innovators are often creative individuals.

The role of champion was made widely known by Kanter (1983). The original, rather vague concept has induced a number of alternative definitions in literature over the years, but has recently been more elaborately defined (Roure 1999, c.f. Esteves & Pastor, 2002). Roure described a project champion as any individual who made a decisive contribution to the innovation by actively and enthusiastically promoting its progress through critical stages in order to obtain resources and/or active support from top management. Based on literature on both organisational innovation and project champions, Beath (1991) found that champions operate on basically three types of interrelated resources: information, material resources for acquiring information, and political support for material resources and rewards. In many instances these resources are divided by person, so there is a need for further elaboration, namely between sponsors, project leaders or implementers. These roles are often identified in the context of technological or ICT innovations (Howell & Higgins, 1990), but treated in bulk (e.g. Parr, Shanks & Darke, 1999). Although several researchers have used the concept of role in the context of interorganisational networks (Heikkinen, Mainela, Still & Tähtinen, 2007; Knight & Harland, 2005; Snow et al., 1992) many authors (see Roure, 1999) have found it difficult to distinguish between different types of roles in their

empirical studies. We considered the following categories useful in our research setting (inspired by Esteves & Pastor, 2002):

- Innovators, typically niche experts, who launch the basic idea.
- Champions (Kanter, 1983; Parr et al., 1999) sell the idea, acquire resources and pave the road for the innovation by removing obstacles, inventing new solutions etc. The champion role often includes two meaningful categories (Esteves & Pastor, 2002).
  - Project leaders, who organise the project to take an innovation into use.
  - Sponsors, who help to overcome obstacles during the project and to gain top management support.
- Gatekeepers, who actively seek new information and influences from outside the organisation.
- Implementers, who coordinate the actual operational rollout of the innovation.

In the following case studies we aim at recognising where and who are the innovators, champions, gatekeepers and implementers in the context of business networks. We also examine information systems to assess whether they are used to compensate the need for more persons in innovating roles.

9.2 Empirical study

Our two case studies present different challenges and solutions to boundary spanning. In both cases the focal firms are international companies with a turnover of several million Euros and thousands of employees. The first is the case of the Network of independent companies. It was formed by three companies creating ICT support for global services which has achieved modest results. The second case describes the successful implementation by the focal company N of the Network of subcontractors, of ICT tools for coordinating and controlling a global service supply chain with information systems.

The research method applied in case 1 was action research, i.e. we were involved in the practical activities of the network and our actions had an effect on the decisions made by the companies. The research projects organised multiple workshops, meetings and interviews. The other case was based on a case study in spring 2006 which included several interviews and group discussions. The following discussion on coordination and ICT builds on the documented research project data. The analysis of the boundary spanning roles is, in turn, purely based on the researchers' reflections on the cases. One researcher of each case explored the development path of the innovation and constructed a description of the roles affecting the process. To improve the reliability of the findings they were cross-checked by colleagues of the same project and of the other case.

9.2.1 Network of independent companies – Partnering for service offering

The first case focuses on joint service development for global markets. The business network (consortium) consists of three companies M, B and C. The primary focus is on the clientele of the two consortium members (M and B).

Company M has become the leading supplier of capital goods within its own global segment and is generally considered the technology leader in its field. It acts as a major contractor in delivery projects where the whole equipment including automation and supporting ICT systems are supplied to customers in close co-operation with subcontractors.

Company M desires to move towards a customer-oriented service (i.e. to the tier positioned next to the customer in FIGURE 58). The company considers the best way to deliver services worldwide could to use a reliable, static partnership network[90]. The final outcome of this development may mean that operation and maintenance of the customers' equipment is outsourced to an alliance of company M with its partners B and C[91]. Opportunities emerge along with advances in ICT, remote diagnostics, control and coordination systems. On the other hand, there is the constant pressure to cut costs.

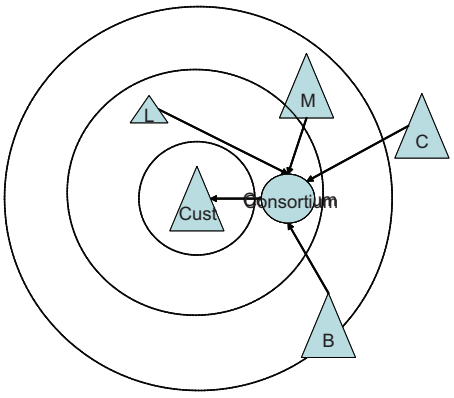

FIGURE 58 Topology of partners forming a consortium for service offering

The network planned to offer customer service, each contract covering a number of years. As this service requires regular visits to the customer sites, the consortium was required to have experts residing close to these sites[92]. At this time, the company M had not outsourced any activities which were in direct contact with the customer. In an attempt to overcome its problem of an insufficient number of experts to be able to visit all of its customers worldwide in person, the company has used remote diagnostics connections with a few of

90 Source: Diary notes on 11.2.2003 phone conversation.
91 Source: Interview M23, 5.4.2004.
92 Source: Workshop W1, 30.10.2002.

its customers. This method, however, proved ineffective for large numbers of customers. The company therefore had to seriously consider the option of using local MRO (maintenance, repair and overhaul) firms with close contacts with their customer sites (marked L in FIGURE 58) as its suppliers. In order to enter into a genuine partnership, the company also had to be prepared to share valuable information concerning its customers with its partners.

9.2.1.1 Network of independent companies: Roles in boundary spanning

The consortium consisted of several boundary spanners from all three core companies. Their work was assisted by researchers to whom the companies outsourced the main project leader role. Researchers acted as facilitators or mediators between the parties. Their role was to aid the learning process of the consortium and to ensure that discussions systematically covered all areas of the business model.

Two senior managers from two companies acted as innovators generating ideas on how the joint service should be organised. This boundary spanning innovation group produced, as suggested e.g. by Nonaka (1991), plurality in views, but also seeds of conflict: The resulting parallel generation of ideas created a competitive situation between the parties.

The consortium members disagreed on how costs and profits should be distributed between members. For instance, company C was willing to share both costs and profits equally[93]. To the contrary, company M, providing the pivotal expertise in the consortium, claimed that as they supplied the most value-added part of the service they should also receive a more than equal share of profits[94]. Due to this disagreement, none of the companies was prepared to fully commit to sponsoring the joint effort. As a result, consortium had trouble in overcoming obstacles during the further phases of the project such as in political knowledge transfer (Carlile, 2002; 2004) required within each company.

The organisational learning process among the consortium representatives proceeded satisfactorily, as each of the companies had its own representative acting as gatekeeper, eagerly seeking new information and influences from outside the organisation. Several of these representatives also acted in parallel as project leaders for their own organisations.

The joint effort came to a close before the practical execution phase started. At that point none of the companies had provided the consortium with a representative who would implement the plan in practice.

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93 Source: Interview C2, 20.4.2004.
94 Source: Interview M29, 29.4.2004.

9.2.1.2 Network of independent companies: Information technology

The information technology solution proposed for the running of the service was based on a hub which would receive and distribute information between equipment and/or people[95]. The data needed for service operations would be collected from customers' equipment and analysed by centralised experts at the project headquarters[96]. Additional data collection and rollout of proposed solutions was planned to be carried out by centres of expertise located in the country of the customer. Thus the delivery of the service was planned to include a lot of ICT support.

However, the stance was quite different in regards to ICT support of the network's negotiations process. The parties were not interested in supporting the innovation and sponsoring activities with ICT. Instead, they relied heavily on face-to-face meetings, which they considered the only productive means of communication.

The core companies did acknowledge that, especially due to the long duration of the service contracts, it would be important for project leaders to be equipped with tools for contract management together with explicit process descriptions and change procedures. This view was accepted because the relationship with the shared customer is multifaceted and long-term and situations were likely to emerge where more than one of the parties comes into direct contact with the customer[97]. Ideally, the parties should have gatekeepers that would gather (with the help of ICT) common information about the configuration and customer situation and record any modifications made, along with any anticipated changes in the performance of the facility. Furthermore, metadata should exist on the creator, responsible organisations, version history, variants and general rights of use of any digital documentation. This would facilitate the roles of the implementers and project leaders for the duration of the operative life of the facility.

9.2.2 Network of subcontractors – Aggregated services delivery

Second case is about a dynamic supply network that is built around its focal company, a global provider of infrastructure installations and services to specific industries. As physical presence is required in the geographical area of the customer, the company relies heavily on local suppliers.

A few years ago the focal company used to rent workers from its suppliers for certain periods of time for its projects. Now, after re-organisation of the supply operations, instead of hiring work months, the sourcing strategy is to buy work packages. The focal company outsources well over 90% of its project tasks[98]. It sees high level project management and supply network management

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95 Source: Meeting E71, 24.10.2003.
96 Source: Meeting E89, 15.12.2003.
97 Source: Workshop 12.12.2003.
98 Source: Meeting ICT4, 23.2.2006.

as its core capabilities[99]. The focal company aims to maintain its hold on all positions which interface with the customers (FIGURE 59). It communicates with the customer and ensures that the information needed to accomplish the task is passed to each supplier. As a typical project's lead time is 4 months, the main coordination effort is to assign, schedule and control the performance of the supplier network. In particular, an important coordination task is change management, i.e. in the event of exceptional situations to re-plan and inform relevant participants of changed project delivery details[100].

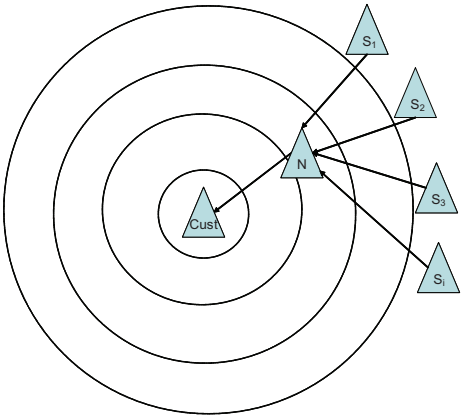

FIGURE 59 Topology of an aggregated service delivery network

Instead of a static partner network, the company considered that the most cost effective means of delivering customer orders worldwide is to use suppliers residing near to the customer sites themselves. A new supply network is thus created for each project. Depending on the scope and location of the project, the number of suppliers varies from 10 to several hundreds of suppliers. However, the focal company is extremely strict in its selection process as it does not want to endanger its brand name by using incompetent suppliers. Special attention is therefore paid in supply network coordination to the sourcing process, contract issues and continuous assessment of suppliers[101].

9.2.2.1 Network of subcontractors: Roles in boundary spanning

The role of innovator in the case network belongs within the focal company's responsibilities. The network was administered by the focal company, which has control over the actions of its suppliers. Furthermore, the network is

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99 Source: Meeting ICT1, 1.10.2005.
100 Source: Interview O16, ERP-manager, 23.3.2006; V14 Vice president of project management., 24.3.2006.
101 Source: Meeting ICT4, 23.2.2006.

dynamic to the extent that no other organisation other than the focal company maintains a continuous presence in it. This means that no innovations regarding network coordination are expected from the other network parties[102]. The driver for the focal company's innovations is cost effectiveness.

In Case II we identified two types of champions: The head of department acted as a sponsor who encouraged and assisted team members and secured the support of top-level management. There were also a couple of project leaders whose responsibility was to coordinate activities such as planning and organising projects and balancing project goals with available resources. In the supplier companies, the role of project leader was to ensure that the focal company's rules and standards are observed correctly. The focal company facilitated, guided and controlled the implementation. It provided training and material for the suppliers to roll out the required information systems. In doing so, it also ensured that the systems are used as planned.

9.2.2.2 Network of subcontractors: Information technology

During the past four years the focal company had invested heavily in information systems to facilitate the coordination of the above described boundary spanning process. The coordination of projects was largely built on rigid breakdown of work into equivalent work packages as used in company's ERP system. The sourcing phase was assisted with e-sourcing and e-auction tools and the following delivery phase with an e-project management system, where work packages were further divided into specific work items. When the supplier had accomplished the item it added the finishing date for that item to the system. After approval by the project manager and the customer, the system informed the focal company's ERP system that the supplier's invoice can be accepted. In the case of exceptional work tasks, such as extra work needed to accomplish a given task, the supplier was required to complete a formal change note in the system. Only then would the focal company process the supplier's extra work notification[103].

The supplier was obliged to use the abovementioned ERP systems. Their incentive to do so was the fact that the focal company paid the supplier's invoices only after the supplier had entered the required data and uploaded the required documents. The system had also shortened the billing process, so that the suppliers received their money sooner than before. These incentives ensured the timeliness of data entry, which in turn made the system an effective control tool for project leaders and implementers.

Supplier performance was evaluated by the focal company's project leaders, gatekeepers and implementers both during and after the project. Quantitative data on quality, speed and reliability was collected automatically

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102 Source: Meeting ICT4, 23.2.2006

103 Source: Interview O16, ERP-manager, 23.3.2006; V14 Vice president of project management., 24.3.2006; Interview O13 Purchasing manager, 23.3.2006.

from the systems for their use. They also entered and analysed qualitative data using ICT tools. Based on this assessment data, the focal company and the supplier could agree on a development plan for improving the supplier's processes.

9.3 Empirical summary

TABLE 12 summarises the boundary spanning roles in the cases.

TABLE 12 Summary of boundary spanning roles

	Network of independent companies	**Network of subcontractors**
Type	Collaborative network	Supply chain
Objective	Reduce transaction costs, Generic service concepts	Cut costs, reduce transaction costs. Business-driven
Offering	Service	Service
Network Type	Static	Dynamic
Power distribution	Equal power	Focal company dominates
Boundary Spanning Roles:		
Innovator	MANY Innovators in two companies, Contradicting opinions	ONE Innovators only in focal company
Champion (sponsor)	NONE Sponsor clearly needed	ONE Sponsors only in focal company
Champion (project leader)	MANY In all companies + outsourced facilitators	ONE Focal company's guidelines set standards
Gatekeeper	MANY Several in all parties	MANY In all parties
Implementer	NONE	MANY Focal company facilitates, guides and controls

The cases seem to confirm the view that all the boundary spanning roles are needed for successful introduction of innovation. The first case, Network of independent companies, was missing sponsors and implementers and the network ceased before reaching execution phase. On the other hand, the second case fully covered all boundary spanner roles and the resulting roll out of a new ICT system along with new procedures for managing the supply chain was considered successful.

The study also depicts how the collaborative network had numerous innovators, project leaders and gatekeepers from all three core companies. Even though, in some companies these roles were played by a single person, the amount of personal relations between participating companies was multiple

compared to the second case. The interaction was mainly synchronous communication (face-to-face meetings), whereas ICT (practically e-mail) was seldom used in supporting the relationships of the boundary spanners. ICT's role, though, was considered important in the product itself, in proving the services to the customer, and in customer relationship management.

In Case II the focal company had clearly defined all roles. The characteristics of the innovation were designed solely by the core company and the roll-out of innovation was successful, at least from the focal company's point of view. There was no need for other parties of the network to have other boundary spanning persons other than the implementers. From the coordination point of view, the new system emphasised heavily the mechanisms building on highly structured processes. In practise, the subcontractors were expected to adopt the new system if they wished to remain suppliers for the focal company.

9.4 Discussion and summary

In this chapter we analysed boundary spanning roles in the context of business networks. Our study results seem to be in line with the suggestion that all the boundary spanning roles are necessary in coordinating the assimilation of innovative business models (Applegate, 1991). For example, in Case I the development of the business model halted. It was evident that the role set was inadequate, and was too arbitrary and broad for the representatives in question. The role of sponsor was completely absent when it was needed to defend and advocate the joint business model. Also, certain company representatives took on all roles, being individually responsible for innovating, gatekeeping, and leading the project at the same time. This approach proved unfeasible; as such a triple role is not a credible solution within the type of knowledge-based organisation that they were representing. On the other hand, in case II all five boundary persons – innovator, project champion, sponsor, gate keeper and implementer - were present to ensure that the outcome was successful.

In case of the Network of subcontractors coordination complexity was reduced by the focal company because it decided on and determined the actual implementation of the business model. It stuck tightly to the customer interface and held the suppliers, contract manufacturers and subcontractors at arm's length. In this way, it was possible to apply an asymmetric set of roles in the coordination of the business network which, on the suppliers' side, required foremost project leaders to make the things happen.

In case of the Network of subcontractors the real benefits were further confirmed by routinising and automating coordination with the help of ICT. ICT required substantial investments by the focal company, as no other party could have otherwise afforded, either alone or jointly. Also the requirements for the system were specified by the one focal company alone. The applications

guided the actions of the suppliers: for instance the suppliers received payment from their work only after they had uploaded the required documents and reports. In this way, the in-built coordination mechanism replaced the personal engagement (Ring & van de Ven, 1994).

This brings up an interesting issue of ownership of the ICT: An expert[104] on inter-organisational systems (IOS) presented his concern over the fact that still the IOS's are being specified and owned by the focal companies. This way the IOS easily becomes just another system for traditional supply chain. Maybe, no real ICT support for the network can be built if it is not jointly specified or controlled by the whole network.

And last, since the level of complexity in coordinating grows quickly in line with the number of partners in the network, we are faced with a question about the increase of persons needed to take care of the boundary spanning coordination in networks. One would expect that (unless no mediating device is introduced) all five boundary roles should be personified in each of the core companies of the business network. This would mean that the number of boundary spanners in the net would increase by 5 each time a new partner joins in. Thus, for instance, in a network of three partners, there would be 15 boundary spanners. One can easily calculate that the number of personal relations would increase much quicker. This evidently, would be too exhaustive way to produce innovations. Thus some mediating devices – perhaps ICT based - should be introduced to lower down the number of spanners and to encourage border-crossing innovation work. The network literature also proposes that trust can be such a mediating device. If the partners trust each other, they can divide the spanner roles between each other, e.g. companies A and B provide innovators and company C provides an implementer etc. In this way the total amount of resources consumed can be reduced. Thus, we can assume that collaboration in networks should lead to delicate balancing of boundary spanning staff on the basis of level of trust between the partners.

Our findings are to be interpreted with caution. The conclusions are based on two case studies of different types of inter-company relationships. The identification of boundary spanners was performed by the researchers and for that reason the subjectivity of these assessments may bias the analysis. We therefore welcome further studies challenging our case study and its findings. An interesting angle of study would be to simulate the pace and proportion of the growth of boundary spanning roles within different types of network topologies and the number of relationships (i.e., the size of the network).

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104 Interview B4: Vice President, Manufacturing Solutions, 3.4.2008.

10 SHARING FOR UNDERSTANDING AND DOING FOR LEARNING: COORDINATION OF LEARNING BUSINESS NETWORK[105]

A number of scholars are currently touching the topic of how to coordinate learning in an inter-organisational context. To name a few, Nooteboom (2000) highlighted the need for partners to reduce cognitive distance in order to better understand each other, and Brown and Duguid (1991) argued the importance of communities-of-practice in tacit knowledge sharing. Boland and Tenkasi (1995) presented boundary objects as tools to help sense-making and understanding between partners and to make inter organisational learning possible. Ciborra and Andreu (2001) developed a generic model of knowledge sharing across a firm's boundaries, and Andersen and Christensen (2000) pointed out that in dyadic business relationships mutual trust and division of work between partners are shaped during the relationship. They proposed a learning process model in which inter-partner differences (e.g. cultural, organisational or strategic) determine the capabilities to absorb and communicate knowledge, both of which influence mutual trust and division of work in the dyadic relationship (see FIGURE 60).

105 This chapter is modified from Heikkilä J., Heikkilä M., Lehmonen J., (2005a). Sharing for understanding and doing for learning: An Emerging Learning Business Network.

