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„Knowledge Transfer and Trust in Networks: The Case
of the Mechatronics Cluster Upper Austria“

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Melanie Holnthoner

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1 Introduction

1.1 Motivation

The aim of this paper is to discuss knowledge management in networks, presenting the case of the Mechatronics Cluster Upper Austria. Nonaka (1991, p96; 2004, p546) points out that knowledge is “the one sure source of lasting competitive advantage...in an economy where the only certainty is uncertainty”, thus emphasizing the importance of knowledge management. To define the functions and elements of knowledge management, a profound understanding of the nature of knowledge and its characteristics is required. The paper concentrates on the knowledge transfer process between the cluster partners. In this context, based on the work of Daft and Lengel, and Büchel and Raub, we debate the different knowledge transfer mechanisms and their degree of media richness and study the influence of the types of knowledge on the choice of the knowledge transfer mechanisms. The description of the features and the dimensions of knowledge refer to the work of Nonaka, Nonaka et al., and Kogut and Zander. We ask the question whether the choice of the communication channels depends on the nature of knowledge and how trust affects the transmission of knowledge.

Our assumptions are examined in the empirical part of the paper which is based on empirical evidence gained from the Mechatronics Cluster Upper Austria.

1.2 Structure

The paper is structured in two central parts. The theoretical part discusses the fundamental principles of knowledge management. It provides basic definitions of knowledge, describes the characteristics of knowledge, and debates the specific knowledge dimensions (chapter 2; chapter 3). In addition, the functions and barriers of knowledge management are determined including an analysis of the process of knowledge creation (chapter 4; chapter 5). Furthermore, the various knowledge transfer mechanisms are presented. Finally, emphasis is placed on the knowledge transfer process in cluster relationships taking into account the influence of trust on the knowledge transfer process (chapter 6; chapter 7). Based on the theoretical background, hypotheses are constructed that will be the subject of discussion in the empirical part of the paper (chapter 8).

In the empirical part of the paper the Mechatronics Cluster Upper Austria is presented, the hypotheses are tested and the empirical results are debated (chapter 9).

2 Importance of Knowledge Management in Organizations

Over the last two decades knowledge management gained in importance and now plays a pivotal role in managing a company. Many scholars emphasize the significance of knowledge management (Nonaka 1991, Birkinshaw 2001, Kogut & Zander 1992). Nonaka (1991, p96; 2004, p546) calls knowledge “the one sure source of lasting competitive advantage...in an economy where the only certainty is uncertainty.” He argues that in the today’s challenging economy, where uncertainty, rapid change and competition dominate, companies can survive by managing knowledge effectively and efficiently. Especially in the today’s global economic environment multinational companies gain from a working knowledge management that helps them to exploit the useful knowledge that exists in the different units of the firm, and to create new knowledge. Kogut and Zander (1992, p383) emphasize that “the analysis of what organizations are should be grounded in the understanding of what they know how to do.” As Inkpen and Ramaswamy (2006, p107) point out “unlike physical assets that depreciate over time, knowledge can increase in value when used, whereas neglect will destroy it.” Good knowledge management requires a profound understanding of the concept of knowledge and the techniques and challenges of knowledge management.

3 Knowledge

To start, several definitions of terms closely linked to knowledge management will be listed to make a clear distinction and to avoid confusion.

Knowledge Management which is the main subject of this paragraph demands the definition of knowledge. Scientists provide various definitions of knowledge depending on their field of research. The following debate mainly concentrates on an economic approach. Knowledge is defined as “justified true belief” according to the traditional approach by Plato (1953) and mentioned by Nonaka (1994, p15). Hedlund and Nonaka (1993) describe knowledge as “cognitive perceptions as well as the skills and expertise embodied in products or services” (referred to by Inkpen & Ramaswamy 2006 p109). Furthermore, according to Inkpen and Ramaswamy (2006 p109) “organizational knowledge creates the capacity for repeatable action by the organization’s members.” Inkpen and Ramaswamy (2006) discuss another definition of knowledge where they identify knowledge as a combination of “information” and “know-how”.

3.1 Information and Know-how

Kogut and Zander (1992, p386) suggest that information is “knowing what something means” and “includes facts, axiomatic propositions, and symbols”, whereas know-how is defined as “knowing how to do something”. Information is “knowledge which can be transmitted without loss of integrity once the syntactical rules required for deciphering it are known” (Kogut & Zander 1992, p386). Know-how “is the accumulated practical skill or expertise that allows a person to do something smoothly and efficiently” (Von Hippel, 1988).

To continue, an attempt to differentiate between knowledge and information should be made. There is no doubt that the two of them are often regarded as synonyms but the existing literature gives clear definitions of the two terms and shows that a differentiation exists when looking at the degree of dependence on the holder of the information or knowledge. As mentioned by Machlup (1983) “information is a flow of messages or meanings which might add to, restructure or change knowledge” (Nonaka 1994, p15). It can be seen that information creates knowledge but that

knowledge compared to information is heavily dependent on a person and its personal commitment. (Nonaka 1994)

3.2 Organization Learning and Intellectual Capital

To continue the list of definitions necessary for accurately discussing the complex topic of knowledge management, the concepts of organization learning and intellectual capital are illustrated. As pointed out by Birkinshaw (2001, p13) organization learning refers to “sharing knowledge among individuals”. Thus, the concentration lies on learning. As will be discussed in this paper organizational learning is regarded as a centerpiece of the knowledge creation process. In contrast to organization learning knowledge management focuses on technical tools for storing knowledge (Birkinshaw 2001, p13). It has to be pointed out that knowledge management and organizational learning cannot be seen as two completely distinctive systems.

The idea behind the concept of intellectual capital is to find ways to measure assets that are not tangible such as knowledge. When dividing intellectual capital into “human capital”, “structural capital” and “customer capital”, useful measures can be determined to convert intangible assets into concrete financial data (Birkinshaw 2001, p13).

3.3 Characteristics of Knowledge

One of the key characteristics of knowledge is that knowledge is an intangible asset. Inkpen and Ramaswamy (2006, p109) compile central characteristics of knowledge that distinguishes knowledge from tangible assets (e.g.; raw materials, plants and equipment):

- No depletion and depreciation of knowledge during production
- Possession by multiple “owners” at the same time
- Embedded and cumulative
- No easy governing of knowledge transfer by contracts
- Difficult valuation and measurement

The above mentioned features of knowledge demonstrate the challenges and problems of managing knowledge.

The following chapter will debate the dimensions of knowledge.

3.4 The Dimensions of Knowledge

When discussing the theory behind knowledge it is important to have one of the central features of organizational knowledge in one's mind, namely that knowledge is an intangible asset. To go deeper it can be observed that there exist different forms of knowledge which are described by the dimensions of organizational knowledge, divided into the epistemological dimension and the ontological dimension of knowledge (Nonaka 1994). The epistemological dimension and most heavily mentioned in literature refers to the classification into "tacit" knowledge and "explicit" (codified) knowledge (Polanyi 1966). In an article by Albino et al. (1998, p55), they identify four factors that influence the knowledge transfer process: actors, context, content, and media. The basic concept of tacit and codified knowledge is part of the content of the knowledge that needs to be transmitted. Albino et al. (1998, p56) say that "the content of the knowledge transfer is the ability to perform a specific task". They identify the instrumental and cultural content as two forms of the content component:

- *Instrumental content*: "All the knowledge necessary to do or to coordinate a job" (Albino et al. 1998, p56).
- *Cultural content*: "The knowledge capability of creating a specific organization's cognitive background."

(Albino et al. 1998, p56)

3.4.1 The Epistemological Dimension of Knowledge (Tacit and Explicit Knowledge)

To start, the following list of features describes explicit or codified knowledge (Nonaka 1991, 2004; Inkpen & Ramaswamy 2006, p110):

- Formal and systematic
- Easy codification: manuals, databases, computer programs
- Easy to share
- Easy reproduction
- Easier to copy by competitors

Next, tacit knowledge is characterized by the following attributes:

- “Personal quality” (Inkpen & Ramaswamy 2006, p110)
- High context specificity (Polanyi 1966; Inkpen & Ramaswamy 2006)
- “Intuitive” (Inkpen & Ramaswamy 2006, p110)
- “Unarticulated” (Inkpen & Ramaswamy 2006, p110)
- Difficult to formalize and to share with others (Polanyi 1966; Nonaka 1991, 2004)
- Made to habit and tradition (Inkpen & Ramaswamy 2006, p110)

Therefore, tacit knowledge cannot be easily “translated” into formal language and it is hard to share it with other individuals because tacit knowledge is not codified and is strongly connected with the knowledge-holder and with the context in which it occurs. Experiences and working skills are associated with tacit knowledge.

The challenge knowledge management faces is to convert tacit knowledge, the most valuable knowledge, into explicit knowledge which can be seen as the pivotal process for organizational knowledge creation (Nonaka 1991, 1994, 2004).

Nonaka (1994, p16) looks at the concept of tacit knowledge in a more practical manner. He argues that tacit knowledge covers “both cognitive and technical elements.” Technical elements are associated with specific “know-how”, “crafts” and “context-related skills”. On the other hand, the cognitive elements can be seen as “mental models”, for example creating working models which enables individuals to “perceive” and “define” their world. The idea of “mental models” is debated by Johnson-Laird (1983). This approach can be related to the cultural content articulated by Albino et al. (1998).

Table 1 summarizes the characteristics of tacit and explicit knowledge.

Tacit knowledge (subjective)	Explicit knowledge (objective)
Knowledge of experience (body)	Knowledge of rationality (mind)
Simultaneous knowledge (here and now)	Sequential knowledge (there and then)
Analog knowledge (practice)	Digital knowledge (theory)

Table 1: Tacit and Explicit Knowledge

Source: Adapted from Nonaka, I., & Takeuchi, H. (1995), *The Knowledge-Creating Company – How Japanese Companies Create the Dynamics of Innovation*, Oxford University Press, New York: p61.