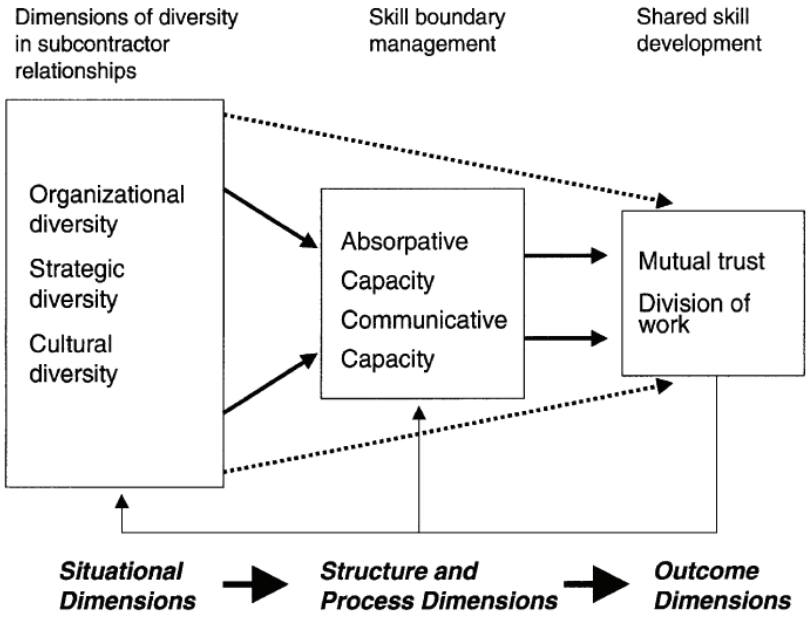

FIGURE 60 Model of shared skill development in a dyadic relationship (Andersen & Christensen, 2000, p. 107)

The problem is that many companies remain undecided as to what level of intensity of co-operation to engage in, its consequences for business and how to deal with the integration of information architecture. For example, in order to remain on the side of caution partners are unlikely to be willing to invest heavily at the beginning of the co-operation period. Instead,

> *As the trustworthiness of a potential partner is circumscribed in the beginning, firms do not commit large resources at one go, but engage in tit-for-tat games where trust gradually builds up and a growing proportion of resources are invested in the relationship, forming a set of ties between the firms.* (Andersen & Christensen, 2000, p. 107).

Moreover, especially in terms of information systems infrastructure, the inter-organisational process adjustment is an adaptive process depending on, for instance, organisations' histories, strategies, practices, hierarchies, cultures and infrastructure (Kumar & van Dissel, 1996). Successful co-operation also requires that the companies are willing to align their internal strategies and processes if this is seen to be essential. Our understanding of the situation leads us to call for an articulated business model which can serve as a coordinating boundary object or conscription device (Boland & Tenkasi 1995) for learning from other partners in co-operation, identifying the roles of the partners and also communicating the business potential of partners within their own organisations. This leads us to develop a framework that combines learning with business models in order to bridge the gap between strategic vision with

business processes and ICT-implementation issues in the business network setting.

In this chapter we illustrate how a joint business modelling helped a network of companies to make sense of inter-firm relationships, capabilities, resources and cultures. It works as a mean of coordination in business networks. In these networks, which can be characterised as having mixed governance (Williamson, 1985), the business model is used - instead of plain market or hierarchical mechanisms - to agree on outline of network's coordination through mutual learning. We can also infer that the process of creating and implementing the business model is closely connected to learning in order to understand the other partners of the network and provides a basis for learning-by-doing for the companies of the network.

10.1 Organisational learning

An extensive variety of differing coordination mechanisms have been proposed in organisational and management literature to cope with increasing complexity. Efficiency in managing, gathering and handling information or knowledge is one of the most persistent themes in successful organisational strategy (Galbraith, 1977; Nonaka, 1991, 1994). Within the field of organisation science it has been conceptualised as processing of information (in the sense of Galbraith, 1977) or as a social act of sense-making (in sense of Weick, 1979; 1975). In the former view, organisations act to reduce uncertainty by collecting and processing more information. The latter approach calls for a collective activity in which the focus is on asking questions and engaging in dialogue in order to reduce equivocality or ambiguity in cases of multiple and conflicting interpretations of an organisational situation (Weick, 1979; Daft & Lengel, 1986).

Much in line with sense-making approach, a contemporaneous book by Argyris and Schön (1978) introduced a conceptualisation of organisational learning. They identified three levels of 'learning loop' within an organisation: single-loop learning is a simple behaviour adjustment in a mismatch or error situation, respecting the organisation's current principles and rules. At a higher level, i.e. double-loop learning, the organisation questions and modifies existing rules and procedures, i.e. coordination mechanisms, in response to mismatch or error. In other words, the organisation tries to make sense of what is going on and what assumptions should be changed in order to achieve better results. The highest organisational learning loop is deutero-learning. This loop refers to the organisational problem solving capacity and capability to redesign policies, structures and techniques in the situation of constantly changing assumptions about the self and the environment. In other words, deutero learning means understanding single-loop and double-loop learning in order to increment them. Thus the challenge for an organisation – or network of organisations - is to provide its members with the necessary conditions for developing its

capacity to assimilate knowledge and to solve problems (Cohen & Levinthal, 1990) between the network partners (Doz, 1996; Gemünden et al., 1996).

Gatterman and Hoffmann (2003) suggest that the success of deutero learning and the restructuring of values and rules can be assessed by the level of acceptance of change within organisations. Evidently, in order for that to take place, not only individuals but also organisations and networks must be provided with the conditions necessary for learning. Indeed, knowledge management literature suggests a variety of models and methods for knowledge creation and sharing through interaction (tacit knowledge) or through documents and information systems (explicit knowledge).

10.2 Learning organisations and knowledge creation

Perhaps the most acknowledged researches on the topic of knowledge creation are the works by Nonaka (Nonaka, 1991; 1994; Nonaka & Takeuchi, 1995; Nonaka & Konno, 1998). Whereas the theory by Argyris and Schön (1978) lies in viewing learning as the "detection and correction" of error (c.f. Senge, 2003), i.e. acting and learning due to conflict between what-is and what-was-supposed, Nonaka (1994) proposes that new knowledge can be created by dialogue which brings up conflicting views. He claims that (Nonaka, 1994, p. 22)

> *chaos, or discontinuity can generate new patterns of interaction between individuals and their environment. Individuals recreate their own systems of knowledge to take account of ambiguity, redundancy, noise, or randomness generated from the organisation and its environment.*

Open discourse and reference models seem to emerge in particular as important enablers for organisational learning (Nonaka, 1991; 1994; Senge, 1994) and even more vital in the context of learning networks. They are needed for members with differing backgrounds and history to achieve a shared desired vision for the future. For example, Schneider, Russell, Beatty & Baird (1994, p. 32) describe organisational learning:

> *First, organizational learning occurs through shared insights, knowledge and mental models. Thus organizations can learn only as fast as the slowest link learns. Change is blocked unless all of the major decision makers learn together, come to share beliefs and goals and are committed to take the actions to change. Second, learning builds on past knowledge and experience – that is, on memory. Organizational memory depends on institutional mechanisms (e.g. policies, strategies and explicit models) used to retain knowledge.*

In line with the view of the firm as a 'sense-making system' (Weick, 1979) Nooteboom (2000) explains the need for shared insights and models by pointing out that information is useless if it is not new, but it is also useless if it is so new that it cannot be understood. He argues that organisations should be able to reduce cognitive distance between its members, i.e. to achieve a

sufficient alignment of mental models, to understand each other and achieve a common goal (Nooteboom, 2000). He also indicates the trade-off between need for cognitive distance for the sake of novelty and cognitive proximity for the sake of efficient absorption. This is precisely the same challenge that Nonaka points out when he suggests that, in addition to creative chaos, the enabling elements for the process of organisational knowledge creation are requisite variety and redundancy of information. This need for variety and at the same time overlapping knowledge domains of individuals is concerned with balancing cognitive distance and cognitive proximity, as mentioned by Nooteboom (2000).

Nonaka (1994), referring to Brown and Duguid's (1991) evolving communities of practice (see also Wenger, 2000; Wenger & Snyder, 2000), points out the significance of links between individuals that span boundaries. He explicitly talks of the need for contacts outside the boundaries of the company, seeing knowledge creation as a process that constantly makes extensive use of knowledge in the environment, especially that of customers and suppliers (Nonaka, 1994). Thus, selecting people with the right mix of knowledge and capabilities for the creation process is critical (Nonaka & Konno, 1998). Nonaka promotes the use of cross-departmental or even cross-organisational teams for organisational knowledge creation:

> *Teams play a central role in the knowledge-creating company because they provide a shared context where individuals can interact with each other and engage in the constant dialogue on which effective reflection depends. Team members create new points of view through dialogue and discussion. They pool their information and examine it from various angles. Eventually, they integrate their diverse individual perspectives into a new collective perspective. This dialogue can -- indeed, should -- involve considerable conflict and disagreement. It is precisely such conflict that pushes employees to question existing premises and make sense of their experience in a new way. Nonaka (1991, p. 104).*

As Ciborra and Andreu (2001) highlight, a firm that is entering an alliance with another firm having its own knowledge management system and practices, may find its own internal knowledge management arrangements and resources too rigid, closed and incompatible. Thus, we also need development of explorative knowledge networks (Nielsen 2002). In viewing business networks as arenas for learning and linking capabilities into strategic intention we refer to the cyclic process described by Ciborra and Andreu (2001). In their learning ladder model for a single firm they illustrate learning with three loops. The lowest loop represents the routinisation of knowledge. The second loop represents the transformation of abstract and construct capabilities from existing work practices. These capabilities are more abstract than work practices; they are 'skills without a place'. The third strategic loop in turn concerns the selection of core capabilities from the capabilities in the context of the competitive environment and the business mission of the firm. Ciborra and Andreu (2001) carry this further by proposing that there is another source of competitive advantage which stems from the establishment of inter-firm linkages, i.e. the recombination of separate learning ladders. How this is done

in an inter-organisational setting remains somewhat open ended in their article, but it resembles the ideas of the cyclical process of learning within an alliance proposed by Doz (1996).

10.3 Coordination of learning business network

In this chapter we draw together our empirical observations and the main viewpoints concerning learning and knowledge creation presented in literature. In particular, we consider their relevance in the context of collaborative business networks.

First, we should keep in mind that developing a real life business network is an emergent and cyclical process over time (van de Ven, 1976; Kumar & van Dissel, 1996). In point of fact, one should realise that we need to coordinate learning in several levels: 1) All the organisations involved are expected to be learning, i.e. adjusting or renewing their operations and strategies according to the needs arising from co-operation within the network and vice versa. Furthermore, in the network setting the organisations most probably also have 2) dyadic relationships, which also require learning. And 3) the network itself is learning. Evidently, the learning phenomenon in networks is a multi organisational iterative process consisting of simultaneous learning cycles (see FIGURE 59).

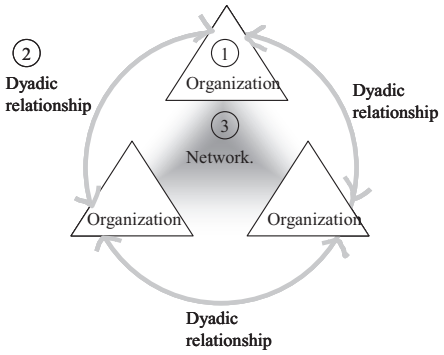

FIGURE 61 A simplified presentation of relationships within a network (Heikkilä & Heikkilä, 2003,p. 286)

One of the key tasks in partnering network is to facilitate and coordinate network level learning. As learning literature points out, the learning capabilities are path dependent. Evidently, the differences in history and cultures are much larger in the business network, which means that equivocality of the task is very high. Independency of partners makes the task even more uncertain, since the partners have the right to exit the co-operation if

they are unsatisfied for instance with the amount of investments required, risks or earning potential.

In FIGURE 62 we depict how network business modelling is related to learning loops.

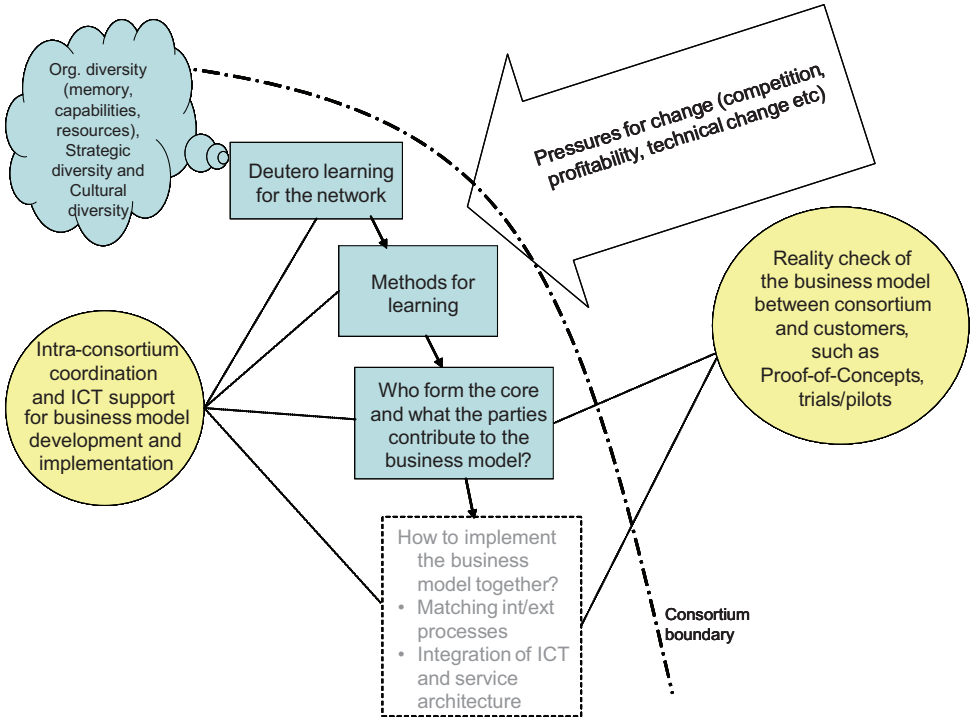

FIGURE 62 Learning in Collaborative Business Network

The starting point for the willingness to co-operate and to begin learning is equivalent to the *situational dimension* of Andersen and Christensen (2000). Different prior experiences of the partners, organisational culture, trust and tendency towards co-opetition instead of competition (Nalebuff & Brandenburger, 1996) are factors characterising the differences between the network partners (the upper left corner of FIGURE 62). The willingness for learning in co-operation is on one hand a product of past experiences and learning, on the other hand it depends on the external pressures for change (such as competition, technical change, changing requirements of the customers, etc.). In our case the organisations have learned to know each other in various circumstances in serving each other, or serving common customers all over the world. They have come to realise that they should co-operate in order to meet the need of the global customer base in a cost-efficient manner. Despite these views there are only a few genuine co-operation projects taking place; this is indicated by little inter-organisational knowledge sharing and few communities spanning organisational boundaries in practice. One of the primary incentives to start learning originates from the tension between vision

and reality (Senge 1994). There is an urge to strive to improve, preferably through systematic thinking and learning together.

Our interpretation of the situation is that each party has a certain degree of information about the customers but not enough for successful innovation of new services. The different backgrounds, histories and contexts of the network parties make it impossible to perform simple data aggregation and thus a fundamental rethinking of the meaning of the information in relation to the business model is required.

As a result, the companies saw the need to create an environment for learning that the parties can understand and critically evaluate in terms of the potential of co-operation[106]. This would require a major change in attitudes and behaviour that calls for *deutero-learning*. To this end the network developed the structure and assessed the changes caused through implementation of the business model in the companies' internal processes, dyadic relationships and in the network as a whole.

An example of the problems stemming from organisational differences is the case of corporate policies regarding confidentiality of information. The possibility to share information is limited by laws of publicly listed companies and by strict application of non-disclosure agreements and defence of intellectual property rights by the participating companies. In spite of these kinds of regulatory and competitive aspects, there are a number of ways in which the parties would like to develop their learning for purposes of networked co-operation. We define these as *methods for learning* that aim at articulating the boundary object, i.e., the business model. Examples of such methods are:

- Workshops and brainstorming sessions with different set of participants. In some cases these were necessary for *intra-organisational* absorption (e.g. with related projects[107]), in other cases they are needed between two parties to resolve obstacles to co-operation (*dyadic relations*[108]). They are also needed at the level of the whole *network* where moderation by the research party plays a vital role.
- Homeworks. Critical issues raised by the participants for discussion were in some cases assigned as 'homework', i.e., sent to the individual parties for resolution[109].
- Scenarios (e.g., Clemons, 1995; Mercer, 1995): the participants wanted to estimate the business potential via alternative future developments to understand the benefits of co-operation, to assess their roles and the need for adjustment (within their organisations,

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106 Source: Diary notes of 16.4.2003; meetings E31, 7.4.2003; E32, 16.4.2003 and E28, 29.3.2003.

107 Such as meetings E13, 17.1.2003 and E28, 29.3.2003.

108 Such as meetings E2, 15.11.2002; E5, 5.12.2002; E15, 1.2.2003; E29, 4.4.2003.

109 In workshop W87, 12.12.2003.

in dyadic relationships and at network level) in different circumstances. This was done with mini- or quick-and-dirty – scenarios[110].

- Role plays (Torvinen & Jalonen, 2000)[111]: it often proves necessary to make abstract ideas more concrete by exchanging roles between parties/customers and acting accordingly in a fictive performance.
- Benchmarks that serve as analogies (e.g. from related industries) in order to make the business model more understandable and concrete[112]. It has been argued that the role of stories or metaphors facilitate the externalisation of tacit knowledge (Nonaka, 1994). In our case, the metaphors take the form of anecdotes that often introduce a delicate concept or deliver a note on certain pitfalls in thinking[113].
- Person-to-person confidential discussions that serve the purposes of trust building via interpersonal trust and commitment (Ariño et al., 2001); also to gain direct feedback[114].

The variety of methods exceeded our expectations. Evidently they are needed to help form a shared and individual understanding of the situation and to reflect upon the external pressures and the anticipated extent of adaptation in each organisation.

The question of *who forms the core of the network, and what should the companies' contributions to the business model be?* is an ongoing discussion. The discussion touches on the business model realm, reflecting upon assets, capabilities, customer relationship, finance and the capacity of the parties to meet the needs of the customers. This involves a lot of discussion between the network and within the companies on strategic issues and implications on already established dyadic relationships between the companies

Proof-of-concept is needed to illustrate whether the business model is viable, at least in principle and to give it a final round of corrections (double-loop learning improving the suggested processes and rules). It also serves as a *reality chec*k for the network and reveals any assumptions held regarding roles and contributions.

The other side of the coin is to identify what the network does *not* cover. As the business model works by mapping means against needs, it also

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110 Meeting E110, 13.-16.3.2004

111 In meeting E104, 20.2.2004

112 In our case study the benchmarks were from aviation industry, E142 and E143, 24.8.2004 and discussed in W145, workshop, 6.-7.9.2004.

113 E.g., concerning attempting to enter a market the rep. of Company A: "Last time we went there with a concept it was like getting prepared for a bear hunt only to be met with a forest full of squirrels".

114 Such as confidential meetings E85; 5.12.2003 and E112, 19.3.2004 confidential meetings (there are many other meetings we researchers are not aware of).

illustrates the need for new resources, capabilities and actors that are not available from the network's set of contributors.

The lowest box in our framework refers to the actual *implementation of the business model.* This includes the effective ways to conduct and develop business processes both within and between parties and the use of communication tools and documents, databases and other content for sharing information between parties. Unfortunately, we cannot provide practical data on these implementation issues since our study ended before decisions over implementation were made.

Our experiences from the case showed some anomalies in ICT-support for the coordination of the learning process. As an example, the researchers of the consortium installed a groupware application as a common shared workspace and document database for intra-consortium coordination in order to support work activities and to make information sharing easier over distance. In this case, however, the classification of information sharing rights appeared to be insufficient and, even though generally being intense ICT users, the participants chose not to use ICT support in this circumstance. Instead the information was exchanged in e-mails and in conversations, sometimes only in dyadic relationships. In any ways, most often incompatible insecure systems were used. This implies that the ICT support for learning, collaborative business network is still in its infancy.

10.4 Discussion and conclusions

The availability of literature on organisational level learning and learning organisations is extensive. In this chapter we concentrated on coordination aspects of learning networks, as this appears to be a relatively new and unexplored area. How does coordination of learning networks differ from learning organisations? On the basis of prior research and our observations on the partner network, we identified the following differences: The parties have different histories and they have partially conflicting business goals, which increase the equivocality of the situation. Also, the independency of partners increases uncertainty as they can leave the network any time. This in turn increases complexity, because the network should prepare for this in terms of technical solutions (e.g., access mechanisms) and in terms of contracts (e.g., ownership of data, exit rights). And lastly, the learning takes place on several layers, i.e. on the network, within dyadic relationships and within organisations.