3.4.2 The Ontological Dimension of Knowledge (Social Interaction)

The second dimension of knowledge refers to the “level of social interaction” (Nonaka 1994, p17). In this context, the importance of the company as a social institution

needs to be emphasized (Nonaka 1991, 1994, 2004; Birkinshaw 2001). The intention of knowledge management is to convert the huge amount of individual knowledge into useful organizational knowledge. Hence, a transformation from informal structures on an individual basis into formal structures on a hierarchical level is part of this dimension of knowledge. The ontological dimension contains different levels of social interaction: Individual, group, organization, and inter-organization (Nonaka 1994). A company's task is to create an organizational environment and atmosphere that fosters knowledge transfer and knowledge creation.

The previous paragraphs highlighted the two basic categories of organizational knowledge that is to say, tacit and explicit knowledge. It should be noted that the span between tacit and explicit knowledge is wide and it cannot be said that knowledge is either only of tacit nature or only of explicit nature. The two types of knowledge complement one another and are both highly important to create new knowledge (Nonaka et al. 2000).

As was mentioned earlier individuals are crucial for an organization to create knowledge. In fact, the organization then is called up to find ways to convert individual knowledge into organizational knowledge. Knowledge creation is not possible without the individual members of a firm and the whole process demands a social system. In their article Albino et al. (1998, p55) deal with the components of knowledge transfer, proposing "actors" as a factor. The knowledge transfer process is dependent on the individual actors and requires specific characteristics of the actors. Wathne et al. (1996) observe three characteristics, i.e. "openness", "trust" and "prior experience":

- *Openness*: "Openness can be understood in terms of overall perceived openness of dialogue, the degree to which the partner representatives work closely together on a common task, and the degree to which the partner representatives perceive that the others withhold (shield) their knowledge." (Wathne et al. 1996, p61 ; Albino et al. 1998, p55)
- *Trust*: The concept of trust is discussed in chapter 7 of this paper.
- *Prior experience*: "It influences the capability of both conveying knowledge through information and internalizing new knowledge." (Albino et al. 1998, p56)

The above stated features are correlated. Trust is positively related to openness and prior experiences positively influence the knowledge transfer (Albino et al. 1998; Wathne et al. 1996).

3.5 The Knowledge Construct by Zander and Kogut (1995)

Zander and Kogut (1995, pp79ff) propose five dimensions to characterize knowledge on individual, group and organizational levels:

- Codifiability
- Teachability
- Complexity
- System Dependence
- Product Observability

These characteristics describe the nature of knowledge that is transferred. The degree of the five dimensions influences the simplicity or the complexity of the knowledge transfer process. In their paper Zander & Kogut (1995) include a time aspect for transferring and imitating knowledge.

Codifiability: “Codifiability captures the degree to which knowledge can be encoded, even if the individual operator does not have the facility to understand” (Zander & Kogut 1995, p79), e.g., software controlling machinery.

Teachability: “Teachability captures the extent to which workers can be trained in schools or on the job; it reflects the training of individual skills” (Zander & Kogut 1995, p79).

Complexity: “Complexity picks up the inherent variations in combining different kinds of competencies” (Zander & Kogut 1995, p79). Furthermore, Kogut and Zander (1992, p633) state that complexity is “the number of critical and interacting elements embraced by an entity or activity.”

System Dependence: “System Dependence captures the degree to which a capability is dependent on many different (groups of) experienced people for its production” (Zander & Kogut 1995, p79).

Product Observability: “Product Observability captures the degree to which capable competitors can copy the manufacturing capability” (Zander & Kogut 1995, p79).

The empirical study of this paper examines the influence of codifiability and teachability on the knowledge transfer process. As far as the time aspect of knowledge transfer is concerned codifiability and teachability are positively related to the speed of the transfer process (Zander & Kogut 1995, pp81ff).

Figure 1 presents the two categories of knowledge suggested by Kogut and Zander (1992, also see chapter 3.1.: Information and Know-how) describing it on the following levels: individual, group, organization and network.

	Individual	Group	Organization	Network
Information	- Facts	- Who knows what	- Profits - Accounting data - Formal and informal structure	- Prices - Whom to contact - Who has what
Know-How	- Skill of how to communicate - Problem solving	- Recipes of organizing such as Taylorist methods or craft production	- Higher-order organizing principles of how to coordinate groups and transfer knowledge	- How to cooperate - How to sell and buy

Figure 1: Categories of Knowledge according to Kogut and Zander (1992)

Source: Adapted from Kogut, B., & Zander, U. (1992), Knowledge of the Firm, Combinative Capabilities, and the Replication of Technology, *Organization Science*, 3 (3): p388; With reference to Hedlund, G., & Nonaka, I. (1991).

4 Knowledge Management

4.1 Definition and Elements of Knowledge Management

Having the above mentioned definitions in mind knowledge management should be put in concrete terms. Birkinshaw (2001, p13) describes knowledge management as a “set of techniques and practices that facilitate the flow of knowledge into and within the firm.”

One crucial consideration Birkinshaw has in his mind is that he understands a company as a social system. This approach concurs with what Nonaka (1991, p96; 2004, p547) identifies as the “Japanese management style”. He differentiates between Western management and Japanese management. The Western style is characterized by seeing the firm as a “machine for information processing” (Nonaka 1991, p96; 2004, p547) where formal and systematic information is important, while on the other hand Japanese firms are considered as “living organisms” (Nonaka 1991, p97; 2004, p547) where individual and informal knowledge is pivotal. Of course, it has to be emphasized that this classification is very strict, but can be seen as correct when observing the development of the traditional management styles. There is no doubt that in the last years the tendency to see the company as a social institution dominated, especially as far as knowledge management is concerned. All the individuals working in a company build the heart of the firm. The challenge of knowledge management is to convert the huge amount of individual knowledge into useful organizational knowledge and to create new knowledge. In this context, Birkinshaw (2001) points out that the individual in a company learns from the company and vice versa. He describes three elements of knowledge management illustrated in Figure 2 (Birkinshaw 2001, p 13):

1. “Improving the informal flows of knowledge between individuals.
2. Building systems for codifying and sharing knowledge within the firm.
3. Tapping into new knowledge from sources outside the firm.”

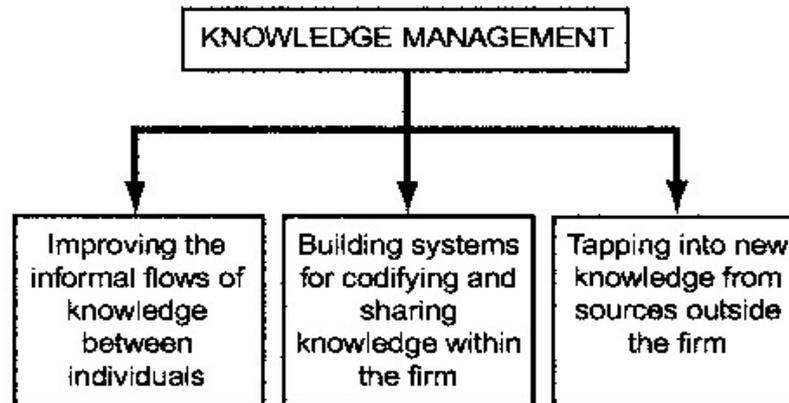


Figure 2: Elements of Knowledge Management

Source: Birkinshaw, J. (2001), Why is Knowledge Management so difficult?, *Business Strategy Review*, 12: p13.

Coming back to give concrete definitions of knowledge management Allee (1997) makes the following attempt; She describes knowledge management as “much more than managing the flow of information. It means nothing less than setting knowledge free to find its own paths. It means fuelling the creative fire of self-questioning in organizations. This means thinking less about knowledge management and more about knowledge partnering” (Allee 1997; Inkpen & Ramaswamy 2006, p111). Inkpen and Ramaswamy (2006, p111) stress three different elements of knowledge management:

- “Individual knowledge-sharing.
- Embedding new knowledge in products and services.
- Transferring knowledge across organizational boundaries.”

Nonaka (1991, p96; 2004, p546) presents knowledge management processes similar to the above debated theory, i.e.:

- Create new knowledge.
- Disseminate it throughout the organization.
- Embody it in new technologies and products.

According to Nonaka (1991, p96; 2004, p546) a company executing the above mentioned tasks is a “knowledge-creating” company that will survive in the today’s highly competitive world. One key function to become a successful company is to create new knowledge. This shows the importance of innovation.

4.2 Barriers of Knowledge Management

Birkinshaw (2001, p15) presents different reasons why knowledge management is facing various problems:

- “Firms do not sufficiently recognize that they are already doing it.
- Information technology is often regarded as a substitute for social interaction.
- Knowledge management typically focuses too much on recycling existing knowledge, rather than generating new knowledge.
- Most knowledge management techniques look like traditional techniques.”

In their research, Kakabadse et al. (2001, p148; referring to TCISKS 1998) categorize barriers of knowledge management into four dimensions as described in Table 2.

People	Inertia to change
	Too busy, no time to learn
	No discipline to act
	Motivation
	Constant staff turnover
	Transferring knowledge to new people
	Teaching older employees new ideas
Management	The fear of giving up power
	The difficulties of passing on power
	Challenging traditional company style
	Imposed constraints
	Lack of understanding about formal approaches
Structure	Inflexible company structures
	Fragmented organizations
	Functional "silos"
	Failure to invest in systems
Knowledge	Extracting knowledge
	Categorizing knowledge
	Rewarding knowledge
	Understanding knowledge management
	Sharing between key knowledge groups
	Making knowledge widely available

Table 2: Barriers of Knowledge Management

Source: Adapted from Kakabadse, N. K., Kouzmin, A., & Kakabadse, A. (2001), From Tacit Knowledge to Knowledge Management, *Knowledge and Process Management*, 8: p147f; With reference to TCISKS (1998), Europe’s State of the Art in Knowledge Management, The Economist Group: London.