In our case study the network learned during the process of joint business modelling in a group representing several companies. With the help of the reference model they aimed at integrating their diverse individual perspectives into a new collective perspective. This dialogue involved considerable conflict and disagreement, which according to Nonaka (1991) forces the partners to

question existing premises and make sense of their experience in a new way. It also points how a network's learning process should start from facilitation of deutero-learning and finally come down to double-level learning through trials, and to practical implementation issues of ICT and processes (in line with Argyris and Schön, 1978).

We were surprised by the number of methods needed to facilitate learning. They also differed qualitatively from our initial expectations: in addition to the standard workshops and meetings, the companies favoured brainstorming, scenarios, role plays, homework, benchmarks and confidential discussions in figuring out alternatives for the business models and their role in different future situations. These are evidently considered useful in triangulating the strategic adaptation and in anticipating the need for intra-organisational change.

Even more surprised we were on the lack of use of ICT during the process. It seems that ICT provides little help in this process, as our attempts to implement a groupware support for the network showed. Information sharing would require much more delicate mechanisms and schemes for classifying the data and documents between partners than is available in current software. Also ICT systems should support the three differing levels of knowledge sharing: within partner organisations, within dyadic relationships, and on the network level.

11 SMART ICT SUPPORT FOR COORDINATION OF COLLABORATIVE BUSINESS NETWORKS [115]

Often e-commerce, inter-organisational systems and business networks are formed by integrating existing ICT-infrastructures in order to make trading and production networks or supply chains more efficient (van de Ven, 1976; Wolters et al., 1999; Hoogeweegen et al., 1999). It is most often assumed that due to ICT, the transaction costs are reduced to the extent that it is worthwhile to outsource ancillary operations and concentrate on core competences (Malone et al., 1987; Picot et al., 1997). Alternatively, the networks between partners and even competitors can also be seen as – not only a means of cutting costs – but a source of new, innovative business ideas, where the network provides the customer with more added value than if the companies were operating independently (Nalebuff & Brandenburger, 1996; Dyer & Singh , 1998).

As shown in earlier studies (e.g. Andersen & Christensen, 2000; Törmänen & Möller, 2003), a vital prerequisite for the success of a network is a mutual adjustment process (Ciborra & Andreu, 2001). Although it is essential to learn from previous experiences, enhance the resource base and assimilate knowledge, it is also required that the companies engage in mutual adjustment processes despite their individually crafted strategies and legacy systems (Powell, 2000; Nielsen, 2002; Nooteboom, 2000). In this way, it is claimed that the participating organisations are thus able to reap the benefits of both the expanded resource base and innovative capacity (Powell, 2000).

ICT can be expected to have a strong role in business networks. Yet, the reality is that ICT projects for business networks have been hampered by difficulties in integrating (legacy) information systems to a sufficient level, differences in organisation cultures and processes (e.g. inability to seamlessly unify processes due to differences in production modes), doubts concerning the

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115 This chapter is modified from Heikkilä J., Heikkilä M., Lehmonen J. and Pekkola S. (2004). Smart ICT support for Business networks.

pay-off of investments, fear of lock-in to focal companies and uncertain future profits and profit sharing (Kumar & van Dissel, 1996; Heikkilä, Vahtera & Reijonen, 2003a, 2003b).

To summarise, ICT is not a panacea, rather it is both an obstacle and enabler. Moreover, establishing and operating a business network seems to require substantial effort in learning and coordinating the activities of the separate parties of a given network. This chapter illustrates the five generations of organisational IS application archetypes. Then, founding on our experiences on a creation of a collaborative network which seeks cost-efficient expansion of global services and where in-depth knowledge of the customers is essential, we suggest some recommendations for future development.

11.1 From internal applications to a networked ICT-infrastructure

FIGURE 63 illustrates the generations of organisational ICT application archetypes on a Porter's (1980) value chain of a single firm. In most competitive organisations all of these archetypes can often be found. This study briefly summarises the worldviews related to applications and illustrates that they were born in response to specific organisational problems. It also depicts a typical ICT-infrastructure of an organisation, which may also be of help when applied in a networked organisation mode.

When considering ICT within a given firm, multiple archetypal applications exist. We can start by identifying some organisational functions which have traditionally been automated, i.e. those functions that have a clear and explicitly defined domain, such as general ledger, payables and receivables, MRP etc. These automated functions provide a vertical view of the organisation's business activities (area 1 of FIGURE 63) and aim at cutting costs, expanding capacity, reducing errors etc. The role of ICT is to formalise activities by creating a coordinated view of the activity.

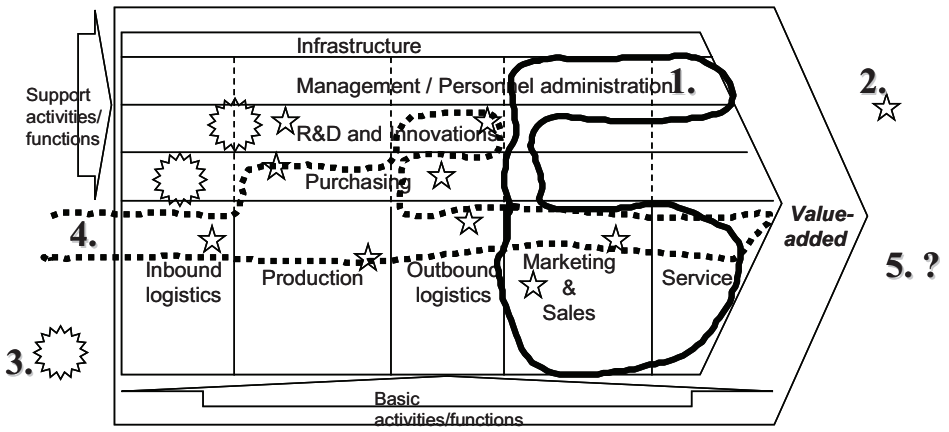

FIGURE 63 Archetypes of ICT applications on Porter's single firm value chain

It is typically expected that all communication occurs via the database – with all operations data being aggregated for those in charge of management and decision making (in sense of Galbraith's vertical information systems, 1977). This is also reflected in the development of such applications; they are clearly confined to specific functions and the concepts and tasks are well defined. At the same time, they easily neglect the differences in personal information processing and working styles.

Since it is difficult to cover business activities completely with functional ICT, the above approach left certain 'holes' in the application map. Hence, personal IT tools have been emerging to increase the productivity of individual, sophisticated and skilled users with the objective of rationalising and augmenting the individual's work (star 2 in FIGURE 63). This improves the resources available for carrying out the tasks. The benefits also stem from compatible and interoperable standard toolsets, which enable tasks to be shared and swapped between employees without losing efficiency and productivity from the organisation's viewpoint – i.e. these ICT related standards can be viewed as programmed coordination mechanisms that regulate work (Galbraith, 1977; Mintzberg, 1979) but also define the common interface for communication between the interdependent activities. Furthermore, individuals can patch any defects in the functional systems and compensate its weaknesses. Nevertheless, as the ongoing discussion on TCO (Total Cost of Ownership) illustrates, there are significant side effects in terms of breakdown situations, inadequate skills and consequent support needs.

Groupware and knowledge management tools (e.g., Notes, BSCW) aim at interconnecting shared toolsets and data for time and place independent remote work (c.f. Grudin, 1994; Robinson, 1992). Thus they help coordination by improving lateral relations (Galbraith, 1977). It is assumed that a group using a groupware application maintains a common goal (multi-pointed star 3 in FIGURE 63) so that the application can support the accumulation of expertise and facilitate the communication. This may shorten the time-to-market-cycle

and improve coordination within the group. Here the focus is clearly on group level as opposed to individual or organisation level. In many cases the underlying social structure is challenged by the vision of shared information, for example the ownership of information is often unclear, which consequently obscures its trustfulness; it is in conflict with different reward structures (Schmidt & Bannon, 1992). It is most likely that these problems escalate when shared activities span across organisational boundaries.

Business process software (e.g. SAP, BAAN) offers a customer-oriented perspective on the organisation's core processes by representing processes of service or production (area 4 in FIGURE 63). They aim at simplifying and streamlining the processes, minimising the number of hand-offs, cutting lead-time and ensuring quality and delivery control. This means that they are very efficient systems in collecting and transmitting data for planning and setting targets (Galbraith, 1977). This focus is also their drawback – the systems usually tend not to tackle wide-ranging processes across the whole organisation nor the multitude or interconnectivity of different processes. So, although the support for standardised processes is good, exceptions and exceptional behaviour hamper full utilisation of the systems.

The fifth type of system (marked as 5? in FIGURE 63) is designed for conducting business transactions on the market. Typically, it describes how the above mentioned systems form a steady state system infrastructure upon which the offerings to the customers are built. There has been recent growing interest in dynamic configuration of *multiple value chains* to meet customer requirements efficiently. Examples of such archetypal prototypes are reported by Hoogeweegen et al. (1999), Camarinha-Matos (2003), and Camarinha-Matos and Afsarmanesh (2004, 2007).

In FIGURE 64 we placed the above mentioned archetypes in the structure vs. communication grid introduced in chapter 5. It shows how the focus of ICT architecture has moved from simple isolated solutions of data bases (1) and personal tools (2) to communication rich support of knowledge work of teams (3) and on the other hand towards streamlining of processes via highly pre-determined means of work breakdown structures etc. (4).

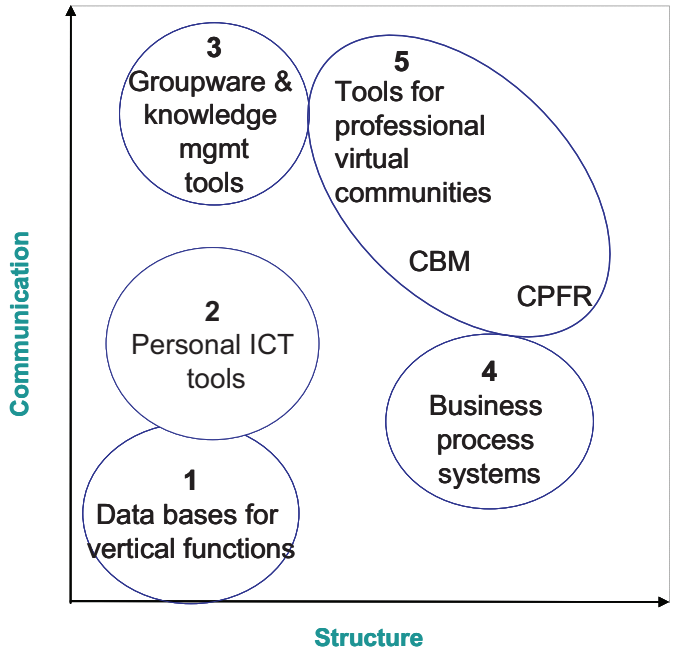

FIGURE 64 Archetypes of IS applications on communication vs. structure grid

The 5th type of systems proving support for business networks is only emerging. For instance, Collaborative Planning, Forecasting, and Replenishment (CPFR) is being espoused as a means of integrating all members of the supply chain. It attempts to coordinate the various activities including production and purchase planning, demand forecasting and inventory replenishment between supply chain trading partners. Selected internal information is exchanged on a shared Web server in order to provide reliable, longer term future views of demand in the supply chain. (Fliedner, 2003). The major barriers to achieving performance objectives seem to be invisibility of actual customer demand and deficiency of collaborative relationships for joint decision making (Chen, Yang & Li, 2007). Skjoett-Larsen, Thernøe and Andresen (2003) especially indicate importance of trust between the collaborative partners and points out that managing CPFR steps requires discussion on the sharing of responsibilities between partners, and on how coordination mechanisms should be improved to align the activities.

An alternative approach proposed is Component Business Model (CBM), where businesses view themselves as a grouping of capabilities that collaborate with other enterprises within a business ecosystem. In other words, the company is transformed into a collection of well-defined autonomous business components, i.e. services that interact with similar entities within the business ecosystem. Process flow becomes net-like, through composition and enhancement (and often parallel execution) of existing services provided by participants in the business ecosystem. The challenge of this approach is that the transition to a service-oriented network requires common interpretation of

service definitions and a highly structured, architectural view of the business. The first requirement for common industry semantics of service definitions applies within and across business domains. The latter means need of radical changes in the enterprise structures and roles to support loose coupling of services. Furthermore, a remarkable change is related to concerns with possible interruption of services: Negotiating with and changing service providers should be facilitated by service intermediaries: Service intermediaries should help to create trust by prequalifying service providers based on past experiences and other criteria. They also can act as registrars, brokers, authenticators, aggregators, hosts etc. As a result, large number of intermediary roles might complicate transactions between parties. (Cherbakov, Kalyana, Harishankar, Galambos & Rackham, 2005)

Third approach aims to support virtual communities by developing communication rich shared working spaces. The communities are bound to certain social rules resulting from commitment of the members to the organisations. A large number of computer supported cooperative tools are becoming widely available for synchronous cooperation. Also social media solutions are being applied to support work of professional communities. In terms of coordination, several approaches to develop flexible workflow systems have been proposed. However, the problematic issues are still many: very limited integration of tools and mechanisms, still limited coordination and management facilities, and no integration of IPR issues in the tools. (Camarinha-Matos, 2003).

All the above mentioned new approaches provide interesting avenues for future ICT architectures, but also share a common problem: Any ICT-infrastructure does not, in fact, work without a considerable amount of human intellectual effort and collaboration. Especially this is the case in business networks where generic coordination mechanism is trust. Although it is possible (in principle) to codify the activities and the processes in business networks in the form of ICT applications, it is evident that still a substantial amount of know-how concerning the organisations' codes-of-conduct must always be articulated, exchanged and learned in discussions between the collaborating parties. Founding on our experiences in an action study, we propose the following recommendations for future ICT development.

11.2 Suggestions for smart ICT

Our suggestions are threefold: First, in the context of collaborative business network we should pay *special attention to the process* of the joint business model development which we believe to act as a trust building activity. According to our observations, the creation of a joint business is a learning-intensive intellectual activity involving the creation, interpretation and exchange of vast quantities of information. The work is often carried in confidential workshops

and meetings to sharpen shared vision and foster trust. But, still ICT could provide some help, for instance in facilitating the meetings and workshops. Furthermore, to define joint expectations, and to evaluate risks regarding the collaboration, ICT could provide means to model (a promising methodological attempt is the e3value by Gordijn, Akkermans, de Kinderen and Pijpers, 2008) and simulate alternative business models their costs and revenues as well as related risks. This would aid business model negotiations and relinquish uncertainty.

Secondly, especially in a case of long-term service deals, there is a need to revise and update the contract on a continuous basis throughout the duration of the customer relationship. In the global setting this means that ICT should support distributed intellectual work both in the model creation and operation stages.

Thirdly, additional problems arise if one party leaves the consortium, if a joint business model becomes obsolete, if a new party enters the consortium, or when deciding what information should be granted to the newcomer. Many of the consequences of ending a collaboration relationship are of a legal nature and are to be regulated by the cooperation agreements, for instance, of the responsibility of customer support and product maintenance during the life cycle of the product or service generated by the network (Camarinha-Matos, 2003). However, in these situations some other concerns of information sharing become critical: most information and discussions are shared with consortium members and with trusted parties (sub-contractors, new partners in the future). For instance, who actually owns the customer data and how can it be shared? Can it be copied or replicated at all? Thus, the smart ICT support for collaborative networks should have clearly stated responsibilities and rights to the material. Aside from the normal technical problems experienced in the handling of documents and permissions of a joint workplace, the conceptual shortcomings of the current groupware regarding network learning support are severe.

In addition to the above mentioned three suggestions for ICT support, we would like to list also some more specific demands put to ICT infrastructure:

- *Shared knowledge management concerning the customer and facilities:* As the relationship with shared customers is multifaceted and long-term, situations will likely emerge when more than one of the parties comes into direct contact with the customer (facilities). Ideally, the parties should gather common information about the configuration and customer situation and record any modifications made, along with any anticipated changes in the performance of the facility.
- *Contract management*: The consortium members must have the contracts at hand whenever needed. In our case it is evident that almost all customer facilities are different and develop at different paces in their individual directions. This means that the consortium must analyse the status of the facilities and be prepared for surprises if the configuration of the facility

changes. In a similar manner, the contract between parties is subject to the strategic changes of the individual companies; thus the contract is amended to allow for such resulting changes in situation (the burden of managing contracts has been investigated in earlier studies on outsourced operations, Heikkilä et al., 2003a, 2003b).

- *Access rights*: A much more fine-grained classification of information is needed than any current groupware is able to provide. At present, we have identified needs for the following categories: open to everyone, to group members only, various subgroups or private. In addition, exchange of confidential business information is found to only occur within dyadic relationships. These factors call for a sophisticated *role- and metadata-based* single-sign-on solution (see e.g. Priebe, Fernandez, Mehlau and Pernul 2004), which would provide a role with access to all of the above mentioned categories of information securely via a uniform interface. As parties are at liberty to enter/leave the relationship, there is an evident need for metadata-based access control to establish, terminate and clear information instances of a specific party.
- *Authenticity and Digital Rights Management:* Again, as the parties are numerous and the relationships long-term, metadata should exist on the creator, responsible organisations, version history, variants and general rights-of-use of any digital documentation – including a description of the means of gathering the necessary metadata. This is needed in order to facilitate tracking of fair and responsible use of the consortium material. It is also a necessary prerequisite for charging on, e.g., pay-per-use basis (see e.g. Iannella, 2001).
- *Explicit process descriptions and change procedures*: In essence, we are suggesting that continuous updates and revisions to the business model should become regular practice. Consequently, there is a need to be explicit about the processes involved in creating a new model (e.g. in the form of a computerised checklist connected to document repositories) and changing an existing model. Our belief is that the processes involved in engineering change management (ECM) represent good current candidates for such purposes.

Furthermore, as explained earlier, although the availability of information is extensive, its utilisation requires new ways of interpreting and combining the data. Ultimately, this will require some form of metadata development to meet the functional requirements of the creation and operating process of the joint business model (Yates & Orlikowski, 1992; Päivärinta, Halttunen & Tyrväinen, 2001), such as domain descriptions, common terms, definitions and functions in order to facilitate data exchange and process integration.

In essence, our suggestions are in opposition to the mainstream integration approach (e.g. CPFR). We suggest that seamless integration of the systems of the participating companies into a single IOS should be avoided due to the sheer number of relationships, consequent adaptation processes and non-

compatible systems that come about as a result of various operational, structural, strategic, or even institutional factors. As an alternative, we recommend aiming at developing more generic information and communication systems to meet the challenges of network coordination and innovation. In short, we see the need for inter-organisational, confidential workshops and meetings to sharpen shared vision and foster trust, the need for cost and revenue estimation in order to relinquish uncertainty and misunderstandings and the need to state all responsibilities and rights on the material. The challenge for ICT is to provide smart support for these intellectual dynamic processes within business networks. Might these solutions form the next generation of ICT archetypes?

PART III: CONCLUSIONS: COORDINATION OF COMPLEX OPERATIONS OVER ORGANISATIONAL BOUNDARIES

12 FINDINGS AND DISCUSSION

This chapter summarises the main findings of this thesis. First I present the findings related to the specific research questions set out in the introduction of this thesis. Then I continue with a discussion on coordination frameworks and ICT for operations crossing organisational boundaries.

12.1 Findings

Findings of Part I
In Part I, we sought answers to the three questions concerning complexity and coordination:

12.1.1 Can coordination framework based on systemic view of organisation (Galbraith, 1977) be applied to illustrate patterns of changes in complexity and coordination mechanisms?

In his seminal work Galbraith (1977) followed the thoughts of March and Simon (1958) that organisations can be conceptualised as information processing systems that have two options to cope with increasing uncertainty: either to increase the information processing capacity, or to reduce the need for processing information. The underlying axiom is that uncertainty means absence of relevant information, and thus the level of uncertainty can be relieved by collecting and processing information more efficiently using lateral relations, by vertical information systems, by organising better for environmental management, by self-contained tasks or by allocating extra resources for information handling. The function of the management is to select the most suitable coordination from the above mechanisms to facilitate collection, processing, exchange and distribution of information (Bensaou & Venkatraman, 1996) for the situation at hand.

Our study in Chapter 4 implies the reason why only few studies (Premkumar et al., 2005; Flynn & Flynn, 1999) had tested, or applied, Galbraith's framework as a whole and why the results of some postulated causalities between mechanisms of the model show conflicting results. The original work of Galbraith is not very clear on the sources of uncertainty, or on how to identify that a coordination mechanism is adopted and implemented. For instance, in our case realm, it was necessary to collect very context and time specific information in order to recognise the changes in coordination mechanisms applied, and this was prone to errors. This made it almost impossible to study the phenomenon with quantitative, variance oriented research methods (Markus and Robey, 1988), so as researchers we came to prefer qualitative and longitudinal approaches.

Based on literature criticising Galbraith's thoughts, we updated his coordination model. First, following Weick (1975, 1979), we preferred to speak about complexity, which includes both uncertainty and equivocality. Second, based on literature (Daft & Lengel, 1986; van de Ven et al., 1976; Weick, 1975, 1979; Perrow, 1967; Argote, 1982; Bensaou & Venkatraman, 1996, Lee & Grover, 2000; Gittell, 2002) we deduced that environment, task and interrelationship form the main sources for complexity. Third, due to evolution of IT to ICT, we preferred to take into account both vertical information systems and any-directional communication technology as one of the primary coordination mechanisms.

We applied the revised coordination model in a longitudinal case study of a network of co-operating business units within a corporation in order to depict interplay of complexity (in the sense of uncertainty and equivocality) with coordination mechanisms over a number of periods of time. By using our model we could explain the evolution of both complexity and coordination mechanisms.

The case study shows how the complexity was constantly growing and that the coordination mechanisms applied concentrate on improving the information processing capacity. To the contrary, the coordination mechanisms that would reduce the need to process information were rarely applied.

As a result we concluded that Galbraith's framework is a useful mental construct can be used to examine patterns of changes in complexity and coordination mechanisms selected by the managers within a company. We proposed some adjustments above to make it more usable in empirical work.

In Chapter 5 we applied an alternative framework to classify coordination mechanisms: instead of grouping the coordination mechanisms to those that reduce the need for information processing, and to those that increase the capacity to process information (as in Galbraith's framework) we grouped the coordination mechanisms according to their support for rich communication and support for structure. This categorisation, founding on organisation science and ICT literature (March and Simon, 1958; Thompson, 1967; Mintzberg, 1979, 1983; Kumar & van Dissel, 1996; Katzy et al., 2004), seems to apply to both analysed case networks, where the mechanisms reducing the need for

information processing (suggested by Galbraith) are often not applicable. By characterising the mechanisms with their ability to support communicative or pre-determined coordination, we can recognise how equivocality and uncertainty require differing characteristics from the coordination mechanisms.

12.1.2 How coordination mechanisms evolve and affect each other?

Our empirical study in Chapter 4 supports previous literature findings of the simultaneous use of multiple coordination mechanisms (Gittell, 2002): We recognised the major changes in the coordination mechanisms in one case organisation during a ten year period. All changes in coordination mechanisms involved application of ICT, most often integrated with new rules or lateral relations mechanism. We also detected loops or causal chains between mechanisms, where an adoption of new mechanisms resulted in a need of change in existing mechanism(s).

Furthermore, the case study shows how the development of coordination mechanisms is not, not even within one company, purely management driven endeavour. In some instances the decision were technology driven and in others the changes in coordination mechanisms were emergent (Markus & Robey,1988; Robey & Sahay, 1996; Orlikowski, 1996), and gradual small adjustments to work methods, tools or routines previously found useful in practice in a smaller setting (Brown, 1999).

12.1.3 What kind of a role does ICT have in organisational coordination?

Based on our studies reported in Chapter 4 we suggest that the evolution of ICT to facilitating both pre-defined, structured coordination (vertical information systems) and communication (any-directional relations) has changed its role in coordination work significantly. It is no more a separate alternative channel to bureaucracy to transmit information between workers and management (in the sense of March and Simon, 1958), but it, for instance, helps to form lateral, informal, distributed groups or teams to solve mutual problems. Similarly, it can be a powerful tool to enforce rules and procedures in practice. Thus we should reconsider its position as an independent coordination mechanism. Rather we would propose that it is a powerful leveraging mechanism, a kind of a multiplier, when it is combined with other coordination mechanisms.

In Chapter 5 we draw a theoretical dichotomy from the organisation science literature: rules, standards and plans provide high structure, whereas mutual adjustment provides means for rich communication. With the help of this communication vs. structure coordination grid we then identified four coordination archetypes and their ICT support. The grid adds our understanding on ICT's role in coordination: Our comparative case study supports Kumar's and van Dissel's (1996) argument about the correlation between network topology and IT: Our comparative case study, how two focal companies had, based on their contrasting network structures, developed

highly sophisticated ICT systems, which provided appropriate type of support for the coordination of their current global operations. This demonstrates how decisions over ICT are highly related to the strategies and network topologies of the organisations.

Based on our analysis we suggest that there is a relationship between the type of complexity (uncertainty, equivocality), the network topology (pooled, sequential, reciprocal (Thompson, 1967)) and the ICT functionalities adopted (pooled IS, supply chain IOS, Networked (Kumar & van Dissel, 1996)). There is no one right combination of ICT functionalities for all business networks, but it is always dependent on the level of complexity dimensions and the network topology.

Findings of Part II

In Part II we sought answers to three more questions on coordination frameworks and ICT for operations crossing organisational boundaries.

12.1.4 How can collaborative business networks be coordinated?

In Part II we discuss coordination in collaborative business networks, which are promoted in literature (e.g. van Heck, & Vervest, 2007; Powell, 2000) to be the leading way of organising profitable, agile business in future. Since collaborative networks include independent actors who are pursuing their own goals and acting purposefully, it is not plausible to assume that management of one company can determine the effective coordination mechanisms for the whole network (contrary to traditional coordination frameworks). Instead, coordination is building more on trust enforced by collaboration and fair deals between the parties (Ring & van de Ven, 1994). The aim of Part II is to bring light to how coordination is managed in collaborative networks.

In an action research of a network of independent companies we depicted and analysed the process of creating and establishing coordination for collaborative business network. We analysed how business modelling can be of help when the parties are determining the suitable portfolio of coordination mechanisms for their joint network. We noticed that business modelling is a two-stream process: on one hand it includes analytical development of the business model. But it also includes many activities of organisational change management (described in Chapter 7).

We bring forward an alternative framework for understanding coordination. We propose that a joint business modelling process plays as an important role in framing coordination in collaborative business networks. It is a useful framework when the parties cannot rely on pure hierarchical coordination, or strict market contracting, but needs to compensate or complement the above mentioned formal coordination mechanisms with trust based coordination. Especially, we see that of crucial importance is the process: The joint business model serves as a dynamic boundary object (Star & Griesemer 1989; Henderson 1991), being developed by the parties in an aim to

set the limits and to generate rules, procedures and ICT support for the joint activities. In this way also the coordination mechanisms relying on coordination by hierarchies and/or markets are agreed upon. In parallel, during the process, this boundary object serves as a tool for sharing and understanding, for learning, and for estimating the fairness of the deal, and eventually also for building trust between the parties.

12.1.5 What is the role of knowledge exchange and boundary spanners in network coordination?

Thanks to increasing means for managing networked activities, companies have started increasingly outsource non-core activities as external business 'components'. As a consequence the number of inter-organisational, changeable interfaces is increasing further accelerating the need for coordination via alternative mechanisms such as business modelling. Previous to this trend, syntactic level tools (as suggested by Carlile, 2004), i.e. rules and databases (Star & Griesemer, 1989), were sufficient for the exchange of knowledge between parties, because these were confined to parties and rules within the same organisation. With the proliferation of subcontracting and networked business relations, changes to the actual operations for cross-boundary cooperation will ask for more semantic level tools (Carlile, 2004). Such are knowledge transfer tools for the clarification of meaning and differences of interpretation (such as groupware). When the goal is to establish joint operations and to combine knowledge between actors, cooperation becomes still more complex. The individual actor is thus obliged to find the means and the will to change their ways of doing business. What may originally have been intended as a flexible extension of resources may in fact require substantial investment, planning and negotiation in order to align the strategies and business processes of the partner companies (i.e. at political level).

Our results in Chapter 8 show how establishing collaborative network entails at least three knowledge boundaries: syntactic, semantic and political (Carlile, 2004). The business modelling process acted as a framework that guided the selection of specific knowledge tools and methods during the process. And the business model itself was utilised as a conscription device, which was jointly modified towards acceptable description of networks operations and coordination. This dialogue involved considerable conflict and disagreement, which according to Nonaka (1991) forces the partners to question existing premises and make sense of their experience in a new way.

The results also point out that even though jointly sketched business model descriptions are suitable for negotiation and agreement within a restricted group, they are not adequate as such for political and semantic knowledge exchange. The outcomes of the conscription process should be concrete: preferably estimates of effects in numbers and money, prototypes and proofs-of-concepts that make possible realistic assessment of the value, fairness and risks of the deal; and concrete. Furthermore, we recognised the need for

more practical and detailed boundary objects in order to advance further towards the harmonised processes. In the end, this would require that business model was converted to formal architecture and process models. This leads us to propose (in Chapter 10) that network's learning process should start from facilitation of deutero-learning and finally come down to double-level learning through trials, and to practical implementation issues of ICT and processes (using the terminology compatible with Argyris and Schön, 1978).

Furthermore, our study results presented in Chapter 9 seem to be in line with the suggestion that the five boundary spanning roles recognised in the literature are necessary in coordinating the assimilation of novel business models (Applegate, 1991). Unless some mediating device is introduced, it is most likely, that all roles should be personified in each of the core companies of the network. However, the early experience indicates that this is probably a too exhaustive way to produce innovative collaboration. Thus some mediating devices should be introduced to lower down the number of spanners and to encourage border-crossing innovation work.

12.1.6 Can ICT help network coordination?

The answer to the last research question was looked for by examining the functional requirements for ICT in the context of business networks. In Chapter 11 we summarised the generations of organisational ICT archetypes and illustrated that they were born in response to specific organisational problems. The networks, and especially collaborative networks, seem to require quite a new generation of ICT applications.

The emerging solutions to support networks seem to have one common challenge: how to generate and maintain trust, which is generally seen as the main coordination mechanism of networks. We therefore propose recommendations for future ICT development:

First, the ICT systems should pay special attention to the process of the joint business model creation, which we believe to act as a trust building activity. ICT should facilitate the meetings and workshops at an affordable cost. For instance it could document the decisions semi-automatically. ICT should also provide means to model and simulate alternative business models, their costs and revenues as well as related risks. Also explicit process descriptions and change procedures should make continuous updates of business models possible.

Second, ICT should support the stage when the business model is put into operation as well. Especially in the business of long term service contracting, there is a need to revise and update the contracts on a continuous basis throughout life-cycle of the customer relationship. In addition to contract management the ICT systems should support shared knowledge management concerning the customer and facilities.

Third, the ownership of the information in networks is a key factor when the practical decisions over transparency of the network are made. Thus, smart

ICT support for collaborative networks should have clearly stated responsibilities and rights to the material and procedure for entry and exit of partners. This means that decisions over access rights, authenticity and digital rights management are of great importance, lowering also the ex-ante costs of contracting and moral hazard.

Ultimately, these demands will require some form of metadata development to meet the functional requirements of the creation and operating process of the joint business model. We also recommend aiming at developing more generic ICT solutions to meet the challenges of network coordination and innovation.

12.2 Discussion

Next I will evaluate and reflect our findings to the theories on coordination frameworks and its ICT support.

12.2.1 Adaptations to conceptual coordination frameworks

The purpose of this thesis was to advance scientific knowledge on coordination frameworks suitable for networked forms of organisations. Coordination was examined as a dynamic phenomenon, focus of which shifted in the course of time from coordination of organisational activities within traditional boundaries of companies to coordination of joint activities that are spread over a network of companies.

One discovery of this thesis, owing to our multiparadigm and longitudinal approach, is that suitability of conceptual coordination frameworks are context dependent. In line with changes in business life also the coordination models providing frames for coordination decisions have to be altered. What was found suitable reference in coordinating in-house operations is not suitable for coordinating networks consisting of several independent companies.

Traditional models and frameworks of organisations often consider organisations as systems where aim of the coordination is to maintain the fit between the level of uncertainty and the internal hierarchy. In the first part of this thesis information processing view of coordination, more specifically a framework presented by Jay Galbraith (1977) was applied to study coordination.

Even though coordination framework proposed by Galbraith is considered to be one of the classics in organisation science (Kunz et al., 1998; Groth, 2001) there is little previous empirical research on how coordination mechanisms are used and how they impact on organisation's performance.

In order to modernise and operationalise the framework we suggest few adaptations: Our first proposition is that the framework should consider complexity, which in addition to uncertainty (understood as missing information) includes also equivocality (Weick, 1975, 1979). Second, we propose

that environment, task and interrelationship should be included in the framework as the main sources for complexity. And third, due to evolution of IT to ICT, we suggest that the framework is updated to take into account both vertical information systems and communication technology as coordination mechanism.

One of the results of this dissertation is that Galbraith's framework – after the above adjustments - is still a compelling reference when conceptualising organisational coordination in situations where the organisational boundaries between what is considered as internal and what is considered as external environment are clear. It depicts the coordination mechanisms that managers can apply to produce the so-called hierarchical coordination (in contrast to market mechanisms). Thus, it can be useful in managing coordination mechanisms in the traditional organisational context.

However, the coordination framework modified from Galbraith (1977) does not fit to coordination in the context of collaborative business networks that deliberately seek interorganisational relationships and increased complexity in order to gain innovativeness or adaptiveness. The framework focused on curbing down uncertainty and increasing ability to process information, and does not share the goals of coordination of collaboration network. Therefore, different kind of conceptualisation of coordination is needed. To our knowledge there are no previous studies on coordination frameworks for networks.

For this purpose, we suggest network's business modelling process consisting of two parts: 1) the systematic analysis of the joint business model and its components, and 2) the parallel organisational change processes.

The business model can work as a structure, a dynamic boundary object, for the negotiations between the (potential) partners over the central aspects of the networked collaboration. This bargaining and sense making process gives opportunities for mutual learning between the parties and provides means to assess uncertainty associated with the deal, the roles, sharing of costs and benefits and the other's trustworthiness (Ring & van de Ven, 1994). Thus, as a result, the parties can assess the fairness of the deal. Also trust between the parties is contested. After all, in the long run sustainable cooperation requires both fair play and trust, and both of them can be advanced during the business model negotiation. Furthermore, the finalised business model actually defines common coordination rules and processes for the network and often is accompanied with contracts, which are considered as formal written coordination mechanisms.

In FIGURE 65 above we have summarised our understanding over the triple role of network's business modelling process in coordination of collaborative networks.

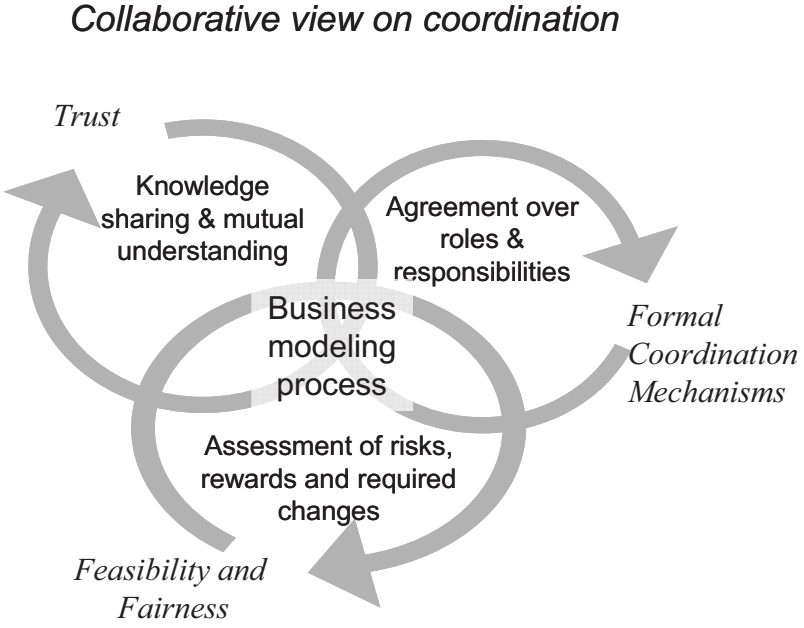

FIGURE 65 Triple role of business modelling process in coordination of collaborative networks

First, it is essential in knowledge sharing, and mutual adjustment between the partners; and it facilitates generation of trust between the parties; second, the risks, rewards and required changes are evaluated during the process. Thus, the partners are able to assess the feasibility and fairness of the deal and to decide whether to enter, stay or leave the network; and third, it functions as a high level coordination framework, thru which explicit agreement over roles and responsibilities can be operationalised into formal coordination mechanisms, such as joint rules and procedures, and contracts. As a result, the network consists of selected partners that find the collaboration as fair and feasible, and the coordination is based – at least to some extent - on trust, and is backed up with jointly agreed formal coordination mechanisms.

Furthermore, the FIGURE 65 implies that the less the network is engaged in knowledge sharing and mutual understanding, the less coordination can build on trust and the more formal coordination mechanisms must be established. An extreme example is a focal company which designs the business model alone and without revealing the model assigns suppliers to carry out parts of the business. In these cases the role of trust in coordination is practically non-existent.

And last, the FIGURE 65 shows that the cycles are repeated and they are affecting each other. Thus, the suitable coordination mechanisms change during the process, and whenever the aspects of the business model are modified.

All in all, our multiparadigm research on coordination points out the need to reconsider the frames of reference as networked business becomes more and

more common. The parties may be exploring innovative, collaborative arrangements, where the traditional view of managers dictating the coordination decisions and curbing down the complexity is not suitable anymore. Instead we should opt for coordination frameworks which elevate adaptiveness and capabilities to learn.

The novelty of our approach comes from the combination of the literature on change management, learning, business models and networks. All these lines of literature are vast on their own pointing out the importance of each other in networked operations. In our coordination framework these views are integrated in a process of joint business modelling.

12.2.2 What did ICT do for coordination since Galbraith?

This thesis shows how the role of ICT in coordination has changed remarkably from the days of Galbraith's (1977) information processing view. Back then it was thought that information systems can help to collect and transmit information upwards in the hierarchy and thus help the managers to make better plans. Investments in information systems was thought to increase the information processing at planning time, while reducing the number of exceptions, which overload the hierarchy. Thus information systems were to help to create and support coordination with pre-determined rules and processes in an aim to cope with increasing uncertainty.

As our longitudinal case study shows, the organisations are facing an ever increasing complexity, and the means they apply to cope with it rarely reduce the complexity, but handle the complexity by improving the information processing and communication capabilities of the firm. Today, ICT is heavily used to support communication within and between organisations. ICT helps not only in information sharing and communication, but also in negotiation (Gurbaxani and Whang, 1991; Malone et al., 1987; Galbraith et al., 2002). In networked settings, where knowledge sharing, learning and adaptation is especially crucial, ICT support for communication based coordination is of increased importance in handling equivocality of complex situations.

On a whole the role of ICT in coordination has grown exponentially: It can leverage and institutionalise the effects of any other coordination mechanisms (Galbraith, 1977), it can be integrated into any component of a business model (Osterwalder & Pigneur, 2002), and it can mediate the relationships between boundary spanners (e.g. through digital bonds, Salo, 2006). It can even foster trust via improved transparency (Vaccaro & Madsen, 2009). The conclusion is that ICT is a powerful and versatile mean of coordination.

Building on theories on organisational coordination (March and Simon, 1958; Thompson, 1967; Mintzberg, 1979, 1983) and information systems (Kumar & van Dissel, 1996; Katzy et al., 2004), we introduced a grid of coordination mechanisms based on their focus on structure and communication. Its advantage is that it points out the dependencies between uncertainty, equivocality, network topology and ICT support. This grid, even though being very simple, seems fruitful in describing coordination in today's knowledge

economy where the amount and number of sources of knowledge are overwhelming. By characterising the ICT mechanisms with their ability to support communicative or structured coordination, we can better recognise that equivocality and uncertainty require differing characteristics from the coordination mechanisms. The grid can also be used as a tool to visualise the current set of coordination mechanisms or ICT functions of an organisation, and available future development paths.