The above chapters serve to give definitions of terms related to knowledge management. For making the whole concept of knowledge management transparent

the attempt to draw clear distinctions between knowledge, information, knowledge management, organization learning and intellectual capital is made. Furthermore, the tasks a knowledge-creating company has to carry out are mentioned which describe the elements of knowledge management, i.e. sharing knowledge, creating new knowledge, transferring knowledge and embodying knowledge in new technologies and products. Knowledge management not only demands for storing knowledge but places emphasis on the creation of new knowledge. Another crucial aspect of knowledge management is stressed in the previous section, which is the social component of knowledge management. Knowledge management is closely linked to the idea of identifying a company as a social institution where the individual and its beliefs and its “commitment” (Polanyi 1958) are pivotal for managing knowledge (Birkinshaw 2001; Nonaka 1991, 2004; Inkpen & Ramaswamy 2006).

Finally, multinational companies face the challenge to manage the knowledge widely dispersed over the organizational units that are acting in a diverse cultural environment. An effective knowledge management guarantees the flow of knowledge from the parent company to its subsidiaries, from subsidiaries to the parent company, and between the different subsidiaries (Mudambi 2002).

The following chapter illustrates the process of organizational knowledge creation based on the work of Nonaka (1991; 1994); Nonaka, Toyama and Konno (1998, 2000); Nonaka, Toyama and Byosière (2001); and Nonaka and Takeuchi (1995).

5 Organizational Knowledge Creation and Knowledge Transfer

Nonaka, Toyama and Konno (2000, p5) understand organizational knowledge creation as a “dynamic process” where a company is capable of constantly creating new knowledge out of knowledge that already exists in a firm and that is characteristic for the company. They discuss the “spiral of knowledge” (Nonaka 1991; 1994; Nonaka & Takeuchi 1995), where specific elements should be combined to create knowledge.

5.1 The Spiral of Knowledge - SECI, Ba and Knowledge Assets

Nonaka, Toyama and Konno (2000, pp5ff) propose three elements of the knowledge-creating process:

1. SECI: Knowledge Conversion Process
2. Ba: Context / “Knowledge Place”
3. Knowledge Assets: Inputs, outputs, moderator of the knowledge-creating process (Figure 3)

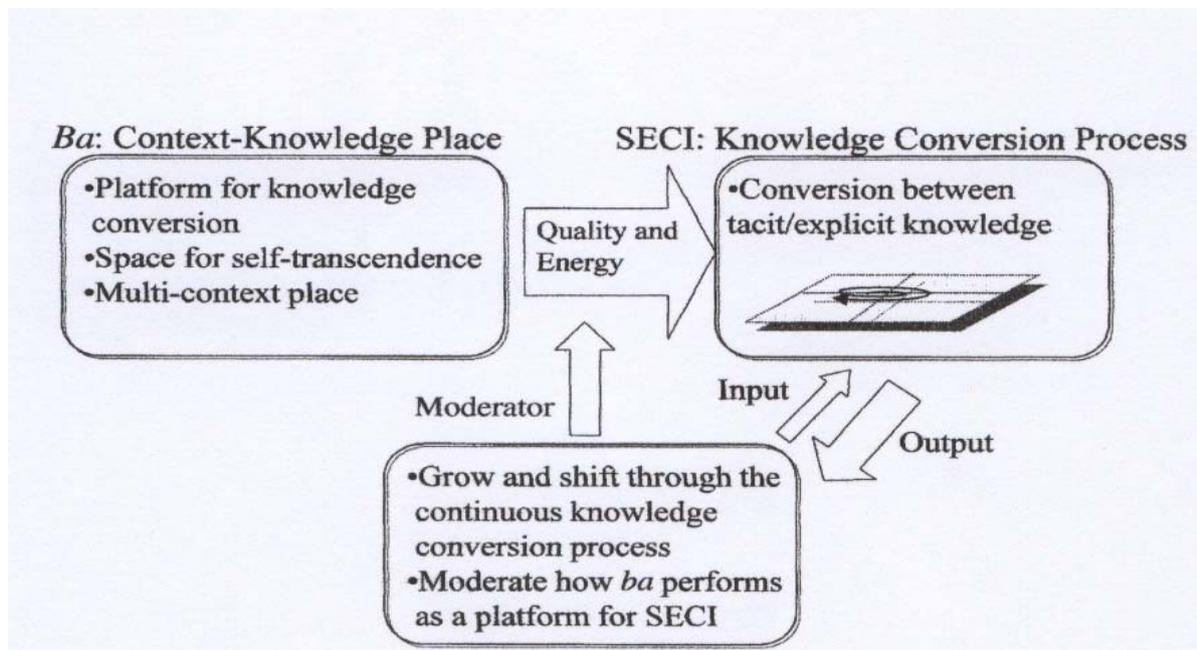


Figure 3: Elements of the Knowledge-Creating Process

Source: Nonaka, I., Toyama, R., & Konno, N. (2000), SECI, BA and Leadership, *Long Range Planning*, 33: p8; Referring to Nonaka, I., Toyama, R., & Konno, N. (1998)

5.1.1 The SECI Process

As pointed out by Nonaka, Toyama and Konno (2000, p9), the SECI process illustrates the “interactions between explicit knowledge and tacit knowledge” which they define as “knowledge conversion”. Because of the classification of knowledge into tacit and explicit knowledge the knowledge conversion process comprises four possible combinations (Nonaka 1991, 1994):

- **S**ocialization: tacit → tacit
- **E**xternalization (Articulation): tacit → explicit
- **C**ombination: explicit → explicit
- **I**nternalization: explicit → tacit

The bold letters above clearly show that the initial letters of the different forms of the conversion process build the abbreviation SECI. The SECI process is shown in Figure 4.

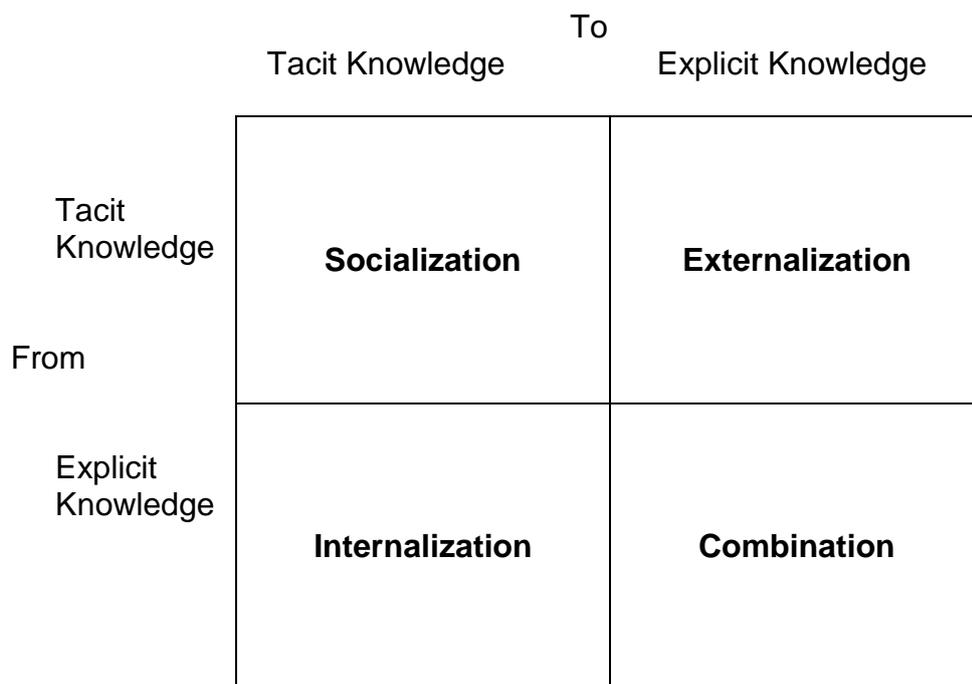


Figure 4: Modes of Knowledge Creation

Source: Adapted from Nonaka, I. (1994), A Dynamic Theory of Organizational Knowledge Creation, *Organization Science*, 5: p19.

Socialization

Socialization is the “process of creating tacit knowledge through shared experience” (Nonaka 1994, p19) Because of the specific features of tacit knowledge social interaction is the only possible way to share tacit knowledge. According to Nonaka, Toyama and Byosière (2001) methods for converting tacit knowledge into tacit

knowledge are observation, imitation and practice of work processes. In addition, they identify informal meetings outside the organization as a good opportunity for the socialization process, as well as contact to representatives outside the organization, e.g. suppliers and customers (Nonaka, Toyama & Byosière 2001; Nonaka, Toyama & Konno 2000). Nonaka (1994, p19) proposes “on-the-job training” as one method of the socialization process. In all these cases the social and emotional aspect plays a pivotal role. The important point to note is that because of the nature of tacit knowledge it has little value as long as it cannot be converted into explicit knowledge.

Externalization

Externalization means converting tacit knowledge into explicit knowledge. This step allows individuals to share knowledge which is crucial for creating new knowledge. Nonaka (1991, p99; 2004, p550) calls it “finding a way to express the inexpressible” and suggests using “figurative language” and “symbolism” for transforming tacit knowledge into concrete concepts. Metaphor, analogy and models are types of figurative language and symbolism.

Combination

Combination refers to the conversion of explicit knowledge into explicit knowledge; strictly speaking new knowledge is created in the sense of establishing a more structured base of existing knowledge. Nonaka (1991; 1994) points out that this process does not really lead to new knowledge creation but combines existing knowledge. The combination of existing explicit knowledge demands the use of specific transfer mechanisms: meetings, telephone conversations, documents, computerized communication networks (Nonaka, Toyama & Byosière 2001, p497). In the combination process explicit knowledge is recorded in manuals, databases, documents, structured concepts etc.

Internalization

The last form of the knowledge creating process converts explicit into tacit knowledge. During this process the explicit knowledge of a company is internalized by the employees of the firm. They begin to make use of the newly acquired knowledge, which Nonaka, Toyama and Konno (2000, p10) and Nonaka, Toyama and Byosière (2001, p497) compare to “learning by doing”. They identify training

programs as a form of the internalization process, where trainees embody explicit knowledge as tacit knowledge. In addition, simulations and experiments help to embody codified knowledge. A firm's explicit knowledge becomes an individual's know-how and enlarges the individual's tacit "knowledge base" (Nonaka, Toyama & Konno 2000, p10).