Overall, our study hints that there seems to be no single right combination of ICT functionalities for all business networks, but it is always dependent on the level of complexity dimensions and the network topology. However, it should be remembered that ICT, being rather costly and slow to change, tends to lock the companies into the selected line of coordination. Drastic changes are difficult to make later on. For this reason, the companies should be active in making the decisions, so that they are not drifted in a situation where the ICT systems reinforce network structures and processes that were not intended.

12.2.3 Future challenges

As our case of emerging collaborative network demonstrated, the ownership of the information is one of the most decisive factors in networked collaboration: open access to information is important for network partners' ability to collaborate in a network and act more intelligently locally. Since the owner of the information has the right to decide whether or not to share it, he can affect the level of transparency within the network. This is one reason, why the way how ICT systems are being designed has a big influence on the network. The other reason, also demonstrated in our empirical cases, is that they institutionalise the rules and procedures for the network, as well as provide means for communication between the partners. Therefore the challenge of the future is to have ICT support for collaborative networks that serves the needs of the whole network.

An expert on inter-organisational systems from an IT service company[116] presented his concern over the fact that the majority of systems – and the data - for networks are owned by the focal companies. He however saw that the general attitude is changing:

> *Couple of year's back it seemed that the systems were largely specified by the focal companies. The situation has not changed much, but, if you compare how we talked about networks five years back to how we talk about them now: the general idea now is that "we are doing this together" instead of the previous "I am the customer, you're the supplier and you are supposed to go to your knees"…It seems that the cooperation within the network is now being planned more systematically, and this brings out new needs also for the ICT supporting the network. (Interview B4: Vice President, Manufacturing Solutions, 3.4.2008.)*

[116] Interview B4: Vice President, Manufacturing Solutions, 3.4.2008.

This positive change in attitudes towards more cooperation would according to him provide possibilities for their vision that network ICT would be provided by an outside party, for instance as a service (SaaS, Software as a Service):

> *The vision for the networks and their ICT systems I have created together with my colleagues, includes the idea that when the partners are really making business together, that is have a joint network strategy, then we have some information in the network that is not owned by the focal company, but belongs to the whole network. Okay, it can still for years be so that it is facilitated by the focal company, but it does not have to be so. It could also be facilitated by a third party (a service provider), but the idea is that its customer would be the whole network, not only the focal company. (Interview B4: Vice President, Manufacturing Solutions, 3.4.2008.)*

If ICT systems are managed by an outside party (as in SaaS), or alternatively, owned by a joint venture, it might be easier to have shared ownership to the information and to facilitate transparency in collaborative networks. Furthermore, this kind of arrangements would perhaps advance adoption of systems with processes and functions building on true collaboration.

Last, we had a look at the emerging solutions for business networks: Collaborative Planning, Forecasting, and Replenishment (CPFR), Component Business Model (CBM), and support for virtual communities. Even though the above mentioned new approaches provide interesting avenues for future ICT architectures, they share a common challenge: how to generate and maintain trust, which is generally seen as the main coordination mechanism of networks.

We therefore proposed that the ICT systems should pay special attention to the process of the joint business model creation, which we believe to act as a trust building activity. In addition to supporting meetings and workshops, ICT should also provide means to model and simulate alternative business models, their costs and revenues as well as related risks. Also explicit process descriptions and change procedures should make continuous updates of business models possible. There are already suitable industry standards available for modelling at business process level, such as BPMN, a business process modelling notation, and BPEL (web services business process execution language) for precise execution semantics. There are also techniques for describing business models: a XML e-business model modelling language (BM^2L, Osterwalder, 2004), Resource-Event-Agent model (REA, McCarthy, 1982; Geerts & McCarthy, 2002), and e3-value (Gordijn et al., 2000; Gordijn et al., 2008; Pijpers, Gordijn & Akkermans, 2009) for modelling value exchanges within an e-business network of multiple business partners (Scuster & Motal, 2009). However, there are still no proper means to simulate effects of differing network business models or to transform business models into process level descriptions. From both practical and research point of view this is an important area needing further development.

13 CONTRIBUTIONS

The objective of this thesis was, through multiparadigm research methodology, to bring out conceptual frameworks of coordination that can be helpful in managing complex operations over organisational boundaries. Of particular interest was the role of ICT in coordination.

Next I will present the major contributions of this thesis.

13.1 Contribution 1: Evolution of coordination

This thesis presents results of several case studies covering data from a period of 18 years from the start of the 90's to the year 2008. We observed how coordination in business has evolved from the coordination of 'in-house' resources and information towards coordination of collaboration in business networks (Stacey, 2007):

In the first years of the study period, the managers were concerned about how to select the most effective coordination mechanisms. These were to facilitate their staff to carry out growingly complex operations in a situation where the tasks are divided in a web of business units within the boundaries of the corporation (Galbraith, 1977).

Towards the turn of the century, the case companies started to take interest in managing their relationships with other companies. The managers were eager to learn how they could benefit from closer collaboration, beyond subcontracting, with other companies. They started to understand that, by combining competences of their own company with the competences and ideas of suppliers, customers, complementors, or even of their competitors, they had a chance to explore the possibilities of providing value-added products or services that were not possible to produce alone (Powell, 1990; Nalebuff & Brandenburger, 1996).

I think the observed change is a reason to revise the frames of references in understanding and selecting suitable coordination mechanisms:

a) First, we show that coordination framework of Galbraith (1977) is suitable for in-house coordination after small modifications. The model's view on companies as cybernetic feedback/feed-forward systems, means that the environment is beyond the influence or control of the organisation, and taken as granted. The managers apply power and rules in coordination decisions within their hierarchical limits of authority. The ultimate aim is to act when the number of exceptions challenging the stability of the organisations is about to go out of control. The standard internal coordination solution to this is to either increase information processing capacity, or to reduce the need for information processing so that the situation becomes more stable again, as suggested by Galbraith (ibid.).

But the above co-ordination solution is challenged by the growth of complexity, understood in terms of equivocality and uncertainty, as evidenced in our research. It leads the management to seek other means for co-ordination:

b) The setting is different in situations where the companies explore opportunities through collaboration in networks. The companies are consciously escalating the complexity by increasing the number of relationships and interdependencies and by aiming at more risky cooperation. On the other hand, they try to simplify the internal operations by concentrating into core competences and streamlined processes. The trade-off is between power and innovativeness; innovativeness does not thrive if the network is tightly controlled by a focal company (Håkansson & Ford, 2002). The main function of coordination is not to limit the complexity or to maintain stability. Instead the goal is to coordinate actions so that sharing of knowledge and learning within the network is advanced (Vervest et al., 2005). Therefore, the coordination mechanisms cannot and should not be decided by one party, but be agreed within the network (Ring & van de Ven, 1994).

13.2 Contribution 2: Business modelling process – a coordination framework for collaborative networks

In this thesis, through one case, we show how the process of business modelling (Osterwalder & Pigneur, 2002) can provide a conceptual frame for understanding coordination. We suggest that collaborative business networks would benefit from using business models as a dynamic boundary object (Star

& Griesemer, 1989; Henderson, 1991). Negotiation over the business model helps mutual learning and provides a balance between formal coordination mechanisms, such as rules, procedures and contracts, and informal ones, such as trust (Ring & van de Ven, 1994).

We can confirm on the basis of our study that network's business modelling process seems to have three functions in coordination of collaborative networks:

1. It is essential in knowledge sharing, and mutual adjustment between the partners; and it facilitates generation of trust between the parties (as suggested by Adler, 2001).
2. The risks, rewards and required changes are, and must be, evaluated and adjusted during the business modelling process. Thus, the partners are able to assess the feasibility and fairness of the deal and to decide whether to enter, stay or leave the network (as proposed by Ring & van de Ven, 1994).
3. It functions as a high level coordination framework, through which explicit agreement over roles and responsibilities can be operationalised into formal coordination mechanisms, such as joint rules and procedures, and contracts (so being a necessary boundary object to realise Galbraith's (1977) coordination strategies for a network).

As a result of the business modelling process the network consists of selected partners that find the collaboration fair and feasible. The coordination is based growingly on trust: there is mutual interest to save transaction costs of ex-ante contracting, because of the growth of the network relations. And trust is supplemented with jointly agreed formal coordination mechanisms in the form of explicated business model.

13.3 Contribution 3: ICT is a versatile and powerful coordination mechanism

This thesis shows how the role of ICT in coordination has changed remarkably: Whereas in early 90's the main function of information systems was to collect and transmit information upwards in the hierarchy and thus help the managers to create and support coordination (Galbraith, 1977), today ICT can be applied to support a variety of coordination mechanisms. Our studies show how ICT is being applied for coordination purposes, for relieving both uncertainty and equivocality (Weick, 1975, 1979) of complex situations, for instance by supporting lateral relations and by institutionalising rules and procedures. We propose that it is a powerful and versatile mean of coordination, especially when being combined with other coordination mechanisms.

In addition, building on previous literature we introduce tentative communication vs. structure coordination grid, which can be used to analyse ICT support of networks (Thompson, 1967; Kumar & van Dissel, 1996; Katzy et al., 2004). We draw a theoretical conclusion that there seems to exist a relationship between the type of complexity, the network type and the set of ICT functionality adopted. There is no single right combination of ICT functionalities for different business networks, but it depends on the dimensions of complexity and the chosen network topology.

Last, we propose some recommendations for the future development of ICT support for networked business: We see a great need for ICT support for inter-organisational, confidential workshops and meetings, for analysis and estimation of the costs and benefits of different business models (by e.g. simulations and value modelling), and for predicting and managing the changes to actual operations (such as managing contract and customer information). The ICT-applications must also pay more attention to access rights, managing responsibilities and stating rights to the material in order to facilitate more smooth entry, operation and exit of partners.

14 QUALITY AND LIMITATIONS OF THE RESEARCH

In this subsection, we discuss how this thesis addresses the requirements of a good qualitative study. We discuss the quality of our research process in terms of its validity and reliability (see TABLE 13) and then examine the transferability (generalisability) and usability of the findings.

14.1 Validity and reliability

Validity refers to how well the observation measures what it purports to measure (Baskerville, 1996). Baskerville (1996) separates four distinct validity types: the extent to which the data from the base case(s) is related to the theory-under-test (Construct validity), will predict some important form of behaviour (Criterion or predictive validity), and the extent to which the causal analysis and explanations offered by the theory reflect the reality at the moment of the observation (Internal validity) and can be applied to similar phenomena (External validity).

One of means to improve validity is triangulation of data, i.e. development of convergencing lines of inquiry. Literature identifies five types of triangulation: triangulation of methods, sources or theories; triangulation through multiple analysts, and multiparadigm triangulation. In this thesis we have improved the quality of the research with

1. Methods triangulation; we have applied intensive case study, comparative case study and action research. Data collection methods include interviewing, observing, participating and utilisation of secondary data such as written documents and archives. The idea is to check out the consistency of findings generated by different methods and analyse inconsistencies.

TABLE 13 Validity, dependability and transferability

Yin 1984; Guba & Lincoln, 1994 ; Hoepfl 1997; Patton, 1999; Creswell & Miller, 2000; Cunningham, 1997; Lewis & Grimes, 1999; Sarker & lee, 1998; Eisenhardt & Graebner, 2007; Myers, 2009; Klein & Myers, 1999; Iversen, 2007; Iversen et al., 2004; Baskerville 1996

Requirements	***Study tactic***	***In this thesis:***
Validity - how accurately the observation measures what it purports to measure	Triangulation - of methods	Intensive case, comparative case, action research; Interviews, observations, workshops, discussions, secondary data, archival measures
	-of sources of data	Re-interviews of key informants, joint discussions backed up with individual interviews
	-through multiple analysts	Multiple researchers observing, interviewing and analysing data
.	-of theory -of paradigm	Post-positivistic paradigm & theories from organisation science vs. social constructionist / pragmatism & views of organisation science and network literature
	Have the key informants review draft case study report	The transcribed interviews were checked by the interviewed, at the same time same clarifying questions may have been asked, the final reports and articles were presented and were reviewed by key informants
	Collaboration with the participants	Active collaboration via workshops and meetings, several interviewees e-mailed material such as calculation and confidential reports after the interview
	Prolonged engagement in the field	Followed the development of the phenomenon of interest for more than 10 years in the same industrial sector, A credible account is achieved by building a tight and holistic discourse
Reliability - the extent to which the study can be repeated with the same results	Establish usefulness of results in the problem situation	The preliminary findings were discussed with the practitioners and their reflections were taken into account in the following improved versions
	Documentation: Use case study protocol and	Our protocol includes: a research plan, a description of case study interview topic, questionnaire outlines for interviews, schedules of interviews
- universality, repeatability, falsifiability	Develop case study data base	The audio files, notes and transcripts collected to cd-discs. The tabular materials and other documents and archival records are collected to cd-discs, or if no digital version was available, to paper archives
	Researcher's role and control in respect to the case organisations and the object being studied.	Scientific interest, no business or work relationship with the cases studied
		The research was carried out as disciplined research projects (project plans and contracts).
Transferability - usefulness of the results outside of its domain of known observations	Contextualisation	The setting, the participants, and the themes of this thesis are described in rich detail.
	Relate the results to existing bodies of knowledge and general concepts	The work and the findings build on previous theries, the findings are generalized to theoretical constructs

2. Triangulation of sources, i.e. examining the consistency of different data sources within the same method. This means comparing and cross-checking the consistency of information derived at different times and by different means within qualitative methods. In this thesis we compared observational, or data obtained from workshops e.g. with interview data; checked for the consistency of what people say over time; and compared the perspectives on coordination in differing contexts.
3. Triangulation through multiple analysts; this thesis is based on joint research of several researchers. By using several researchers we tried to reduce the potential bias that comes from a single person doing all the data gathering, analysis and synthesis. Furthermore, having two or more researchers analysing and comparing findings provided an important check on selective perception and blind interpretive bias.
4. Theory triangulation: A fourth kind of triangulation involves using different theoretical perspectives or theories to look at the same phenomenon. Here we have utilised theories and frameworks from traditional organisation science and compared them to views of learning organisations, ICT, change management and business networks.
5. Multiparadigm triangulation; Lewis and Grimes (1999) propose applying multiple paradigms and their respective data collection and analysis methods as means of highest level of triangulation. In this thesis we applied two differing research philosophical views, namely post-positivistic and pragmatism in order to examine the phenomenon of interest as it evolved in time.

Another technique we have applied to improve the quality of this research was to *have key informants review the case study reports:* The procedure is to have the reports reviewed not just by academic colleagues, but also by the participants and informants in the cases. Even though no objective truth may exist, the process helps in identifying the various perspectives. The corrections made in this review process increase the internal validity and also the usefulness of the results in the problem situation of the study (Iversen, 2007; Iversen et al., 2004). In our study the transcribed interviews were sent to the interviewees for checking. At the same time some additional clarifying questions may have been posed. Many of the interviewees also e-mailed us some data or confidential studies later on to back up their interview. Also the articles produced in the research projects were presented to and acknowledged by our key informants.

In this thesis we attempted to provide explanation of the phenomenon being studied and to reveal new knowledge that would not be found without qualitative, in depth research strategy. Especially, as the aim of this thesis is to study a dynamic phenomenon, our decision to use longitudinal qualitative approach is justified; we could avoid the problem of having only a 'snapshot' view of the phenomenon, and were able analyse changes in the object of our study within longer periods of time.

For the above reasons we are quite confident about the validity of our research. However, there is also another side of the coin: The use of multitude

of triangulation types also results in a vast data set collected with differing methods, frameworks and paradigms. This clearly sets major challenges in establishing *chain of evidence,* which would improve reliability (qualitative researcher prefers to speak about dependability). That is the study should be constructed in a way that a reader can follow the derivation of evidence from initial research questions to conclusions. Sarker and Lee (1998) set a good example for establishing chain of evidence by creating a detailed processual narrative of the case study prior to testing the statements. It provides the reader with a sense of the sequence of events that led to a particular outcome from the point of origin, and allows the reader to make his own judgments about the validity of the case study (see Appendix C: an exception of the processual narrative from the start of my research). Other techniques used here for addressing data reliability include direct quotes from transcribed interviews (e.g. in Chapter 4). We have set up a study database (see e.g. Huberman and Miles, 1998) which includes all the study notes; study documents such as interview tapes and transcribes; and secondary data collected during this research. The list of research data is included in the appendix B and an example of interview outline is in Appendix D.

The reader may also wonder what kind of experience or personal connections I have to the people and topic studied. I finalised my licentiate thesis at the Helsinki School of Economics in 1996 on Information Systems. During my HSE years I did some conceptual research and also took part as a junior researcher in a case study. Coincidentally, the organisation M was also one of the case organisations in that study. My personal motivation for this research came solely from the prospects it provided for scientific work which would also help the practitioners to learn about coordination.

In 1998 I was hired to University of Jyväskylä to a research project funded by the Academy of Finland. The project was initiated by the university and the company M agreed as the case company. Chapter 4 is an outcome of that project. Chapter 5 is written based on a study on ICT support for coordination of global projects funded by the participating organisations. Also this research project was initiated by the researchers. To the contrary, the action research reported in Part II was initiated by one of the companies. It started with a study funded by 6 companies, and was followed by another research project funded by Finnish funding agency for technology and innovation, Jyväskylä Innovation Ltd. (local innovation incubator company) and three companies. All projects had written research plans describing the project management, schedules and the scientific goals of the projects. Furthermore, in the last action research study all the partners signed a consortium agreement.

Since this thesis is written on the basis of team work, it is correct to evaluate my own contribution to the research: I have participated in generating the research ideas and questions, as well as deciding over the methodology, research methods and research design in all research projects. Similarly I personally took part in all data collection, analysis and interpretation. Four chapters are modified for this thesis by me based on previously published co-

authored papers; others are products of my own. More detailed information is available in Appendix A.

14.2 Transferability and usability (Generalisability)

Generalisability of the research results is often considered as a dominant measure of good research. Whereas nomothetic scientific work aims to prove its truthfulness and legitimacy by statistical generalization to a certain population, many systems thinkers have argued that the purpose of IS research needs to be to produce actionable knowledge, that is, rules of thumb which can be used by people or organisations to solve problems (Metcalfe & Lynch, 2002).

This thesis draws on the research carried out in co-operation with companies. The participating people from the business shared with us researchers the interest on the topic of coordination: the practitioners looking ways to improve the coordination in practice and us researchers looking ways to understand the evolving phenomenon of organisational coordination. This work, especially towards the end of the thesis, attempted to build new constructs and theories by building on previous literature, on reflective cooperation with practitioners, and by examining the extensive empirical data. We applied deductive and abductive reasoning to derive theoretical findings. We followed the principle of dialogical reasoning (Klein & Myers, 1999) meaning that we were sensitive to possible contradictions between our theoretical preconceptions and actual findings.

As a result the thesis generalises the findings to theoretical constructs and models hopefully of interest to wider research community (Klein & Myers, 1999; Iversen et al., 2004; Baskerville 1996). The validity and reliability of the developed constructs and theories within the observed cases were verified in previous section.

Ultimately, we were not interested only in development of the theories for the studied base cases, but also in the utility of these theories in other business settings (Lee & Baskerville, 2003). For that reason, we kept the frameworks and models not too vague and not too detailed, so that they could be useful and valid beyond the observed cases. These constructs explain coordination, not in the predictive sense of the word, but as a kind of road map or guide that can be of help when practitioners are negotiating and deciding over coordination mechanisms for their business networks.

In this thesis the evolving phenomenon of coordination was examined in networks providing high-technology products and services for global markets in manufacturing and ICT industry, but it is probable that the findings would be transferable also to other industries characterised by differing compositions of organisational network relationships supported by smart ICT.

15 FURTHER STUDIES

This dissertation has attempted to open up a new avenue of research on the topic of coordination in collaborative business networks. It has expanded our knowledge on the phenomenon of organisational coordination and brought the business model into the central focus as the enabler of network coordination when collaboration and knowledge sharing is wished for. There are still many ways in which we can further our understanding related to coordination of business networks. Next, we set out our future research questions continuing the research avenue.

A scholarly continuation of our studies would be to question our results by making hypothesis that could be quantitatively or qualitatively tested in other contexts. Then the validity and generalisability of the findings could be assessed.

Furthermore, since the aim of the thesis was to produce new knowledge on an evolving phenomenon of organisational coordination, it would be fascinating to study the importance of coordination mechanisms as the network evolves from early phases to maturity, and to closing stages.

Moreover, more conceptual studies could be carried out to define the ontology and process for the network business model more carefully. This topic was touched only slightly in this thesis. Ideally, this could work as a guideline for the networks in building their coordination structures and in selecting appropriate coordination mechanisms.

In addition to the above mentioned topics, an interesting area of research is related to the knowledge sharing and learning within networks. A research topic worth of following would be to study whether networks actually favour learning and innovation as suggested in the literature. How R&D activities and intellectual property right questions are/could be organised?

And last, but not least, it would be important to study the communication and information systems supporting networked business. The challenge for ICT is to provide smart support for these intellectual dynamic processes within business networks. What are the requirements and limitations of these systems

for differing types of networks, and during the differing phases of the network? How can we simulate business models and how they can be transferred to business process models? If, as we suggested, the full integration of partner's ICT systems is not the best solution, what are then suitable levels of integration for networks? Are there any solutions to the problems related to the ownership and the usage of the systems: high costs to the investing partners, power issues, trust issues, security, and ownership of the data?

In our currently on-going studies we already carry on with some of the research avenues set out in this thesis, such as studying the requirements for ICT systems for networks, and the challenges of managing innovation in networked relationships. On a whole, the topic is found important by both practitioners and academics: for example several national research agendas point out business networks and management of network relationships as one of major focus areas. Similarly, international research consortiums, such as Smart Business Networks, in which University of Jyväskylä has participated since its establishment, enable the co-operation between and across the researchers and industry on the topics of business networks and information systems. This co-operation guarantees that the research focuses on questions that are considered important for advancement of science and for practical management of networks as well. The active research community – in which also I intend to belong – will ensure that the research around the phenomenon will continue.

16 EXECUTIVE SUMMARY

This thesis focuses on the topic of organisational coordination. The aim is to gain more understanding on how activities are coordinated, how coordination differs within time and context, and what is the role of information and communication in coordination. The objective is, through multiparadigm research methodology, to bring out conceptual coordination frameworks that can be helpful when considering coordination of complex operations over organisational boundaries. Of particular interest is the role of ICT in coordination.

Organisational coordination is examined as a dynamic phenomenon, focus of which shifted in the course of time from coordination of organisational activities within traditional boundaries of companies to coordination of joint activities that are spread over a network of companies. This shaped also the nature of the research, so that in line with the evolution of the phenomenon this thesis consists of two research methodological approaches, post positivism and pragmatism. The research builds on literature from multiple domains, such as organisational science as well as literature on organisational learning, organisational networks and information systems. This way it seeks to achieve a richer longitudinal view on the phenomenon. The empirical research methods follow the methodological choices: The thesis starts with a post-positivistic case study examining evolution of complexity and coordination. This is added with a more specific comparison case of ICT tools for coordination. And last, the phenomenon is studied in an action research following the pragmatist research tradition.

The major contributions of this thesis are the following:

1. **Evolution of coordination**: Building on empirical data covering a period of 18 years we observe how the coordination in business has evolved from coordination of 'in-house' resources and information into coordination of collaboration in business networks. This change, to our mind, calls for a similar change in frame of reference applied to understand selection of suitable coordination mechanisms.

Traditional models and frameworks of organisations often consider organisations as cybernetic systems, where managers are expected to apply their hierarchical power in coordination decisions in order to maintain the fit between the external environment and the internal hierarchy. We show that a slightly improved Galbraith's framework (1977) is a compelling reference when conceptualising organisational coordination in situations where the organisational boundaries between what is considered as internal and what is considered as external environment are clear. The model depicts the coordination mechanisms that managers can apply to produce the so-called hierarchical coordination (in contrast to market mechanisms). It can be fruitful in analysing the evolution of both complexity and coordination mechanisms in the traditional organisational context.

2. **Business modelling process – a coordination framework for collaborative networks**: However to understand coordination in collaborative networks we should rather adopt conceptual frames that values - instead of stability – learning and adaptiveness. In this thesis, through one case, we show how the process of business modelling can provide a new conceptual frame for organisational coordination. We suggest that collaborative business networks would benefit from using business models as a dynamic boundary object. The network's business model has a triple role: First, it's creation and modification plays a significant role in facilitating the mutual learning and creation of trust between the partners; Second, it functions as a mean to assess the fairness of the deal, based on which the independent parties can make their decision whether to enter, stay or leave the network; and third it functions as a high level coordination framework, which is operationalised in joint rules and procedures, and parts of it are confirmed as formal contracts.
3. **ICT is a versatile and powerful coordination mechanism** This thesis shows the importance of ICT in coordination: ICT can leverage and institutionalise the effects of any other coordination mechanisms (Galbraith, 1977), it can be integrated into any component of a business model (Osterwalder & Pigneur, 2002), and it can mediate the relationships between boundary spanners. The versatility makes ICT a powerful coordination mechanism both within organisations and in networks.
   Building on previous literature we introduce tentative communication vs. structure coordination grid, which can be used to analyse ICT support of networks (Thompson, 1967; Kumar & van Dissel, 1996; Katzy et al., 2004). We draw a theoretical conclusion that there seems to exist a relationship between the type of complexity, the network type and the set of ICT functionality adopted. Overall, our study hints that there seems to be no one right combination of ICT functionalities for all business networks, but it is always dependent on the level of complexity dimensions and the network topology. However, it should be remembered that ICT, being rather costly and slow to change, tends to lock the companies to the selected line of coordination. For this reason, the companies should be

active in making the decisions, so that they are not drifted in a situation where the ICT systems reinforce a network structure and processes that were not intended.

Last, we propose some recommendations for the future development of ICT functionalities for networked business: We point out the need to support the learning intensive process of business modelling (such as tools for inter-organisational, confidential workshops and meetings), for analysis and estimation of the costs and benefits of different business models (such as tools for simulations and value modelling), and for predicting and managing the changes to actual operations (such as tools for managing contract and customer information). The ICT-applications must also pay more attention to ownership, access rights, managing responsibilities and rights to the information in order to facilitate more smooth entry, operation and exit of partners.

The conclusions presented above are a step towards providing theoretically and empirically supported understanding of coordination in networked settings. They are based on qualitative case studies, in an aim to produce new concepts and frameworks. Further research in different contexts could test the relevance and advance further the business process modelling approach to network coordination and the development of ICT for networks.

YHTEENVETO (FINNISH SUMMARY)

Tämä tutkimus keskittyy verkostomaisen liiketoiminnan koordinointiin ja sen pyrkimyksenä on ymmärtää miten verkoston toimintaa voidaan ohjata ja kuinka koordinoinnin tavat ja menetelmät ovat muuttuneet ajan myötä. Tavoitteena on moniparadigmaatisen tutkimusmetodologian avulla luoda uusia käsitteellisiä viitekehyksiä, jotka auttavat jäsentämään ja kehittämään monimutkaisten verkostuneiden liiketoimintasuhteiden koordinointia. Erityisen mielenkiinnon kohteena on tieto- ja kommunikaatioteknologian (ICT) rooli koordinoinnissa.

Tutkimuksessa koordinointia tarkastellaan organisaatioteorioiden, organisaation oppimisen, verkostomaisen toiminnan ja ICT tutkimuksen kautta ja siinä hyödynnetään tietoja, jotka kerättiin usean tutkijan voimin kolmessa eri tapaustutukimuksessa. Nämä tiedot muodostavat pitkittäisaineiston, joka kuvaa verkostomaisen toiminnan kehittymistä sekä tapoja sen koordinoimisessa 18 vuoden ajalla.

Työn teoreettiset kontribuutiot liittyvät koordinaation painopisteen muutokseen organisaation perinteisten rajojen sisällä tapahtuvan toiminnan ohjauksesta kohti useista yrityksistä koostuvan verkoston toiminnan johtamiseen ja sen myötä uudenlaisten teoreettisten koordinaatiota kuvaavien mallien tarpeeseen, kuten liiketoimintamallin hyödyntämiseen verkoston ohjauksessa. Lisäksi tarkastellaan ICT:n merkitystä koordinaatiomekanismina:

1. Perinteiset koordinaatiomallit ja -viitekehykset yleensä kuvaavat yrityksen toiminnan johtamista ja hallintaa systeeminä, jossa johtajat käyttävät asemaansa perustuvaa valtaa päättäessään miten toiminnat organisoidaan ja hallitaan. Organisaation sisällä tehtävien muutoksien tavoitteena on mukauttaa toimintatavat sopimaan muuttuneisiin ulkoisen ympäristön vaatimuksiin. Työn alkuosassa sovellamme hieman päivitettyä Jay Galbraithin vuonna 1977 esittelemää koordinoinnin mallia kuvaamaan ja käsitteellistämään yrityksen soveltamia ohjauksen menetelmiä silloin kuin tarkastelun kohteena on yksittäinen yritys. Tämä malli koostuu hierarkiaan perustuvista ohjausmekanismeista, joita käyttöönottamalla yritys voi epävarmuuden kasvaessa sovittaa informaation prosessoinnin kapasiteettinsa vastaamaan paremmin informattion prosessoinin tarvetta. Malli osoittautui case-tutkimuksessamme hedelmälliseksi keinoksi analysoida niin kompleksisuuden kasvua kuin yrityksen soveltamien koordinaatiokeinojen muutosta.
2. Pitkittäistutkimuksessamme voitiin kuitenkin havaita kuinka koordinointi yritystoiminnassa on siirtynyt organisaation sisäisten toimintojen ja informaation hallinnasta yhä enemmän aktiviteettien koordinointiin liiketoimintaverkostoissa. Tämän myötä myös perinteisten organisaatioteorioiden esittämien viitekehysten ja

ajatusmallien tilalle tarvitaan uudenlaisia malleja kuvaamaan koordinaatiota ja sen menetelmiä. Tasapainon ja epävarmuuden vähentämisen sijaan pääpaino onkin usein verkoston oppimisessa ja muutosherkkyydessä. Tässä väitökirjatutkimuksessa esitellään empiirisen tapauksen avulla kuinka verkoston liiketoimintamallin kehittämisprosessi voisi toimia uudenlaisena kehikkona ja dynaamisena rajaobjektina verkostomaisten liiketoimintasuhteiden ohjauksesta sovittaessa. Liiiketoimintamallilla nähtiin olevan kolmenlainen rooli: ensiksikin liiketoimintamallin luominen ja muokkaaminen verkoston toimijoiden yhteistyönä auttaa oppimista ja tiedon vaihtoa sekä helpottaa luottamuksen syntymistä verkoston sisällä. Toiseksi, se toimii välineenä, jonka avulla kukin osapuoli voi arvioida yhteistyön hyödyllisyyttä ja siten tehdä päätöksen verkostoon liittymisestä, pysymisestä tai eroamisesta. Kolmanneksi, liiketoimintamallin kehittämisprosessi toimiii korkeantason viitekehyksenä koordinaatiomekanismien luomiselle, sillä sen aikana osapuolet neuvottelevat tärkeimmistä yhteisistä pelisäännöistä, jotka lopulta sisällytetään formaaleihin sopimuksiin sekä operationalisoidaan verkoston prosesseihin, käytänteisiin ja informaatiojärjestelmiin.

3. Tämä väitöstutkimus myös tuo esiin ICT:n tärkeyden koordinointityössä. Tieto- ja kommunikaatioteknologioiden monimuotoisuus tekee niistä voimallisen koordinaatiomekanismin niin yksittäisen yrityksen sisällä kuin verkostossakin. Sen avulla voidaan institutionalisoida sääntöjä ja toimintatapoja ja se voidaan integroida mihin tahansa liiketoimintamallin peruskomponenteista (esim osana tuotetta, tuotantoa, toimitusta, asiakassuhteen hoitoa jne.). Sillä voidaan myös auttaa verkoston jäsenten välistä kommunikointia. Aiempaan kirjallisuuteen pohjautuen esittelemme yksinkertaisen nelikentän koordinaatiomekanismien luokittelulle: horisontaalinen akseli kuvaa strukturointiin perustuvan koordinaation käytön laajuutta ja vertikaalinen taas kuvaa kommunikaation käytön astetta koordinointityössä. Teorian ja tieto- ja kommunikaatiojärjestelmiin fokusoidun empiirisen analyysin perusteella näyttäisi siltä, että kompleksisuuden muodolla sekä verkoston rakenteella on vaikutusta siihen minkälaisia toiminnallisuuksia verkostot haluavat omiin tietojärjestelmiinsä toteutettavan. Lopuksi annamme joitakin suosituksia ICT:n kehittämiseksi paremmin verkoston koordinoinnin tarpeita vastaavaksi. ICTn tulisi mielestämme tukea paremmin oppimisintensiivistä liiketoimintamallinnuksen prosessia (esim. tarjoamalla välineitä yritystenvälisten, luottamuksellisten työpajojen ja tapaamisten organisointiin ja dokumentointiin), sen tulisi auttaa analysoimaan ja arvioimaan vaihtoehtoisten liiketoimintamallien kustannuksia ja hyötyjä (kuten simuloinnit ja arvonmallinnukset), ja

ennustamaan sekä hallinnoimaan muutoksia varsinaisissa operaatioissa (kuten työkaluja, joilla voi hallinnoida sopimuksia ja asiakastietoja). Tarvetta olisi myös parantaa ICT-sovelluksien pääsyoikeuksien ja vastuiden hallinnointia sekä tiedon omistajuuteen liittyviä seikkoja ottaen huomioon sen, että erilaisten yritysten tulisi pystyä sujuvasti liittymään, tomimaan sekä irtautumaan verkostosta ja sen tietojärjestelmistä.

Tässä työssä on luotu uusia käsitteellisiä malleja ja viitekehyksiä, joiden tarkoituksena on hyödyttää niin tutkimusyhteisöä kuin myös verkoston koordinointimekanismien luomista käytännössä. Lisätutkimukset toisenlaisissa konteksteissa ovat kuitenkin tarpeellisia, jotta tässä työssä esitettyjen mallien ja viitekehysten hyödyllisyyttä ja hyvyyttä voitaisiin arvioida ja niitä voitaisiin kehittää edelleen.

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VOCABULARY

Abductive reasoning — abduction was originally presented by Charles S. Peirce (1839-1914) as a "weak", third main mode of inference besides deduction and induction. He proposed that abduction is closely related to many kinds of cognitive processes, such as instincts, perception, practices and mediated activity in general (Paavola, 2004; Burch, 2006). Abduction is formally formulated as follows: "The surprising fact, C, is observed; But if A were true, C would be a matter of course. Hence, there is reason to suspect that A is true" (Peirce, 1903, as cited in Paavola, 2006, p. 39).

Action research — a research method that focuses on research and learning through intervening and observing the process of change in real settings (Baskerville, 1999).

Asset specificity — the extent to which the investments made to support a particular transaction have a higher value to that transaction than they would have if they were redeployed for any other purpose. Williamson (1985) argued that transaction-specific assets are non-redeployable physical and human investments that are specialised and unique to a task.

Business model — tells how the strategy is implemented by describing e.g. product offering, IT-infrastructure, financials customers and supplier relationships. "The business model depicts the content, structure, and governance of transactions designed so as to create value through the exploitation of business opportunities" (Amit & Zott, 2001, p. 493).

Business network — the network of connected organisations mutually and cooperatively working together.

Boundary object — the concept was introduced by Susan Leigh Star and James R. Griesemer (1989, p. 393):*"Boundary objects are both plastic enough to adapt to local needs and constraints of the several parties employing them, yet robust enough to maintain a common identity across sites. They are weakly structured in common use, and become strongly structured in individual-site use. They may be abstract or concrete. They have different meanings in different social worlds but their structure is common enough to more than one world to make them recognizable means of translation. The creation and management of boundary objects is key in developing and maintaining coherence across intersecting social worlds."*

Boundary spanning	refers to behaviours intended to establish relationships and interactions with external actors (Marrone et al., 2007). Boundary spanners are people who maintain the inter-organisational relationships and who interact with their equivalents in client or supplier or other external organisations.
Collaborative business network	is in this book defined as a group of participating businesses that agree to cooperate in some novel, knowledge enhancing ways and to depend on each other to some extent, in an aim to reach business objectives, perceived by each participant as fair play, and sustainable over time as a network.
Comparative case study	a comparison case (Stake, 1994), where attention is fixed upon the few attributes being compared instead of providing a 'thick description' of the cases. In the comparison, the analyst develops an understanding why certain conditions did or did not occur, and then offers interpretation.
Complexity	includes both uncertainty defined by Galbraith (1977) as absence of information, and equivocality defined by Weick (1975, 1979) as ambiguity, the existence of multiple and conflicting interpretations about situation.
Constructivism	is grounded in the conception that such phenomena as science, knowledge, evidence and truth are *social constructions.* Constructions are not "true", in any absolute sense. Instead, knowledge is seen impermanent and situated historically and culturally.
Coordination	management of dependencies between activities (Malone & Crowston, 1994).
Coordination actions	include all the information processing necessary to coordinate the work of people and machines that perform the primary processes (Malone & Crowston, 1994).
Coordination framework	theoretical constructs that help to analyse and explain actions taken to improve coordination.
Coordination mechanism	means or methods that aim at coordination by providing structure for the activities or by facilitating the interaction between the actors.
Cybernetic system	**"***is a system that possess input, state and output, and consequently an evolution equation. Such a system is cybernetic if it is possible to distinguish an observational*

	sequence (of the inputs), followed by a decisional sequence leading to the effectors organs (related to outputs), being well understood that the observational sequence allows the system to observe its environment and itself." (http://www.imprint.co.uk/thesaurus/cybernetic%20system.htm)
Delivery project	delivery of goods to customers organised as projects. Includes project management activities and tasks from acquisition to shipping and installation. Often refers to delivery of customer specific products and services.
Deductive reasoning	deductive reasoning works from the more general to the more specific. Deduction yields *valid* conclusions, which must be true given that their premises are true (Johnson-Laird, 1999).
Epistemology	the study of knowledge and justified belief (Steup, 2006).
Equivocality	situations marked by equivocality are ambiguous and thus subject to multiple interpretations (Weick, 1979; Daft & Lengel, 1986).
Inductive reasoning	inductive reasoning works, moving from specific observations to broader generalisations and theories. E.g. Klauer (1996) describes induction as the process whereby regularities or order are detected and, inversely, whereby apparent regularities, seeming generalisations, are disproved or falsified.
Intensive case study	in intensive case studies the researcher develops an intensive understanding of the events and practices of one person, group, or organisation. The aim is to provide a history, description, or interpretation of unique and typical events. (Stake, 1994).
Interdependency	is when two or more organisations must take each other into account if they are to accomplish their goals (Crowston, 1994).
Ontology	the study of being or existence. Ontological assumptions are the assumptions of the very essence of phenomenon under investigation (Burrell & Morgan, 1979).
Organisation	1) the action of organising something; the structure or arrangement of related or connected items; an efficient and orderly approach to tasks, 2) an organised body of people with a particular purpose, esp. a business, society, association, etc. (Oxford English Dictionary).

Multiparadigm Approach	by applying several paradigms we can analyse the topic of interest from several angles and thus via multiparadigm triangulation are able to reach a richer and more extensive view on it (Lewis and Grimes, 1999).
Positivism	positivism holds that the only authentic knowledge is scientific knowledge, and that such knowledge can only come from positive affirmation of theories through strict scientific method. (www.en.wikipedia.org/wiki/Positivist)
Post-positivism	a relieved version of positivism that preserves the basic assumptions of positivism, i.e. ontological realism, the possibility of objective truth, and the use of experimental methodology. (Denzin & Lincoln, 1994).
Pragmatism	presented by American scientists C.S. Peirce, William James and John Dewey. Especially Jamesian pragmatism sees that we can never distance ourselves from our purposive human action. (Pihlström, (1996).
System	an organised or connected group of objects; a set or assemblage of things connected, associated, or interdependent, so as to form a complex unity; a whole composed of parts in orderly arrangement according to some scheme or plan (Oxford English Dictionary).
Systems thinking	is generally divided into two parts: "*Hard systems thinking assumes that the world is a set of systems (i.e. is systemic) and that these can be systematically engineered to achieve objectives. In the soft tradition, the world is assumed to be problematic, but it is also assumed that the process of inquiry into the problematic situations that make up the world can be organized as a system. In other words, assumed systemicity is shifted: from taking the world to be systemic to taking the process of inquiry to be systemic (Checkland 1983, 1985b).*" Checkland (2000, p. 49).
Transaction costs	incur in making an economic exchange. Examples are search and information costs, bargaining costs and policing and enforcement costs. Williamson (1985) applied temporal categorisation for these costs, before (*ex ante*) and during or after the transaction (*ex post*). Ex ante refers to the effort of pre-specifying the details of transaction (e.g.

	agreement) in beforehand of its execution. Ex post relates to the situation where transaction fails and the parties should engage in actions to correct misalignments.
Trust	can be defined as faith in the goodwill of others not harm your interests when you are vulnerable to them (van de Ven and Ring, 2006). In short, trust is based on the expectation that others will behave as expected (Jarvenpaa et al. 1998).
Uncertainty	is defined by Galbraith as "*the difference between the amount of information required to perform the task and the amount of information already possessed by the organization*" (Galbraith, 1977, p. 37).