The importance of an individual's tacit knowledge qualifies the above mentioned statement that tacit knowledge alone is of no value for the company. It is true that tacit knowledge is not very useful in knowledge management as long as it cannot be expressed and shared among the members of the company but there is no doubt that tacit knowledge in the form of technical know-how is extremely valuable for an organization (Nonaka, Toyama & Konno 2000).

The key challenge for an organization is to be able to pass on the internalized or tacit knowledge which again leads to the first step of the SECI process, i.e., socialization. Nonaka (1991; 1994) and Nonaka and Takeuchi (1995) describe the whole knowledge conversion process as the "spiral of knowledge creation". Nonaka argues that "the interactions between tacit knowledge and explicit knowledge will tend to become larger in scale and faster in speed as more actors in and around the organization become involved" (Nonaka 1994, p20). Figure 5 represents the model of the spiral of organizational knowledge creation.

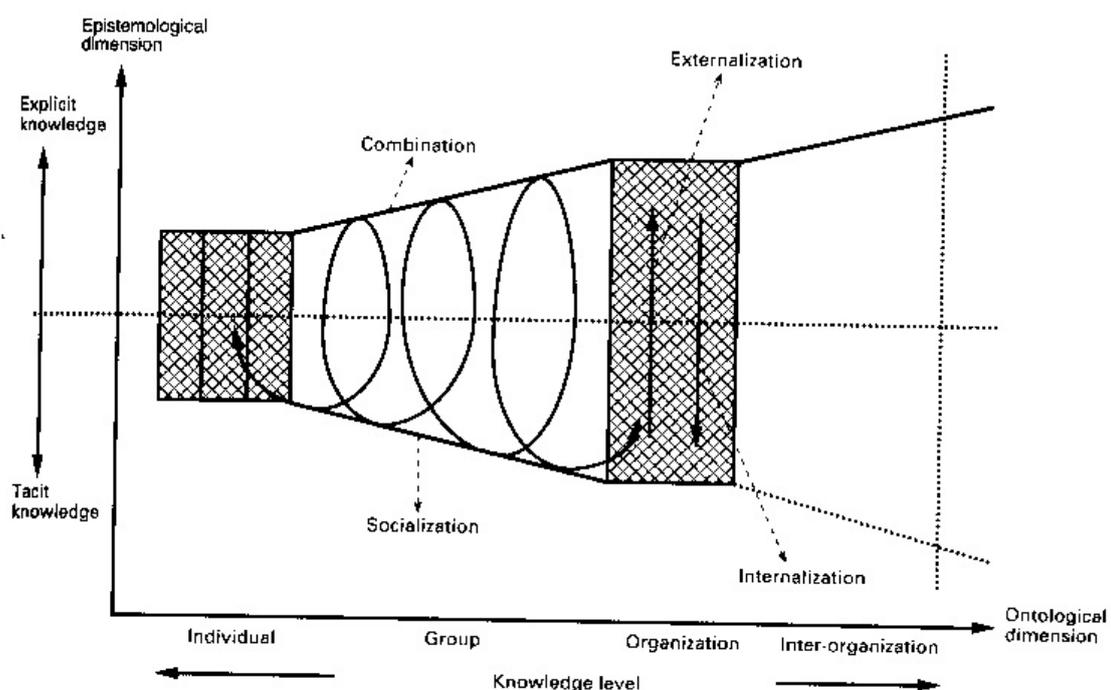


Figure 5: Spiral of Organizational Knowledge Creation

Source: Nonaka, I., & Takeuchi, H. (1995), *The Knowledge-Creating Company – How Japanese Companies Create the Dynamics of Innovation*, Oxford University Press: p73.

After having dealt with the knowledge conversion process, the so called SECI process, three considerable observations can be made which at the same time sum up the SECI process. First, the four phases of the knowledge conversion process ask for a continuous interaction between tacit and explicit knowledge. Second, the whole process does not only takes place at one level when looking at the participants of the knowledge conversion process, which is to be said that a continuous exchange between parties inside and outside the organization occurs, involving the individual members of a company, divisions, the firm as a whole but as well groups outside the company like customers, suppliers etc. Third, the knowledge creating process does not stop after having gone through the four steps once, rather it has to be understood as a constant recurrence of socialization, externalization, combination and internalization which leads to the concept of the spiral of knowledge.

Again, the SECI process highlights the crucial role of the individual members of an organization who can be seen as inevitable factors, even initiators, of the knowledge creation process. Finally, it highlights that the true creation of new valuable knowledge happens when converting tacit knowledge into explicit knowledge. (Nonaka 1991; 1994; Nonaka, Toyama & Konno 2000; Nonaka, Toyama & Byosière 2001; Nonaka & Takeuchi 1995)

The second element of the dynamic knowledge creation process according to Nonaka, Toyama and Konno (2000) and Nonaka and Konno (1998) is the concept of Ba.

5.1.2 The Concept of Ba

In their studies Nonaka and Konno (1998), Nonaka, Toyama and Konno (2000) and Nonaka, Toyama and Byosière (2001) analyze that knowledge, especially tacit knowledge, is a context-specific intangible asset. In fact, they propose that knowledge creation requires a context. This context is associated with the individuals who are part of the knowledge creation process. The theory behind “ba” was introduced by a Japanese philosopher (Kitaro Nishida 1921; 1970). The context mentioned above is called “ba”, it is a kind of “place”. Nonaka, Toyama and Byosière (2001, p499) define it as a “context in which knowledge is shared, created and utilized, in recognition of the fact that knowledge needs a context in order to exist.” However, they argue that “ba” does not necessarily have to be a place in the sense of

a physical construct but that it can also be understood in terms of a virtual or a mental “place”, i.e., the participants share the same attitude and experiences (Nonaka & Konno 1998, p40). As stated above the key function in the knowledge creation process is seen in the interaction between the individuals who participate in this process. Thus, interaction is made possible because of “ba”.

Another dimension of “ba” is the time aspect, which means that “ba” does not only refer to space but also to time (Nonaka, Toyama & Konno 2000).

Nonaka, Toyama and Konno (2000, p14) highlight that “ba is a place where information is interpreted to become knowledge.” They draw a distinction between four different types of “ba”, each corresponding to one of the four phases of the SECI process (based on Nonaka & Konno 1998):

- *Originating Ba*: “Originating ba” can be best regarded as the counterpart to socialization in the SECI process, because this form of “ba” supports the exchange of tacit knowledge among the individuals of the company. The transfer of tacit knowledge and in more detail of emotions, ideas and experiences happens best through face-to-face communication.
- *Dialoguing Ba*: “Dialoguing ba” enables externalization. It happens through dialogues between the individuals. “It is the place where individuals’ mental models and skills are shared, converted into common terms, and articulated as concepts” (Nonaka, Toyama & Konno 2000, p17). It mainly takes place on a group level.
- *Systemizing Ba*: “Systemizing ba” is defined as context on a group level. This “place” provides technology (information technology) that offers the framework for the combination phase of the SECI process.
- *Exercising Ba*: “Exercising ba” supports the conversion from explicit into tacit knowledge (i.e., internalization) on an individual level. Nonaka, Toyama and Byosière (2001) mention on-the-job training as an example.

Figure 6 illustrates the complexity behind the concept of “ba”.

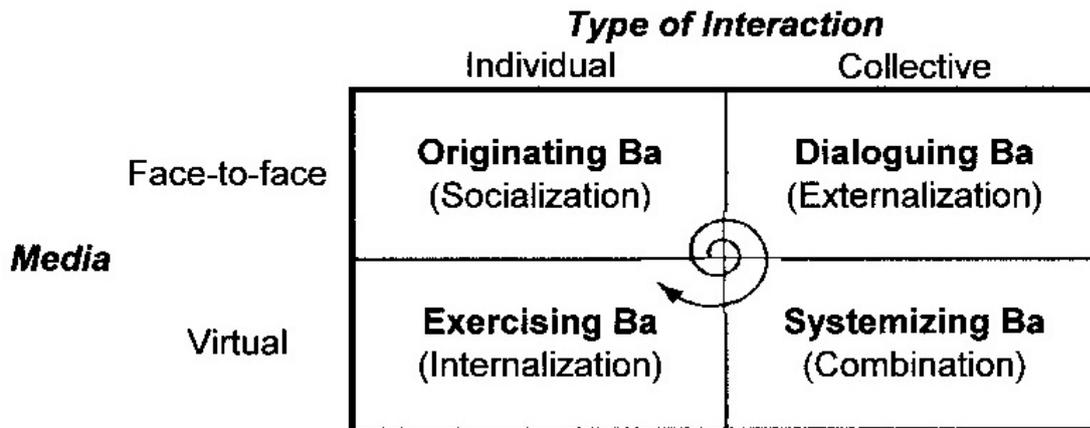


Figure 6: Types of Ba

Source: Adapted from Nonaka, I., Toyama, R., & Konno, N. (2000), SECI, BA and Leadership, *Long Range Planning*, 33: p16.

In this context, Albino et al. (1999, p56) identify “context” as one of the factors in the knowledge transfer process. They distinguish between internal context and external context. The internal context is associated with the “organizational culture” (e.g., set of behaviors, technical skills, technological assets, attitudes, values), whereas the external context is referred to the “conditions in which inter-organizational relationships take place” (Albino et al. 1999, p56).

5.1.3 Knowledge Assets

Nonaka, Toyama and Konno (2000, p20) define knowledge assets as “firm-specific resources that are indispensable to create values for the firm”. As already discussed above they identify “inputs, outputs and moderating factors” as knowledge assets. In addition, they provide a good example for a knowledge asset that functions both as moderator and as an output – trust: Trust can be regarded as an output of the whole process, but trust also influences the interaction (or the “ba”) between the individuals of the knowledge-creating process (moderating effect).