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Appendix A: contributors in this thesis

What?		*Who?*
CH4	*Research idea*	The initial research idea of studying Galbraith's model was proposed by Kalle Lyytinen (K.L.). Marikka Heikkilä (M.H.) developed the idea further.
	Research questions	M.H., taking into consideration the research already conducted by other researchers Eija Karsten (E.K.) , Ojelanki Ngwenyama (O.N.) and K.L.
	Research methodology	M.H.
	Methods	Case method was selected by M.H. and K.L.
	Research design	M.H.
	Data collection	First contact to the case organisation was arranged by K.L..- M.H. got access to data collected before in the case org. From that on data was collected primarily by M.H.
	Analysis	M.H.
	Interpretation	M.H.
	Writing	M.H. wrote the chapter. K.L. commented some early versions. Also a case study was written on the topic: Applegate, L., Heikkilä, M. & Lyytinen, K. (2004), Metso Paper: Globalization of Finnish Metal Workshops Harvard Business School Case (9-805-057) and Teaching Note (9-805-058).
CH5	*Research idea*	The initial research idea of the study was by M.H.
	Research questions	Team - M.H., Vesa Kortteinen (V.K.), Petri Mäkinen (P.M.), Tommi Vigman (T.V.), Jukka Heikkilä (J.H) and Timo Riipinen (T.R.)
	Research methodology	M.H.
	Methods	M.H.
	Research design	M.H. developed the research design together with the company representatives. Access to the other case was arranged by J.H.
	Data collection	Team
	Analysis	Team
	Interpretation	M.H. interpreted the data in collaboration with the research team.
	Writing	M.H. wrote the chapter. A previous unpublished version was co-authored by J.H.
CH7	*All*	M.H.
CH8	*Research idea*	The initial idea to study networks came from company M. The research idea was developed further by the research team - J.H., M.H., and in some instances Hannu Vahtera (H.V.) later on followed by Jari Lehmonen (J.L).
	Research questions	The research questions were decided by the team in co-operation with the practitioners.

	Research methodology	Team
	Methods	Team
	Research design	Team
	Data collection	Team, with the help of Jani Rahja (J.R), Ville Manninen (V.M.), Heikki Paananen (H.P.), Peter Törnroos (P.T.), Kirsti Korhonen (K.K.) and Jun Li (J.L.).
	Analysis	M.H., J.H. and J.L.
	Interpretation	M.H. and J.H.
	Writing	Ch 7 is modified by M.H. from previous articles Heikkilä, J., Heikkilä, M. & Tinnilä, M. (2005b). The Role of Business Models in Developing Business Networks, in T. Saarinen, M. Tinnilä & A. Tseng (eds.) *Managing Business in a Multi-Channel World: Success Factors for E-Business*, Idea Group, Inc., Hershey, p. 232-246. Heikkilä, J., Heikkilä, M. & Lehmonen, J. (2004). Joint Development of Novel Business Models, in W. Lamersdorf, V. Tschammer & S. Amarger (eds.) *Building the E-Service Society*, Kluwer Academic Publishers, Boston, p. 433-454. Heikkilä, M. & Heikkilä, J. (2006). Liiketoimintamalli yritysverkoston kehittämisen välineenä, *Konsepti*, 3(1), available from www.muutoslaboratorio.fi/konsepti
CH9	*Research idea*	The research idea was developed by the research team - J.H., Samuli Pekkola (S.P.) and M.H.
	Research questions	Team
	Research methodology	Team
	Methods	Team
	Analysis	Team
	Interpretation	Team
	Writing	Chapter is modified by M.H. from book chapter Heikkilä, J., Heikkilä, M. & Pekkola, S. (2008). Coordinating and boundary spanning roles of business networks, in P. Vervest, E. Van Heck & K. Preis (eds.), Smart Business Networks: a new paradigm, ERIM, Rotterdam, p. 411-430.
CH10	*Research idea*	Team - J.H., M.H. and J.L.
	Research questions	The research questions were decided in co-operation with the practitioners.
	Research methodology	Team
	Methods	Team
	Analysis	Team
	Interpretation	M.H., J.L. and J.H. The practitioners commented.
	Writing	Chapter is modified by M.H. from a journal paper Heikkilä J., Heikkilä M., Lehmonen J., (2005a). Sharing for understanding and doing for learning: An Emerging Learning Business Network, *ICFAI Journal of Knowledge Management*, 3(1), p. 28-45.

CH11	*Research idea*	The research idea was developed by the research team - J.H., S.P. and M.H.
	Research questions	Team
	Research methodology	Team
	Methods	Team
	Analysis	Team
	Interpretation	Team
	Writing	Chapter is modified by M.H. from book chapter Heikkilä, J., Heikkilä, M., Lehmonen, J. & Pekkola, S., (2005c). Smart ICT Support for Business Networks, in P. Vervest, E. van Heck, K. Preiss, L-F. Pau (Eds.) Smart Business Networks, Springer, Berlin, p. 389-404

Appendix B: Empirical data

Interviews

Ref.		*Informant*	*Position*	*Company*	*Network of business units*	*Network of subcontractors*	*Network of independent companies*	*Date*	*Interviewer*	*Data*			
										Recorded	*Transcribed*	*Memo*	*I participated personally*
V	1	H.J.	VP,Project development	M	x			1.11.97	O.N. + K.L.	1	1		
V	2	V.I.	Infrastucture	M	x			26.3.98	E.K.	1	1		
V	3	H.J.	VP,Project development	M	x			8.12.00	M.H. + K.L.			1	1
V	6	Y.E.	VP, Engineering	M	x			30.3.01	M.H.	1		1	1
V	7	H.A.	VP, Purchasing	M	x			2.4.01	M.H.	1		1	1
V	8	H.E.	VP, References	M	x			18.4.01	M.H.	1	1		1
V	9	K.J.	VP, projects	M	x			26.4.01	M.H.	1		1	1
V	10	N.M.	VP, Finance and Administration	M	x			10.5.01	M.H.	1		1	1
V	11	K.M.	Vice president of RTD	M	x			1.7.02	M.H.	1	1		1
V	12	K.L.	VP, care and maintenance	M	x			28.5.02	M.H., J.R., J.H. + H.V.	1	1		1
V	13	H.E.	VP, Maintenance	M	x			12.6.02	M.H.	1	1		1
V	14	S.S.	VP, proj development	N		x		24.3.06	P.M. + V.K.	1	1		
V	4	H.J.	VP of proj development + VP										
V	5	K.K.	of projects,	M	x			9.3.01	M.H.	1	1		1
S	1	K.J.	Care & Maintenance	M sister			x	20.6.02	J.R.	1	1		
S	2	H.A.	Care & Maintenance	M sister			x	27.5.04	K.K.			1	
P	1	P.E.	Project manager	M	x			9.6.97	E.K.	1	1		
P	2	V.J.	Project manager	M	x			9.6.97	E.K.	1	1		
P	3	H.J.	Project manager	M	x			9.6.97	E.K.	1	1		
P	4	K.O.	Project manager	M	x			9.6.97	E.K.	1	1		
P	5	H.I.	Project manager	M	x			10.6.97	E.K.	1	1		
P	6	L.J.	Project manager	M	x			10.6.97	E.K.	1	1		
P	7	M.E.	Project manager	M	x			11.6.97	E.K.	1	1		
P	8	I.J.	Project manager	M	x			11.6.97	E.K.	1	1		
P	9	R.K.	Project manager	M	x			11.6.97	E.K.	1	1		
P	10	M.T.	Project manager	M	x			11.6.97	E.K.	1	1		
P	11	T.O.	Project manager	M	x			12.6.97	E.K.	1	1		
P	12	K.M.	Project manager	M	x			12.6.97	E.K.	1	1		
P	13	H.M.	Project manager	M	x			1.11.97	O.N. + K.L.	1	1		
P	14	R.K.	Project manager	M	x			1.11.97	O.N.	1	1		
P	15	T.J.	Project manager	M	x			1.11.97	O.N.	1	1		
P	16	H.P.	Project manager	M	x			1.12.97	O.N.	1	1		
P	17	I.J.	Project manager	M	x			25.3.98	E.K.	1	1		
P	18	K.O.	Project manager	M	x			1.5.99	K.L.	1	1		
P	19	K.H.	Project manager	M	x			1.5.99	K.L.	1	1		
P	20	R.A.	Project manager	M	x			1.5.99	K.L.	1	1		

Interviews cont.

Ref.		*Informant*	*Position*	*Company*	*Network of business units*	*Network of subcontractors*	*Network of independent companies*	*Date*	*Interviewer*	*Data*			
										Recorded	*Transcribed*	*Memo*	*I participated personally*
P	23	I.J.	Project manager	M	x			25.4.01	M.H.	1		1	1
P	24	S.T.	Project manager	M	x			25.4.01	M.H.	1		1	1
P	25	T.J.	Project manager	M	x			15.3.06	M.H. + T.V.	1	1		1
P	26	R.K.	Project manager	M	x			15.3.06	M.H. + T.V.	1	1		1
O	1	H.V.	Deleloper of the Tasman	M	x			1.11.97	O.N.	1	1		
O	2	A.A.	Engineering	M	x			27.3.98	E.K.	1	1		
O	3	H.O.	Production manager	M	x			4.4.01	M.H.	1		1	1
O	4	R.P.	Customer training	M	x			6.4.01	M.H.	1		1	1
O	5	K.S.	+ Market information Manager										
O	6	H.E.	Sales manager	M	x			17.4.01	M.H.	1		1	1
O	7	L.L.	Mger, master scheduling	M	x			24.4.01	M.H.	1		1	1
O	8	S.T.	Office manager	M	x			3.5.01	M.H.	1		1	1
O	9	T.E.	IS manager	M	x			4.5.01	M.H.	1		1	1
O	10	J.K.	Care & Maintenance	M	x			5.7.02	M.H.	1	1		1
O	11	H.V.	Project manager	M	x			15.3.06	M.H. + T.V.	1	1		1
O	12	H.J.	Project & references, infra	N		x		23.3.06	P.M. + V.K.	1	1		
O	13	V.T.	ICT manager of projects	N		x		23.3.06	P.M., V.K. + T.V.	1	1		
O	14	V.T.	Manager, Scheduling	N		x		7.7.06	T.V. + T.R.	1	1		
O	15	V.P.	Manager, Purchasing	N		x		24.3.06	P.M. + V.K.	1	1		
O	16	V.J.	ERP-manager	N		x		23.3.06	P.M., V.K., T.V. + T.R.	1	1		
M	1	H.A.	Negotiations & Sales	M			x	3.9.02	M.H.	1	1		1
M	2	D.T.	Project & references, infra	M			x	6.6.02	J.R.	1	1		
M	3	P.H.	Negotiations & Sales	M			x	27.6.02	M.H.	1	1		1
M	4	P.J.	Project & references	M			x	5.6.02	M.H.	1	1		1
M	5	L.J.	Project & references, infra	M			x	21.8.02	J.R.	1	1		
M	6	L.K.	Project & references	M			x	22.8.02	J.R.	1	1		
M	7	H.A.	Purchasing manager+D31	M			x	15.8.02	J.R.	1	1		
M	8	S.H.	Purchasing	M			x	26.9.02	J.H. + J.L.	1	1		
M	9	A.J.	Care & Maintenance	M			x	11.6.02	J.R.	1	1		
M	10	K.J.	Care & Maintenance	M			x	18.6.02	J.R.	1	1		
M	11	K.A.	Care & Maintenance	M			x	31.7.02	M.H.	1	1		1
M	12	I.H.	Infrastucture, RTD	M			x	5.7.02	M.H.	1	1		1
M	13	P.M.	Care & Maintenance	M			x	5.7.02	J.R.	1	1		
M	14	S.M.	Care & Maintenance	M			x	18.6.02	J.R.	1	1		

Interviews cont.

Ref.		*Informant*	*Position*	*Company*	*Network of business units*	*Network of subcontractors*	*Network of independent companies*	*Date*	*Interviewer*	*Data* *Recorded*	*Transcribed*	*Memo*	*I participated personally*
M	15	L.J.	Infrastucture	M			x	7.6.02	J.R.	1	1		
M	16	T.E.	Infrastucture	M			x	14.6.02	J.R.	1	1		
M	17	V.E.	Infrastucture	M			x	10.6.02	J.R.	1	1		
M	18	H.E.	Care & Maintenance	M			x	3.12.03	M.H. + J.L.	1	1		1
M	19	H.A.	Care & Maintenance	M			x	5.12.03	M.H. + J.L.	1	1		1
M	20	H.S.	Project & references	M			x	15.12.03	M.H. + J.L.	1	1		1
M	21	K.P.	Project & references	M			x	12.2.04	M.H. + J.L.	1	1		1
M	22	K.I.	Care & Maintenance	M			x	4.12.03	M.H. + J.L.	1	1		1
M	23	S.M.	Care & Maintenance	M			x	5.4.04	M.H. + J.L.	1	1		1
M	24	T.P.	Negotiations & Sales	M			x	8.12.03	M.H. + J.L.	1	1		1
M	25	L.J.	Project & references	M			x	4.2.04	M.H. + J.L.	1	1		1
M	26	L.K.	Project & references	M			x	12.2.04	M.H. + J.L.	1	1		1
M	27	P.H.	Negotiations & Sales	M			x	25.2.04	K.K.			1	
M	28	A.N.	Infrastucture	M			x	29.4.04	H.P., P.T. + J.L.	1	1		
M	29	A.N.	Infrastucture	M			x	29.4.04	J.L + J.L.	1		1	
CU	1	A.D.	Infrastucture	C ust			x	20.8.04	K.K.			1	
CU	2	T.D.	Infrastucture	C ust			x	15.9.04	K.K.			1	
CU	3	S.L.	Infrastucture	C ust			x	5.5.04	K.K.			1	
CU	4	K.M.	Infrastucture	C ust			x	24.3.04	K.K.			1	
CU	4	L.J.	Infrastucture	C			x	25.5.04	K.K.			1	
CU	5	S.A.		ust									
C	1	M.H.	Infrastucture	C			x	19.5.04	H.P., P.T. + J.L.	1	1		
C	2	M.H.	Infrastucture	C			x	20.4.04	J.L.	1		1	
B	1	V.J.	Infrastucture	B			x	30.4.04	H.P., P.T., J.L.+ J.L.	1	1		
B	2	V.J.	Infrastucture	B			x	30.4.04	J.L., J.H. + J.L.	1		1	
B	3	J.L.	Infrastucture	B			x	18.5.04	J.L., M.H., +V.M.	1	1		1
B	4	R:R:	VP, manufacturing solutions	B				3.4.08	M.H.+J..H.+ T.W.	1	1		1
A	1	P.V.	Project & references	M	x			27.3.98	E.K.	1	1		
A	2	K.R.	Project & references	M	x			1.5.99	K.L.	1	1		
A	3	P.V.	project assistant	M	x			8.5.01	M.H.	1	1		1

Interviews cont.

Ref.		*Informant*	*Position*	*Company*	*Network of business units*	*Network of subcontractors*	*Network of independent companies*	*Date*	*Interviewer*	*Data*			
										Recorded	*Transcribed*	*Memo*	*I participated personally*
A	5	K.S.	Project & references	M	x			15.3.06	M.H. + T.V.	1	1		1
A	4	Y.J.	project assistant+	M	x			1.5.00	K.L.	1	1		
P	21	N.M.	2*project manager										
P	22	N.N.											
TOTAL	**99**									**91**	**76**	**24**	**40**

Workshops

	Participating organisations				*Case Network studied*				*Work hours*		*Data*		
Ref	*Research*	*Business*	*Funding*	*No of participants*	*Network of business ..*	*Network of ..*	*Network of independent companies*	*Date*	*Duration in hours*	*Total man hours*	*Recorded*	*Transcribed*	*Memo*	I participated personally
W1	1	4	1	11			x	30.10.02	2	22		1	1
W14	1	6	1	16			x	27.1.03	3	48		1	1
W19	1	4	1	12			x	18.2.03	3	36		1	1
W27	2	4	1	12			x	19.3.03	2,5	30		1	1
W87	2	3	1	13			x	12.12.03	9,5	123,5		1	1
W114	2	3	0	9			x	19.3.04	4	36		1	1
W120	2	3	1	8			x	20.4.04	4	32		1	1
W132	3	3	0	12			x	24.5.04	6,5	78		1	1
W138	3	3	1	14			x	9.6.-10.6.04	11	128		1	1
W145	2	3	0	9			x	6.9.-7.9.04	10	90		1	1
ICT1	1	2	0	11	x	x		12.9.06	4,5	49,5		1	1
TOTAL	**11**				**1**	**1**	**10**		**60**	**673**		**11**	**11**
Avg	**2**	**3**	**1**	**12**					**5**	**61**			

Meetings

	Participating organisations				*Case Network studied*				*Work hours*		*Data*		
Ref	*Research*	*Business*	*Funding*	*No of participants*	*Network of business units*	*Network of subcontractors*	*Network of independent companies*	*Date*	*Duration in hours*	*Total man hours*	*Recorded Transcribed*	*Memo*	*I participated personally*
G1	1	1		3	X			6.11.98	2	6		1	1
G2	1	1		4	X			13.1.99	2	8		1	1
G3	1	1		15	X			31.5.99	3,5	52,5		1	1
G4	1	1		3	X			8.12.00	3	9		1	1
G5	1	1		3	X			15.8.01	2,5	7,5		1	1
ICT1	1	1		2		x		1.10.05	2	4		1	1
ICT2	1	1		3	X			25.11.05	2,5	7,5		1	1
ICT3	1	1		7	X			16.12.05	4	28		1	1
ICT4	1	1		10		x		23.2.06	5	50		1	1
ICT5	1	1		6		x		24.10.2006	3	18		1	1
E2	1	1	1	6			x	15.11.2002	2	12		1	
E4	1		1	2			x	22.11.2002	0,5	1		1	
E5	1	1	1	3			x	5.12.2002	2	6		1	
E7		1	1	2			x	11.12.2002	1	2		1	
E8		1	1	2			x	11.12.2002	1	2		1	
E9		1	1	2			x	12.12.2002	1	2		1	
E10	1	1		2			x	13.12.2002	1	2		1	
E12	1	1	1	5			x	10.1.2003	2	10		1	1
E13	1	1	1	3			x	17.1.2003	1	3		1	
E15		2		2			x	1.2.2003	1	2		1	
E18	1	1		4			x	14.2.2003	2	8		1	1
E20	1	1		2			x	25.2.2003	0,5	1		1	
E24	2			2			x	7.3.2003	16	32		1	
E28	1	1	1	3			x	29.3.2003	2	6		1	
E29		2		3			x	4.4.2003	1	3		1	
E31	1		1	4			x	7.4.2003	1	4		1	
E32	1	1		3			x	16.4.2003	1	3		1	
E35	1	1		3			x	14.5.2003	2	6		1	1
E36	1	1		6			x	16.5.2003	2	12		1	1
E37	1	1		5			x	2.6.2003	2	10		1	1
E38	1		1	4			x	4.6.2003	4	16		1	1
E40	1	2		5			x	16.6.2003	2	10		1	1
E41	1		1	3			x	24.6.2003	2	6		1	1
E46	1		1	3			x	5.9.2003	2	6		1	1
E49	1	3	2	11			x	19.9.2003	2	22		1	1
E50	1	1		2			x	19.9.2003	0,5	1		1	1
E54	1	1		4			x	2.10.2003	4	16		1	1
E55	1	1		3			x	3.10.2003	2	6		1	1
E59	2			4			x	10.10.2003	8	32		1	1

Meetings (cont.)