Knowledge assets are split into four different groups (Nonaka, Toyama & Konno 2000), i.e.:

- Experiential Knowledge Assets
- Conceptual Knowledge Assets
- Systemic Knowledge Assets
- Routine Knowledge Assets

Experiential knowledge assets correspond to tacit knowledge, in more detail they are related to the transmission of tacit knowledge. Figure 6 shows the different components of experiential knowledge assets. The key argument in this context is the difficulty to transfer tacit knowledge because of the nature of this type of knowledge. Tacit knowledge can be best articulated by shared experiences where the importance of the participation of human beings in this process has to be noted and as a consequence, the high personal involvement and commitment linked to this social process. Additionally, it has to be mentioned that all stakeholders of the company (inside and outside the organization) are involved in sharing experiences. To continue, conceptual knowledge assets will be the subject of discussion. Here, conceptual knowledge assets are equivalent to explicit knowledge and refer to the perception of members of the firm as well to the perception of the customers. Figure 6 lists examples of conceptual knowledge assets. Next, systemic knowledge assets are described. Systemic knowledge assets are explicit knowledge. This explicit knowledge is systemized and formal, it is easy to transfer and therefore, easily accessible for everyone including competitors which requires an efficient protection of those knowledge assets (see Figure 7). Finally, routine knowledge assets become the center of debate. Routine knowledge assets can be compared to the output of an internalization process, which means that explicit knowledge becomes tacit and therefore becomes routine for the members of an organization and consequently, influences the organizational culture of a company. (Nonaka, Toyama & Konno 2000; Nonaka, Toyama & Byosière 2001)

To summarize the concepts of the SECI process, “ba” and knowledge assets, it becomes apparent that the entire theory is founded on categorizing knowledge into tacit and explicit knowledge. By interaction and transmission of tacit and explicit knowledge the knowledge creating process takes place. SECI illustrates the knowledge creating process, “ba” refers to the “place”, better described as the context, in which knowledge is transferred, and the knowledge assets are defined as the inputs, outputs and moderating factors of the process of knowledge creation (Nonaka et al. 2000, p5). All these concepts are closely linked to each other (Nonaka et al. 2000; Nonaka et al. 2001).

<p>Experientiel Knowledge Assets Tacit knowledge shared through common experiences</p> <ul style="list-style-type: none"> - Skills and know-how of individuals - Care, love, trust, and security - Energy, passion, and tension 	<p>Conceptual Knowledge Assets Explicit knowledge articulated through images, symbols, and language</p> <ul style="list-style-type: none"> - Product concepts - Design - Brand equity
<p>Routine Knowledge Assets Tacit knowledge routinized and embedded in actions and practices</p> <ul style="list-style-type: none"> - Know-how in daily operations - Organizational routines - Organizational culture 	<p>Systemic Knowledge Assets Systemized and packaged explicit knowledge</p> <ul style="list-style-type: none"> - Documents, specifications, manuals - Database - Patents and licenses

Figure 7: Types of Knowledge Assets

Source: Adapted from Nonaka, I., Toyama, R., & Konno, N. (2000), SECI, BA and Leadership, *Long Range Planning*, 33: p20; With reference to Nonaka, Toyama & Konno (1998).

To come to a last important aspect of the knowledge creation process, we refer to Nonaka (1991; 2004, pp552ff). He emphasizes the pivotal role of middle managers in the knowledge creation process. They serve as interface between frontline employees and senior managers. Frontline employees work on the base, they really have concrete insights into how things run in reality; they know the facts of day-to-day business. On the other hand, senior executives set a mission for the company and articulate their expectations for the future in a more abstract way. They do not only declare a company vision in general but they also set the knowledge vision. Middle managers collect information from both parties and try to avoid misinterpretations and convert the knowledge into a concrete and explicit form. Middle managers “serve as a bridge between the visionary ideals of the top and the often chaotic market reality of those on the front line of the business” (Nonaka 1991, p104; 2004, p555). Nonaka (1988b, 1991) and Nonaka and Takeuchi (1995) propose “middle-up-down management” as the most suitable management concept for the knowledge creation process because it supports collaboration amongst all members of the company at all levels, whether horizontal or vertical.

5.2 Knowledge Transfer - A Model by Albino et al. (1999)

In their paper Albino et al. (1999, pp54f) propose a framework for the knowledge transfer process in industrial districts. The transmission of knowledge is embedded in

two systems: the “information system” and the “interpretative” system. The information system corresponds to an “operational level”, whereas the interpretative system can be understood on a “conceptual level.” They identify the information system as a system where knowledge is transferred from one actor to another using that form of media that is suitable for the type of knowledge that needs to be transferred. When analyzing the interpretative system Albino et al. (1999) refer to Gilbert and Cordey-Hayes (1996). The interpretative system is related to the theory of organizational learning. In their model Gilbert and Cordey-Hayes (1996, p303) make a distinction between four stages of the interpretative system:

- *Acquisition*: Knowledge needs to be acquired from the organizational environment (learning from the past, hiring individuals).
- *Communication*: The knowledge acquired has to be disseminated throughout the organization.
- *Application*: The knowledge has to be applied to guarantee retention.
- *Assimilation*: Assimilation is the “process of cumulative learning involving changes in individuals’ abilities and organization’s routines as a direct result of the use of acquired knowledge” (Albino et al. 1999, p55).

In their work Albino et al. (1999, p55) introduce four factors that influence the knowledge-transfer process: actors, context, content and media. The first three components have already been discussed; media will be the subject of debate in the next section of this paper.

To continue, an important issue of this paper will be the focus of the next chapter. As already mentioned above, a company is constantly confronted with knowledge management. Knowledge processing is regarded as one of the functions of knowledge management. This happens by using various communication channels. This leads to the different knowledge transfer mechanisms which play a central role in this paper. Information managers face the difficulty to choose the right media to attain an efficient knowledge management. The wrong choice of media is one of the major reasons for ineffective knowledge management (Büchel & Raub 2001). The concepts of “media choice” and “information richness” are based on studies by Daft and Lengel (1983; 1984; 1986) and were further developed by Büchel and Raub (2001).

5.3 Knowledge Transfer and Media Choice

As stated above media choice represents a key element of information processing (Büchel and Raub 2001, Daft and Lengel 1984).

In this context, Büchel and Raub (2001) discuss the knowledge transfer process in connection with the construct of organizational learning (see chapter 5.2: Albino et al. 1999: interpretative system) and stress the importance of information processing for organizational learning.

Before dealing in more detail with media choice the reasons for information processing should be debated. Daft and Lengel (1986, p555) mention two fundamental reasons: the reduction of uncertainty and equivocality (ambiguity). They refer to Weick (1979) and Daft and Macintosh (1981). As Daft and Lengel (1984, p194) point out, “organizational success is based on the organization’s ability to process information of appropriate richness to reduce uncertainty and clarify ambiguity.”

5.3.1 Uncertainty and Equivocality

Uncertainty: Daft and Lengel (1986, p556) identify uncertainty as the “absence or lack of information.” The organization’s purpose is to eliminate or reduce uncertainty by collecting more and more information. Galbraith (1974, p28) argues that “the greater the task uncertainty, the greater the amount of information that must be processed among decision makers during task execution in order to achieve a given level of performance.”

Equivocality/Ambiguity: Equivocality and ambiguity can be used interchangeably. According to Daft and Lengel (1986, p556) equivocality is described as the “existence of multiple and conflicting interpretations about an organizational situation” (Weick 1979; Daft & McIntosh 1981). For managers high equivocality means a big challenge and requires experience and interaction with other managers to reach a lower level of ambiguity.

To respond to uncertainty and equivocality managers have to apply the most suitable form of media. It has to be argued that uncertainty and ambiguity refer to the context in which information processing takes place. This argument has already be dealt with

by Nonaka (1991), as mentioned above, who emphasizes the importance of the knowledge context when transferring information. Figure 8 presents the framework of uncertainty and equivocality and describes different knowledge problems.

EQUIVOCALITY	High	1. High Equivocality, Low Uncertainty Occasional ambiguous, unclear events, managers define questions, develop common grammar, gather opinions.	2. High Equivocality, High Uncertainty Many ambiguous, unclear events, managers define questions, also seek answers, gather objective data and exchange opinions.
	Low	3. Low Equivocality, Low Uncertainty Clear, well-defined situation, managers need few answers, gather routine objective data.	4. Low Equivocality, High Uncertainty Many, well-defined problems, managers ask many questions, seek explicit answers, gather new, quantitative data.
		Low	High
		UNCERTAINTY	

Figure 8: Uncertainty and Equivocality

Source: Daft, R. L., & Lengel, R. H. (1986), Organizational Requirements, Media Richness and Structural Design, *Management Science*, 32: p557.

5.3.2 Media Choice

Büchel and Raub (2001, p520) define media choice “as the selection of choice of channels of communication.” The channels of communication can be in written form, voice or visual transfer, not to forget the big category of electronic transmission channels (“new media”). Each medium of communication is characterized by distinctive features, including feedback, channel, source, language, storage and reach (Daft and Lengel 1984).

Daft and Lengel (1984, p196; based on Bodensteiner 1970) make the following classification of communication media:

- Face-to-face
- Telephone
- Personal, written (e.g. letters, memos)
- Formal, written (e.g. documents, bulletins)
- Formal, numeric (computer output)

Daft and Lengel elaborated this classification in 1984. Therefore, it was impossible to consider modern electronic communication channels like e-mail or videoconferencing. In the study of Büchel and Raub (2001, p522) the new types of media are included:

- Face-to-face
- Videoconferencing
- Telephone
- Voice mail
- Fax
- Electronic communication (E-Mail)
- Formal letter
- Numeric output

The above mentioned communication channels represent the knowledge transfer mechanisms which are subject of this paper and the empirical study, but they will be debated in more detail in another section of this paper. Table 3 summarizes the types of communication media and its features.

Medium	Features					
	Feedback	Channel	Source	Language	Storage	Reach
Face-to-face communication	Immediate	Visual, audio	Personal	Body, natural	Limited	Limited
Videoconferencing	Almost immediate	Visual, audio	Personal	Body, natural	Limited	Moderate
Telephone	Fast	Audio	Personal	Natural	Limited	Limited
Voice mail	Moderate	Limited audio	Personal	Natural	Possible	Moderate
Fax	Moderate	Text	Personal	Natural	Possible	Moderate
Electronic communication	Moderate	Text	Personal, impersonal	Natural	Possible	Wide
Formal letter	Slow	Text	Personal, impersonal	Natural	Possible	Wide
Numeric output	Slow	Text	impersonal	Numeric	Possible	Wide

Table 3: Characteristics of Communication Media

Source: Adapted from Büchel, B., & Raub, S. (2001), Media Choice and Organizational Learning, In *Handbook of Organizational Learning and Knowledge*, Oxford: p522.

Two important concepts behind media choice are in the focus of the next chapter, i. e., media richness, media scope and media perception.

5.3.2.1 *Media Richness*

The concept of media richness was introduced by Lengel (1983). Daft and Lengel (1984, p196) define media richness as the “potential information-carrying capacity of data.” Another definition by Daft and Lengel (1986, p560) sees information richness as “the ability of information to change understanding within a time interval.” In fact, the different types of media vary in their capacity to reduce uncertainty and equivocality. According to Daft and Lengel (1984, pp1996f) the degree of media richness of the different channels of communication depends on four different features:

- Feedback (Immediate, fast, slow)
- Channels (Visual, audio, limited visual)
- Source (Personal, impersonal)
- Language (Natural, body, numeric)

Observing the different knowledge transfer mechanisms and taking into consideration the above stated features, face-to-face communication turns out to be the richest medium whereas formal numeric text is at the lowest level. Face-to-face communication provides immediate feedback, it is based on personal interaction and facilitates an exchange of complex information using natural and body language and visual communication channels. In contrast, a written numeric text just allows slow feedback and is limited to transmit the data contained in the written document without considering additional information that can be transferred via facial expression, voice or body language (Daft & Lengel 1984).

Büchel and Raub (2001) added a concept that responds to the emergence of “new communication media”, that is the concept of “media scope”. It includes additional features of communication channels.

5.3.2.2 *Media Scope*

According to Büchel und Raub (2001, p522) media scope describes “storage, referring to the ability to keep messages in memory, and reach, referring to the ability to address multiple people simultaneously.” Hence, storage and reach enlarge the above listed features of communication channels.

As discussed by Büchel and Raub (2001, pp523ff) media perception plays an additional role as far as media choice is concerned. The various media channels are perceived and valued differently by the members of an organization depending on their social context. The organization itself and its attitude towards the different types of communication channels can have great impact on the choice of media.

Examining the impact of uncertainty and equivocality on media richness and media scope an inverse relationship can be observed. To reduce uncertainty an organization has to obtain as much information as possible which is supported by transfer mechanisms high in media scope. In this case, an organization's employees have broad access to information. As far as media richness is concerned channels of high media richness are not very suitable for collecting and storing a high amount of information. On the other hand, high equivocality demands for communication channels that are high in media richness so that ambiguous information can be made clear. Face-to-face communication is most appropriate in such a situation. In general, a trade-off between media richness and media scope always exists and the choice of the "perfect communication media" is unrealistic (Büchel & Raub 2001). Figure 9 highlights the concepts of media richness and media scope.

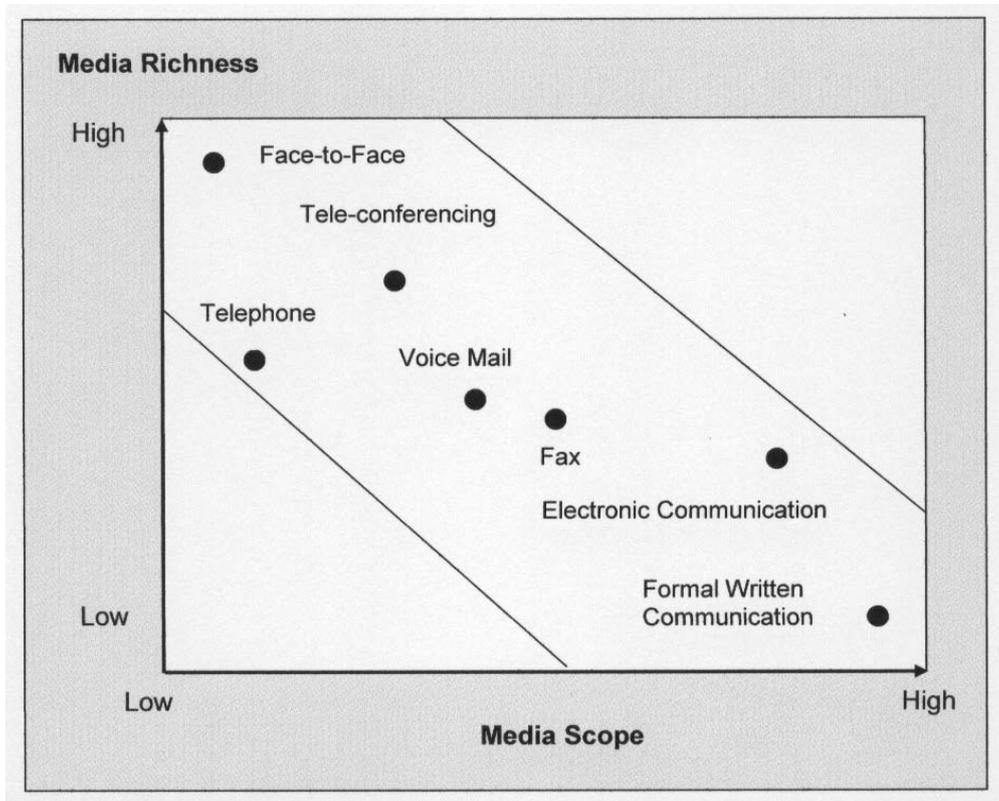


Figure 9: Media Richness/Media Scope

Source: Adapted from Büchel, B., & Raub, S. (2001), Media Choice and Organizational Learning, In *Handbook of Organizational Learning and Knowledge*, Oxford: p523.

Studying the paper of Daft and Lengel (1986), they give examples of knowledge transfer mechanisms that illustrate the trade-off between media richness and media scope. They discuss seven structural mechanisms (Daft & Lengel 1986, pp 560-562):

- Group meetings
- Integrators
- Direct contact
- Planning
- Special reports
- Formal information systems
- Rules and regulations

To come to an important point, in the following section equivocality reduction can be understood in terms of coming to an agreement about interpretation of information whereas uncertainty reduction is related to data-sharing. Group meetings (e.g., committees, task forces, teams; Daft & Lengel 1986, p560) involve a structure of high media richness and low media scope. Thus, group meetings support the reduction of equivocality. Through group meetings, managers analyze tasks, and solve problems which results in standardizing different interpretations and opinions. According to Daft and Lengel (1986, p561) integrators “represent the assignment of an organizational position to a boundary spanning activity within the organization.” They mention product managers and brand managers as examples for integrators. With respect to media richness and media scope this structure supports the reduction of ambiguity because it is a transfer mechanism high in media richness. Direct contact describes a personal form of knowledge transmission and occurs between two parties, whether on an informal basis (meetings) or on a formal basis (written form). Generally, direct contact mainly fosters the reduction of equivocality but also serves to transmit objective information to reduce uncertainty. Next, planning combines characteristics of both categories: equivocality reduction and uncertainty reduction. In the beginning of the planning phase ambiguity is high and demands informal channels, but in later stages of the planning process plans are elaborated which leads to the application of formal communication media and therefore, reduces uncertainty. To continue, Daft and Lengel (1984; 1986, p562) present one-time studies and surveys as examples of special reports. The idea behind special reports is to reduce uncertainty through collecting and interpreting information. Special reports are regarded as transfer mechanisms lower in information richness. Formal information systems such as

computer reports, performance evaluations, budgets and statistical information, result in a reduction of uncertainty. Formal information systems provide concrete data, and are low in media richness and high in media scope (Daft and Lengel 1986, p562; Daft and Macintosh 1981). Finally, rules and regulations stand at the lowest end of the media richness scale. Rules and regulations propose solutions to problems that have occurred in the past. This structural mechanism mainly serves to reduce uncertainty. It is characterized by high media scope (Daft and Lengel 1986).

Both Büchel and Raub (2001), and Daft and Lengel (1986) mention task analyzability as an important aspect of media choice. Büchel and Raub (2001, p525) define it as “the way that individuals are able to respond to problems that arise in the process of task completion”. Analyzable tasks can be described as tasks for which problem solutions already exist. In contrast, unanalyzable tasks do not have such a solution. A relation between analyzability and equivocality can be observed, meaning that unanalyzable information is equivocal. As a consequence, task analyzability influences media choice. High unanalyzability demands high media richness.

Daft and Lengel (1986) address another essential factor influencing an organization’s knowledge management: the company’s environment. A high amount of events cannot be predicted and analyzed and information about the environment is certain or uncertain, thus, again leading to the challenge to find the right trade-off between media richness and media scope.

To react to this complex situations managers have to look for a suitable organizational structure that responds to uncertainty and equivocality which are influenced by analyzability, interdepartmental relations and environmental factors.

As already stated above the transfer of knowledge is an important aspect of organizational learning. Büchel and Raub (2001, p525) argue that information acquisition, interpretation, distribution and storage are components of organizational learning. This approach can be compared to the interpretative system in the knowledge transfer model by Albino et al. (1999; see chapter 5.2) who suggest the following categorization: acquisition, communication, application and assimilation. Büchel and Raub (2001) point out that depending on the stage of organizational learning, different information transfer mechanisms are required taking into account the degree of media richness and media scope. First, information is acquired from

outside the company. In the case of gathering as much new information as possible, a mechanism high in media scope is needed. On the other hand, to disentangle complex information a medium of high media richness comes to the fore. To link up to information interpretation, it is obvious that during the interpretation process confusion can arise because managers may interpret information in various ways. According to Huber (1991) and Büchel and Raub (2001) this amount of diverging interpretation has to be brought to a “common view”. Thus, applying the theory discussed above, a rich communication medium is necessary. For information distribution across the organization media high in scope is required, because information should be wide spread through the company, thus enlarging the stock of organizational knowledge. The stock of information includes information from the past. The members of an organization can use the already existing knowledge stocks. Examples for knowledge stocks are databases, which demand media high in scope to guarantee all employees equal access to the information. In contrast, incorporating information to the organization as routine and considering the individual company demands for rich media. (Büchel and Raub 2001)

Table 4 summarizes the choice of communication media in the organizational learning process.