	Participating organisations				Case Network studied				Work hours		Data		
Ref	*Research*	*Business*	*Funding*	*No of participants*	*Network of business units*	*Network of subcontractors*	*Network of independent companies*	*Date*	*Duration in hours*	*Total man hours*	*Recorded*	*Transcribed*	*Memo*	*I participated personally*
E66	2			2			x	17.10.2003	8	16			1	1
E67	2			1			x	16.10.2003	2	2			1	
E68	1	1		3			x	20.10.2003	2	6			1	
E71	1	3	2	10			x	24.10.2003	2	20			1	1
E72	1	1		4			x	24.10.2003	1	4			1	1
E73	2	1	1	4			x	30.10.2003	3	12			1	
E75	2			4			x	12.11.2003	8	32			1	1
E76	2			4			x	13.11.2003	8	32			1	1
E77	2			4			x	14.11.2003	3,5	14			1	1
E83	1	1		5			x	4.12.2003	3	15			1	1
E85		2		3			x	5.12.2003	1	3			1	
E89	1	2		5			x	15.12.2003	2	10			1	1
E90	2			2			x	17.12.2003	0,5	1			1	1
E92	1	1		2			x	19.12.2003	3	6			1	
E94	1	1		4			x	3.2.2004	1	4			1	1
E96	1	1		6			x	9.2.2004	2	12			1	1
E101	1	1		4			x	13.2.2004	1	4			1	1
E102	2			3			x	17.2.2004	2	6			1	
E104	2	3	1	10			x	20.2.2004	2	20			1	1
E106	2			2			x	26.2.2004	1	2			1	
E108	2			6			x	8.3.2004	4	24			1	1
E110	1	2		6			x	13.3.2004	12	72			1	
E112		2		2			x	19.3.2004	1	2			1	1
E113	2	3		8			x	19.3.2004	0,5	4			1	1
E116	2			4			x	1.4.2004	4	16			1	1
E117	3			5			x	2.4.2004	8	40			1	1
E123	2			4			x	27.4.2004	1,5	6			1	1
E128	1	3		6			x	3.5.2004	3	18			1	1
E133	2			1			x	26.5.2004	28,5	28,5			1	
E137		3	1	8			x	9.6.2004	3	24			1	1
E142	2			2			x	24.8.2004	3	6			1	1
E143	2			2			x	24.8.2004	3	6			1	1
E147	3	3	1	14			x	30.9.2004	5	70			1	1
E148	1	2	1	5			x	19.11.2004	1	5,5			1	1
TOTAL 73					7	3	63		232	976			73	49
Avg	1	1	1	4					3	13				

Other data

	Participating organisations				*Case Network studied*				*Work hours*		*Data*			
Reference	*Research*	*Business*	*Funding*	*Number of participants*	*Network of business units*	*Network of subcontractors*	*Network of independent comp.*	*Date*	*Duration in hours*	*Total man hours*	*Recorded*	*Transcribed*	*Memo*	*Description*
G6		1			1			17.3.00					x	Statistics of projects using Notes 1995-1999
G7		1			1			27.4.01					x	Staff statistics 1990-2000
G8		1			1			9.5.01					x	Customer satisfaction survey results
G9		1			1			9.5.01					x	Statistics on reliability of deliveries
G10		1			1			17.4.01					x	Internal report on quality costs
G11		1			1			27.4.01					x	Project organisation charts
G12		1			1			5.4.01					x	Project meetings schedule
G13	1	1			1			2.5.99	2,5				x	Participation to internal groupware user-training
G14	1	1			1			10.11.04	2,5				x	Participation to internal groupware user-training
G15					1			8.6.01					x	Statistics on number of personal computers
G7		1			1			26.4.01					x	Estimate on average length of projects
G6		1			1			4.5.01					x	Database of all finished projects 1990-2000
G7		1			1			15.5.01					x	Excel of orders booked and net sales 1990-2000
ICT6	1	1			1			19.1.06	3,5				x	Participation to internal groupware user-training
ICT7		2			1	1		3.10.06					x	Data on functionalities of ICT systems
							23	2003-2004	11,3	23,9			x	phone conversation threads
							23	2003-2004	7,9	31,3			x	e-mail threads
							6	2003-2004	19,5	28,5			x	presentations etc
TOTAL					**15**	**1**	**52**		**47**	**84**			**18**	
Avg	**1**	**1**							**8**	**30**				

Appendix C: Excerpt from narrative for part I

Introduction

The aim of this research is to analyse whether the coordination mechanisms set forth by Galbraith in 1977 still describe the actions taken by organisations of today. Figure 1 summarises the relationships that are suggested based on Galbraith, and literature on complexity. The basic assumptions based on literature are that increase in complexity has a negative effect on performance, and that an organisation may adjust this causality by coordination mechanisms. Complexity is estimated as variety and volatility in task, in organisation network, and in external environment. Performance can be approximated with use of resources and output. Coordination mechanisms are rules, creation of self contained tasks, lateral resources, communication and/or computing technology and environmental management.

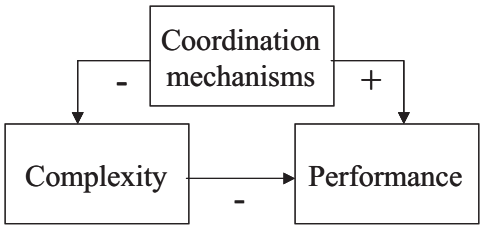

Figure 1: Theoretical causalities between complexity, coordination mechanisms, and performance (based on Galbraith, 1977).

Complexity is expected to have a negative causal relationship with organisation's performance (see Figure 2). Since the causal chain from increase in complexity via corrective mechanisms to change in output takes considerable time, it is necessary to study the question with a longitudinal approach.

Research design

In the following we discuss what question we study, what data we consider to be relevant, what data we should collect, and how we analyse the results.

More specifically we propose based on previous literature:

H1. Complexity has increased in organisational environment

H2. The negative effects of increased complexity can be coped with coordination methods

H3. Otherwise the performance deteriorates

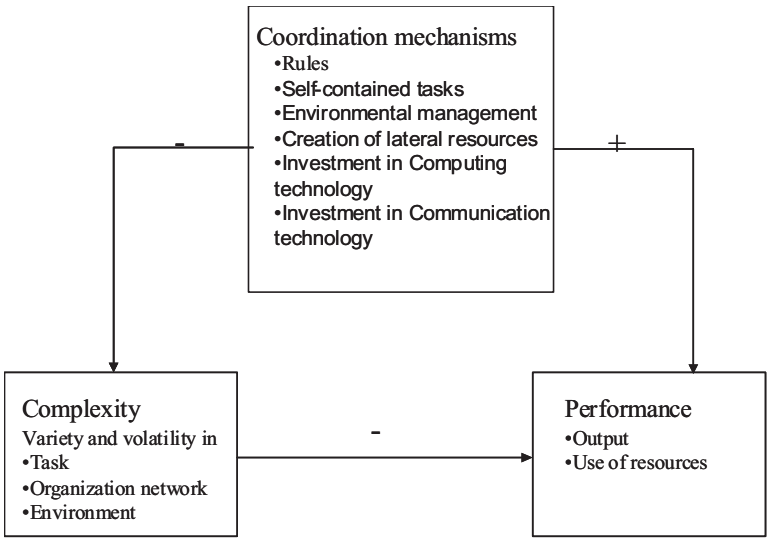

Figure 2. Theoretical causalities.

Unit of analysis

In this study the unit of analysis is the activity of delivery of customer specific products, more commonly called delivery projects, within Company M. Company M identifies three key business processes (see Figure 3): 1) Sell and deliver customer specific products, 2) Sell and deliver service products, and 3) develop new products (R&D). Out of these the first process accounts for 75% of the annual income while the second process accounts for 25% percent. Process 3. is critical for maintaining the technological leadership in the global market and to ensure the value adding capability of the corporation.

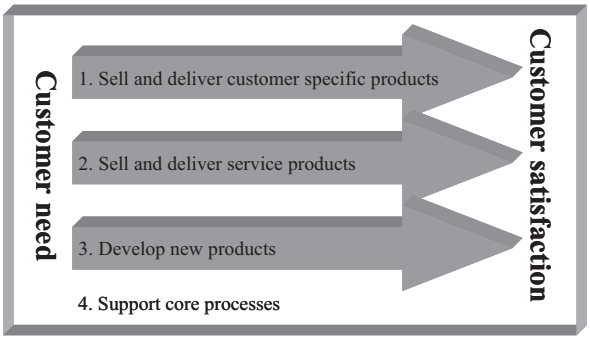

Figure 3. Key business processes of M.

The activity of delivery of customer specific products, the unit of analysis of our study, forms a substantial part of the company's first core process. Each time a

new sales and delivery process is started the Company launches a new sales project, and later on a new delivery project it achieves a deal.

Research process:

1. The first task is to operationalise the concept of complexity by providing some initial suggestions for measures, asking the interviewees to comment on them, and to recommend more accurate or accessible metrics for depicting variety and volatility of task, environment and organisation network.
2. measure the change in complexity between years 1990 and 2000. If the complexity has not increased our suggestion H1 is not true.
3. measure the performance of the unit of analysis, i.e. the activity of project deliveries. Again we have some initial suggestions for measures, asked the interviewees to comment on them, and to recommend more accurate or accessible metrics for depicting qualitative and quantitative performance.
4. ask the interviewees for the coordination measures taken and their impression of effectiveness and outcomes from these measures.
5. find the data from various sources to analyse the performance. If performance has deteriorated we can assume that coordination measures did not help the organisation to cope with complexity, and thus we should reject H2. If H1 (complexity has increased) was supported but H2 rejected we cannot reject H3.
6. The final step is to analyse the interview data for reasoning in what way (how) the coordination mechanisms applied during the study period changed the activity to be less fragile.

STEP 1: Operationalise the concept of complexity

Initial suggestions: in 12/2000 I proposed the first draft of measures of complexity in a discussion with Kalle Lyytinen and J.H. and A.K: from Company M (in memoM08122000.doc). After the comments a new version was made (in complexityMeasures2.doc). This is included in the interview questionnaire (in interviewQuestionnaire.doc).

…

Appendix D: example of an interview outline

Marikka Heikkilä
Jyväskylän yliopisto
e-mail: marikka.heikkila@jyu.fi

17.4.01

The title of the interviewee
The interviewee

Interview outline, 18.4. at 13

A study on coordination of complex projects

CASE: Company M – delivery projects •the analysis of 10 years, topic is coordination

Background information on the interviewee, *work*

- ◊ Work history
  - ◊ when started working for the company
  - ◊ the career
- ◊ Current vacancy

General about the department

"(two quotations from previous interviews – omitted)"

- ◊ the tasks
- ◊ the staff and the roles, changes

The department as a part of the delivery project

- ◊ what is done, in what phase, changes
- ◊ How many persons take part in projects
- ◊ with whom do you co-operate / communicate? (project managers, assistants, production, automation, customer, suppliers, other)

Complexity

Complexity	Increase / change in		+ increases, - decreases costs (within parenthesis set up costs of coordination mechanisms)			
	Complex task	Specialization	+	+		
		Customization & asset specificity	+		+	+
		Rate at which products become obsolete	+	+	+	+
	Unstable environment	Number & variety of external parties			+	+
		Spatial distribution				+
		Time and quality pressures	+	+		+
	Interdependency	Number & variety of internal parties	+	+	+	
		Spatial distribution	+	+		

Coordination mechanisms	Manipulate coordination costs by using		Coordination costs: Decision information costs	Agency costs	Contractual costs	Operational costs	Production costs
	Structural mechanisms	Self-contained tasks	-				+
		Lateral relations	-	- (+)			
	Information and communication technology	Computing technology	- (+)	-			
		Communications technology	- (+)	-	-	-	
	Modify environment	Co-operation			- (+)	-	
		Manipulate the demand and company image				- (+)	
	Motivation and learning						
	Adaptation	Increase resources	-				+

Coordination mechanisms (When and what was the aim of)

Structural: Any changes to organisation chart that have affected projects?

1. Tasks grouped according to customers, resources etc?
2. Any new coordinators, work groups, direct communication channels that would ease communication or control?

Information and communication technology

1. Do accounting systems affect projects? How? Any changes?
2. Production and logistics systems, Management and decision support systems
3. CSCW
4. fax, Lan, e-mail
5. phone, mobiles, remote connections, internet

Environmental mechanisms

1. co-operation with customers, suppliers, officials, competitors
2. Management of customer base and product portfolio
3. standardisation of parts, focus on core competence
4. modularisation

Mechanisms for creating knowledge and learning

1. Training, Motivation
2. Learning from the customers and partners, Organisational learning (how to support)

Changes in input/output

1. Changes in time available per unit of output
2. changes in person resources per unit of output

Appendix E: An excerpt from the diary of part II

9.2.2004 Meeting with Company C

Present: H.M., M.P. and H.P. from C
J.H., M.H. and J.L., University of Jyväskylä

-We discussed about the results expected in May (business plan for the business sector is decided within the company C at that time)

-The company C has some research material on ICT and communication. H.P. will mail it to us.

-There is a need for integrated communications. In the business segment we are dealing with the competence is too much divided according to technologies, it should be more shared. We should consider what to combine and sell in a package, not sell all separately.

-C pointed that we need a hypothetical model which would provide a basis for the conversation between the companies. This would then be modified during the meetings and workshops.

-We discussed also about our proposition in the previous workshop:

- The problems are financing, risk aversion, short pay back time
- The service package should be more concrete
- For example in (xx) part of the service, investment costs, warehouse value, the supplier will keep the goods in its own balance sheet until the installation. It has a couple of global suppliers, the logistics is important.
- Where are the lead-users?

-Discussed about the article submitted to IFIP

- Development of joint business model
- Strategic alignment
- Process alignment
- Are all the companies inside the network triangle?
- Ontological model for the joint development

-Next steps

- Facilitation – JYU should be actively involved
- Do we have all the persons affecting the strategy?
- Company C has some experience in (xx) business segment. on the process alignment and customer relationship which might be of use.
- Timing of customer case II should be agreed.
- All the docs of the consortium will be available in intranet (Notes Aviator).

Subjective comments by M.H.

- Company C wants us to arrange more meetings for the consortium. JYU should be even more active in facilitation.

- Company C wants to see the material we collect from our intranet.

- After the meeting I discussed with M.P. She expressed their concern that Company B might be too product oriented, so that they try to sell their current product portfolio, not thinking strategic enough. The Company C is aiming with this consortium to defining a business model for partnering.

11.2.2004 The consortium was presented in Company M's internal seminar

Present: J.L., J.P., H.M., K.L., P.A. J.O. + some others from M
J.H. and J.L., University of Jyväskylä
J.N. from the breeding company
2 other presenters

The comments received:

From J.L.: The current practices should be modelled – what value is there with the new model?

From J.P.: From which kind of technological services and products the service concept consists of ? What solutions the companies B and C can offer currently?

- What are the ICT systems needed at the customers site, how to cope with interfaces and protocols?
- Service contracts:
  - Continuous improvement, contracts that require service level agreement
  - Liabilities (also about the net, viruses etc.)
  - Content of the service

From H.M: alternative services and earning logics.

From K.L.: What is the additional value from co-operating with B and C

From P.A.: There is potential. Customer Z just outsourced its (XX).

12.2.2004 J.V. from Company B asks information from yesterday's seminar.

J.V.@CompanyB wrote:

Hi, Did you have some kind of a meeting yesterday about the consortium?

J.V

From: Marikka Heikkilä [mailto:marikka.heikkila@jyu.fi]
Sent: 12. February 2004 21:19
To: J.V@CompanyB
Subject: Re: Consortium meeting yesterday

Hello, Just arrived from (X)city where we conducted some interviews.

Yesterday Company M had a seminar day, which was arranged by J.O. It concerned our consortium and couple of other related issues. J.H. and J.L. participated from JYU. They also gave a presentation on the consortium. The audience consisted of Company M's key persons. Only presenters were from outside

B.W. Marikka

J.V.@CompanyB wrote:

Hi Marikka,

I already heard in the afternoon about the meeting already from J.N. From the point of view of Company B the on going projects are important.

J.

13.2.2004 Meeting with Company M

Present N.A., Company M
J.H., M.H. and J.L., University of Jyväskylä

- Discussed about the challenges in customer relations:
  - How to change the practices in customer end
  - The role of labour unions
  - N.A: inspired by Zeithaml's research (e.g. A conceptual model of service quality and its implications for future research, A.Parasuraman, Valarie A. Zeithaml, Leonard L. Berry, Journal of Marketing Vol. 49(Fall 1985), 41-50

-Customer expectations according to N.A. : More output, Less costs per output, Competitive advantage

-Viewpoint of the customers

- How to provide justification for the value proposal, how to finance within the scope of 1 to 3 years

- How to provide references.

N.A. needs advice in the following

- How to integrate different levels and explain in concrete terms the elements of the service
- How to describe the business processes so that they are understandable
- Action plan ! how it should be put into practise.

Appendix F: Complexity sources in ch. 4

Complexity Sources		*Phase I*	*Phase II*	*Phase III*	*Phase IV*
Task	*Predictability*	Demand follows global trends in the consumption of end-products making the market quite *predictable*			
	Variety	All tailored, Engineered-to-order, No production to stock			
	Difficulty	Size of the project measured in Euros			
		36-85M€		71-108M€	
	Analysability			New generation of the main product introduced based on high-technology. Global technology leader	
	Diversity of goals associated with number of different products				
	Availability of time, money or attention			Available lead time reduced by 10-20%.	
Dependencies	*Depth of interdependency*	Independent companies	Sequential	Reciprocal, as business units formed a production web	
	Number of persons	Within a project 2-3 companies involved	Within a project 7 companies involved	Within a project 10 companies involved	
	Differentiation, specialisation	Within a project 23 managerial roles	Within a project 27 managerial roles		Within a project 35 managerial roles
	Power-dependency		4 separate companies merged together	Multiple profit centres disaligned goals	Merger
	Goal compatibility, Trust				Constant change
Environment	*Homogeneity-heterogeneity*	The customer base is stable and customer relationships are firm and long-lasting			
	Organisational intrusiveness			Demand turning to less predictable renewals Large amount of subcontractors	
	Stability – dynamism	Cyclical demand			
	Analysability of cause-effect relationships	Environment easy to analyse			
	Diversity of goals associated with number of different markets, clients			Demand turning to more equivocal renewals Large amount of subcontractors	

Appendix G: coordination mechanisms in ch. 4

Coordination mechanisms		*Phase 1*	*Phase 2*	*Phase 3*	*Phase 4*
Rules	*Rules, routines*			Project managers expected their project workers to adopt Tasman	A new recommendation for scheduling project meetings was proposed
Increase capacity to process information	*Investment in information systems*	MRP-system	Tasman was developed as a personal document dossier for project managers		Formats, folders etc. tools in Tasman to support rules
			All project managers and assistants had an own PC + LAN. Sharing of documents	Information sharing and communication within the organisation was advanced by providing training and giving all personnel the right to access Lotus Notes work desk and applications	
			e-mail for internal communication		
			Tasman used as a communication channel between the project workers	Mobile technologies	
	Lateral relations	Project manager is responsible for *lateral coordination* and communication			Additional lateral coordination person to coordinate actions across business units
					Common project R&D group established between business units
Reduce the need for information processing	*Self-contained tasks*	Project manager manages a temporal project organisation	Establishment of project manager teams as self-contained groups didn't work out as well as expected	Gradual change of role from secretary to assistant	
	Environmental management				

Appendix H: Data collection sheet for ch. 5

Global delievries & ICT, 16.9.2006	*Is the functionality used?*	*What can be improved?*	*Who benefits?*	*Why benefits?*	*Why is it needed?*
1.Generating reports					
2.File sharing /management					
3.Version control					
4.Contact list					
5.Tracker (milestone)					
6.Discussion forum/group					
7.Group calendar					
8.Voting system					
9.E-mail					
10.Multiple languages interface					
11.Time card system					
12.Bookmarks					
13.Todo list					
14.Task reminder					
15.Search system					
16.Ability for integration to another system					
17.Personalized profile					
18.Survey and feedback					
19.Access level based on role					
20.Access control/Security					
21.New events e-mail notification					
22.Project planning					
23.Create and manage announcements					
24.Post team announcements					
25.News group					
26.Web conferencing					
27.Instant messaging /chat					
28.Audio conferencing					

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