Learning process	Factors influencing learning context	Media choice based on media richness and scope	Importance of media perception
Information acquisition	Capturing weak signals Unanalyzable tasks	Media richness	Medium
	Analyzable	Media scope	Low
Information distribution	High interdependence Hierarchical and spatial barriers	Media scope	High
Information interpretation	Consensus	Media richness	High
Organizational memory	Individuals, routines	Media richness	High
	Database systems, archives	Media scope	Low

Table 4: Media Choice in the Learning Process

Source: Adapted from Büchel, B., & Raub, S. (2001), Media Choice and Organizational Learning, In *Handbook of Organizational Learning and Knowledge*, Oxford: p530.

The discussion of media choice in the previous section identified various knowledge transfer mechanisms. Inkpen and Ramaswamy (2006, p112) list concrete examples of knowledge transfer mechanisms: “Personnel movement, training, communication and personal relationships, observation, transfer of goods and services, patents,

scientific publications, interactions with suppliers and customers.” The empirical study of this paper is founded on the discussion about knowledge transfer mechanisms and the nature of knowledge.

The big section about the basic theory of knowledge management including the nature of knowledge itself, the dimensions of knowledge, the knowledge creation process and knowledge transfer mechanisms is herewith closed. The focus of this paper lies on the challenge to find suitable transfer mechanisms depending on the type of knowledge that is the subject of transmission and depending on internal organizational structures and environmental factors.

6 Industry Clusters

The concept of cluster was heavily debated by Porter in *The Competitive Advantage of Nations* (1990).

6.1 Definition

“A cluster is a geographically proximate group of companies and associated institutions in a particular field, linked by commonalities and complementarities” (Porter 1998, p199).

The basic idea behind clustering is to gain a competitive advantage for the organizations. Porter (HBR1998,p78) describes the actors that are part of the cluster: “suppliers of specialized inputs...and providers of specialized infrastructure,... customers,...manufacturers of complementary products,...companies in industries related by skills, technologies, or common inputs,...governmental institutions”, and educational institutions.

Doeringer and Terkla (1996, p176) propose the following definition of industry clusters: “Industry clusters are regional concentrations of industries that improve their combined economic advantage through co-location.”

Anderson (1994, p26) argues that “an industry cluster is a group of companies that rely on an active set of relationships among themselves for individual efficiency and competitiveness.” He describes those relationships that are categorized into three groups:

- *Buyer-Supplier Relationships*: This category can be compared to what Porter (1990) calls a “vertical cluster”.
- *Competitor and Collaborator Relationships*: Companies produce similar products which they sell on a common market. Thus, they obtain similar information. It can be compared to Porter’s (1990) “horizontal cluster”.
- *Shared-Resource Relationships*: Companies share similar technology, use similar natural resources and human resources (horizontal cluster).

6.2 Porter’s Diamond

Porter (1990) introduces four determinants that explain the competitive advantage of nations, where the influence of the local or home economic environment on

competition is crucial. He combines the determinants in one system that he calls the “diamond”. In other words, the diamond concept describes the factors that are responsible for gaining a competitive advantage: Porter (1990, pp71ff) identified four conditions:

- Factor conditions
- Demand conditions
- Firm strategy, structure, and rivalry
- Related and supporting industries

Furthermore, he proposes “government” (government policies) and “chance” (unpredictable events, e.g., financial crisis, wars) as additional factors. Figure 10 illustrates the different determinants and presents the interaction among them.

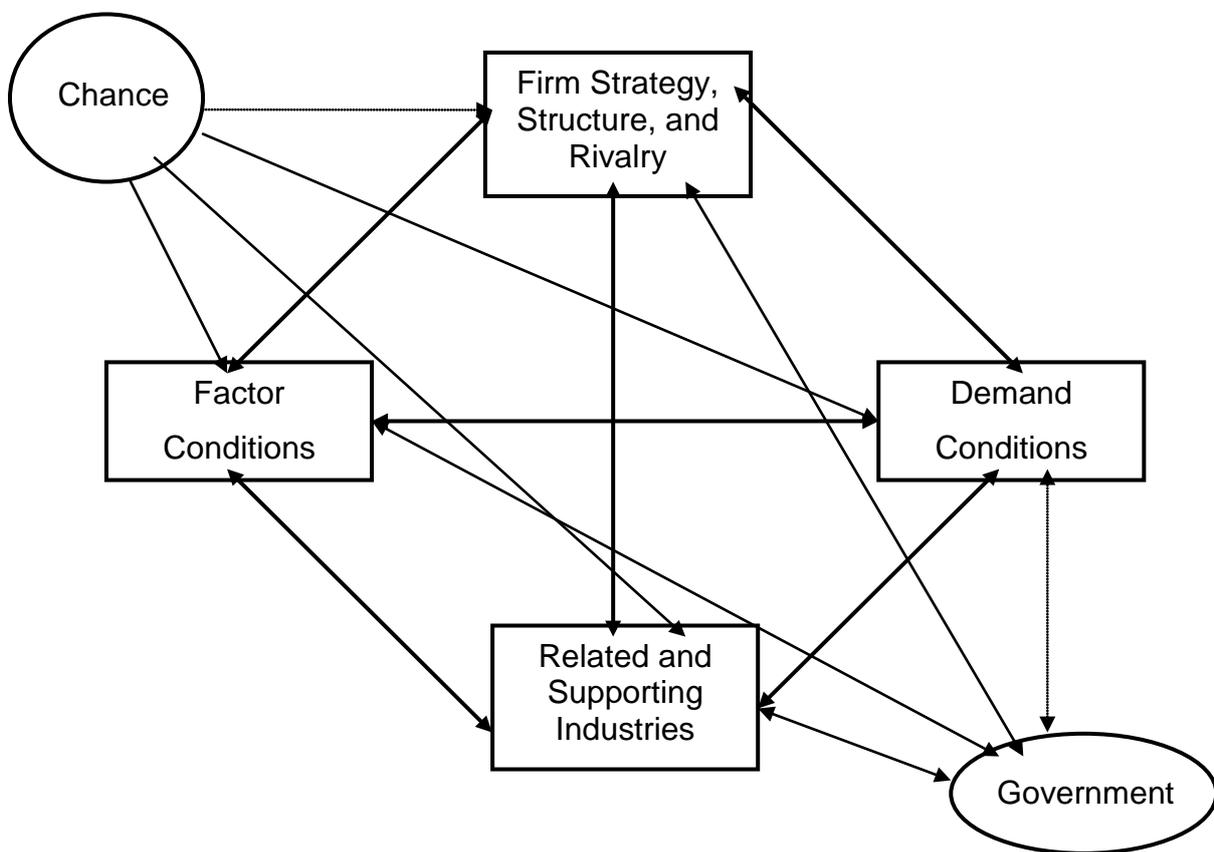


Figure 10: Porter’s Diamond

Source: Adapted from Porter, M. E. (1990), *The Competitive Advantage of Nations*, New York: Free Press: p127.

Factor conditions (Porter 1990, pp73ff): Factor conditions refer to the “factors of production” and include human resources, physical resources, knowledge resources, capital resources and infrastructure. A nation or an organization gain competitive

advantage “when a nation will export those goods which make intensive use of the factors with which it is relatively well endowed” (Porter 1990, p74). The factors should be specialized and unique for the company.

Demand conditions: Demand conditions refer to the home-market demand.

Firm strategy, structure and rivalry: Firm strategy and structure are influenced by national circumstances. National circumstances refer to religion, educational systems or social structure. In addition, the firm strategy is determined by the management style varying across nations and depending on the cultural background. Furthermore, local competition fosters innovation.

Related and supporting industries: “The presence or absence in the nation of supplier industries and related industries that are internationally competitive” (Porter 1990, p71).

6.3 Benefits of Clusters

Productivity: Porter (HBR1998, p81) emphasizes that “being part of a cluster allows companies to operate more productively in sourcing inputs; accessing information, technology, and needed institutions; coordinating with related companies; and measuring and motivating improvement.”

Innovation: As Porter (HBR1998, p83) points out clustering fosters innovation. Because of the geographic proximity firms can rapidly respond to buyer’s needs and rapidly react to technology developments in the partner companies. As already mentioned above rivalry enhances innovation.

New business formation: Porter (HBR1998, p84) gives reasons why new companies are founded within clusters: low entry barriers, the ease of identifying new business opportunities (i.e., niche markets), available resources, established relationships, and the support of well informed financial institutions and investors.

6.4 Knowledge Transfer in Clusters

As already stated above the geographical proximity of the cluster partners reduces the time of the knowledge transfer process and facilitates the flow of information.

Cluster companies can use the knowledge that exists within the cluster and easily have access to it. In this context, personal communication media are advantageous. An atmosphere of trust encourages the exchange of information between the cluster partners. Next, cluster companies can benefit from the knowledge of the educational institutions in the cluster. Finally, the above discussed conditions encourage innovation which is an important part of knowledge management (Porter 1998).

The next paragraphs concentrate on trust in organizational settings and links trust and knowledge management. It is examined what degree of trust leads to effective knowledge management.

7 Trust

Given that organizations are social institutions living from the people working in the companies trust plays a pivotal role because trust is a human concept. Thus, the discussion about trust also involves the discussion of psychological aspects.

The concept of trust is dealt with by different scientists, such as psychologists, sociologists and economists. This paper focuses on the basic theory behind trust, where scientists of all disciplines mainly agree, followed by a debate about the organizational aspects of trust.

7.1 Definition

The purpose of this section is to give a definition of trust. Mayer et al. (1995, p712) define it as “the willingness of a party to be vulnerable to the actions of another party based on the expectation that the other will perform a particular action important to the trustor, irrespective of the ability to monitor or control that other party.” According to Rousseau et al. (1998, p395) “trust is a psychological state comprising the intention to accept vulnerability based upon positive expectations of the intentions or behavior of another.” It is obvious that the behavior of the trusted party is of great importance. Levin et al. (2002, p4) call it “perceived trustworthiness” and refer to “that quality of the trusted party that makes the trustor willing to be vulnerable.” They use the terms trust and perceived trustworthiness interchangeably. Mayer et al. (1995, p716), based on Good (1988), state that “trust is based on the expectations of how another person will behave, based on that person’s current and previous implicit and explicit claims.” In this line, it is possible to identify aspects of trust that all disciplines have in common: expectations about the other part’s behavior and the acceptance of vulnerability.

7.1.1 Conditions for Trust

Rousseau et al. (1998) summarize the conditions under which trust can occur, namely risk and interdependence. Lane (1998) mentions the absence of opportunistic behavior of the trustee as additional condition.

Risk: Risk arises because of uncertainty. Uncertainty refers among other things to the “absence of information” as already stressed in this paper (Daft and Lengel 1986,

p556). A general definition of risk is given by Rousseau et al. (1998, p395) with reference to Chiles and McMackin (1996): "Risk is the perceived probability of loss, as interpreted by a decision maker." Rousseau et al. (1998) emphasize that under complete certain, riskless conditions trust would not be necessary. Lane (1998, p3) highlights the argument that "in economic theory, risk arises because trusting behaviour exposes the agent to the presumed opportunistic behaviour of her business partner."

Interdependence: According to Lane (1998) interdependence refers to the relationship between the trusting and the trusted party. One party is dependent on the other party to complete a task, and therefore has to trust.

Absence of opportunistic behavior: The trusting party presumes that when taking a certain degree of risk and vulnerability the trustor will not show opportunistic behavior (Lane 1998).

An additional observation made by scientists from all disciplines describes the dynamic nature of trust. Rousseau et al. (1998) point out that the degree of trust changes over time. Depending on the phase the two involved parties are in their relationship, the degree of trust may differ.

To summarize, it is referred to Rousseau et al. (1998, p395) who say that "trust is not a behavior (e.g., cooperation), or a choice (e.g., taking a risk), but an underlying psychological condition that can cause or result from such actions." In this respect, willingness of vulnerability, reliance, expectations, risk and interdependence are keywords.

7.1.2 Benefits of Trust

Rousseau et al. (1998, p394) address the benefits of trust that have been identified to be of importance by various scientists:

- Positively influences cooperative behavior (Gambetta 1988)
- Enables adaptive organizational forms (e.g.: networks) (Miles and Snow 1992)
- Reduces conflicts
- Decreases transaction costs
- Facilitates rapid formulation of ad hoc work groups (Meyerson et al. 1996)

- Provides effective responses to crisis

As debated above the behavior and characteristics of the trustor and trustee are crucial and worth to be studied in more detail, as done by Mayer et al. (1995, pp714ff).

7.1.3 Characteristics of the Trustor

Mayer et al. (1995, p715) use the term “propensity to trust” which is defined as “the general willingness to trust others”. This means that trustors vary in their degree of trusting another party. This can be explained by diverging past experiences, types of personality or cultural background (see Hofstede 1980).

7.1.4 Characteristics of the Trustee

The characteristics of the trustee are closely linked to the concept of trustworthiness, as mentioned above. The trustee’s attributes influence the trustor’s decision to trust or not. Mayer et al. (1995, pp717ff) highlight three considerable and often debated characteristics that are regarded as the “factors of trustworthiness”:

- *Ability/Competence*: According to Mayer et al. (1995, p717) ability is “that group of skills, competencies, and characteristics that enable a party to have influence within some specific domain.” Levin et al. (2002, p2) call it “competence-based trust”. In such a case, the trusting party relies on a specified competence or expertise of the trustee.
- *Benevolence*: Mayer et al. (1995, p718) propose to define benevolence as the “extent to which a trustee is believed to want to do good to the trustor, aside from an egocentric profit motive.” The condition here is that the trustee does not act in an opportunistic way. In their paper Levin et al. (2002, p2) use the term “benevolence-based trust”.
- *Integrity*: According to Mayer et al. (1995, p719) integrity refers to the “trustor’s perception that the trustee adheres to a set of principles that that the trustor finds acceptable.” In this context, experiences made with the trustee in the past and the trustee’s reputation are of great impact.

The trustee's ability, benevolence, and integrity contributes to the perceived trustworthiness, which was described by Levin et al. (2002, p4) as "that quality of the trusted party that makes the trustor willing to be vulnerable."

Whereas scientists from various disciplines agree for the most part on the definition of trust and its benefits, different views prevail considering the function of trust, whether trust can be seen as cause, effect or moderator.

7.1.5 The Role of Trust.

In their paper Dirks and Ferrin (2001) present two different approaches of how trust creates the above stated benefits.

Trust as a Main Effect (Dirks & Ferrin 2001, pp451ff)

The first approach is based on regarding trust as a "main effect" on different factors, for instance "workplace behaviors" and "performance outcomes" such as "communication and information sharing, organizational citizenship behavior, effort, conflict, negotiation behaviors, individual performance, and unit (e.g., group) performance" (Dirks & Ferrin, p452). They argue that this perspective illustrates that a direct positive relation between trust and the just mentioned benefits exists. Mayer et al. (1995, pp717ff) support this view by discussing the influence of "perceived trustworthiness" (factors: ability, benevolence, and integrity) on the willingness to trust and to take risk. The higher the trust level, the more positive effects on the different factors can be observed. In addition, Dirks and Ferrin (2001, pp452ff) stress the main effect of trust on "workplace attitudes", such as job satisfaction, and on "cognitive and perceptual constructs. Dirks and Ferrin (2001) compare existing studies in the literature about trust and its effect on the above listed factors and find not very significant results.

This paper focuses on the effects of trust on knowledge transfer (see sections below).

Trust as a Moderator

The second approach of Dirks and Ferrin (2001, pp455ff) deals with trust as a moderating effect. Thus, this model opposes the direct effect of trust on outcomes, but introduces the assumption that the organization benefits from trust in a way that trust "facilitates (i. e., moderates) the effects of other determinants on work attitudes,

perceptions, behaviors, and performance outcomes” (Dirks & Ferrin 2001, p455). They state that “trust provides the conditions under which cooperation, higher performance and/or more positive attitudes and perceptions are likely to occur” (Dirks & Ferrin 2001, p455). In this respect, trust indirectly affects different outcomes. Trust has an effect on how the trustor and the trustee “measure” the behavior of the other party based on the interpretation of present or past behavior of the other party. Thus, trust as a moderator does not directly causes an action or behavior, it rather affects the motivation to take an action (Dirks & Ferrin 2001, p456).

After having presented the two different approaches it is worth to mention that the existing literature mainly deals with the first concept, namely the role of trust as main effect on outcomes, and neglects the role of trust as a moderating effect.

7.1.6 Trust as a Dynamic Construct

Rousseau et al. (1998, pp395ff) summarize that the evolution of trust is a continuous process that takes time. Rousseau et al. (1998, p395) analyze that “trust changes over time – developing, building, declining, and even resurfacing in long-standing relationships”. As described in previous sections of this paper, the development of trust depends on various factors, amongst under things on the characteristics of the trustor and the trustee and their shared past experiences. Consequently, the degree of trust at the beginning of a relationship is not that strong as later on, there is even no trust. Thus, one of the most important aspects of trust is its dynamic nature. Of course, trust can also be destroyed when already developed because of violations by the parties involved. In this case, it turns out to be very difficult to rebuild trust.

7.2 Trust in Organizations

The following sections concentrate on trust in organization or between different firms in networks. The question to ask is whether and how trust influences organizational performance. As already stated above trust involves a risk taking behavior when cooperating or sharing information with other parties (Mayer et al. 1995) which leads to better individual or group performance.

As already discussed above trust can lead to a reduction of transaction costs, but another function of trust can be that trust serves as a medium of organizational

control replacing or supplementing control via price and hierarchical structures (Bradach and Eccles 1989).

As articulated in the article by Wicks et al. (1999) a high degree of trust does not always positively influences outcomes. They observe that neither an overinvestment in trust, nor an underinvestment in trust is advantageous. Wicks et al. (1999, p99) claim that “firms that overinvest in trust – trust too much or invest in trusting relationships that have little value for the firm – may be misallocating precious resources and /or taking unnecessary risks that could have a substantial negative effect on firm performance.” In contrast, “firms that underinvest in trust – trust too little or do not invest in creating trusting relationships that have substantial value for the firm – may miss out on opportunities to create cost savings or develop organizational capabilities vital for the realization of firm objectives” (Wicks et al. 1999, p99). They introduce the concept of “optimal trust” which refers to the challenge to find the perfect level of trust between underinvestment and overinvestment depending on the actors involved and on the situation. Wicks et al. (1999, pp107ff) propose three levels of trust:

- *Low*: A relationship of low trust depends on the “reliance of rational prediction (e.g., monitoring, incentives, and penalties)”. This can be related to the definition of weak ties (see discussion below).
- *Moderate*: A relationship of moderate trust combines “rational prediction” and “affect-based belief on moral character”.
- *High*: A high level of trust is characterized by the “reliance on affect-based belief on moral character. This can be related to the definition of strong ties (see discussion below).

(Wicks et al. 1999, p107)

Figure 11 presents the different levels of trust related to the benefits, costs, and risks.

Level	Costs	Benefits	Risks	Associated With
High trust	Few options and alternatives	Low agency and transaction costs	Assessing betrayal	Strong ties
	Limited monitoring ability	Preferred trading partner	Betrayal	Interdependent relationship
	Costs of creating and maintaining relation	High capacity for adaptation, cooperation, and commitment	Divorce Stifled creativity	
Moderate trust	Some agency and transaction costs	Significant options and alternatives	Worst or best of high trust and low trust?	Weak ties
	Some capacity for adaptation, cooperation, and commitment	Some monitoring ability	Reputation	Moderately interdependent relationship
	Some costs of creating and maintaining relation	Preferred trading partner		
Low trust	High agency and transaction costs	Many options and alternatives	Opportunism	Few or no ties
	Low capacity for adaptation, cooperation, and commitment	Low cost of relationship	Encouraging opportunism	Independent relationship
	No preferred partner	Great deal of monitoring	Insufficient commitment	

Figure 11: Trust Levels: Benefits, Costs, Risks

Source: Wicks, A.C., Berman, S.L., & Jones, T.M. (1999), "The structure of Optimal Trust: Moral and Strategic Implications", *Academy of Management Review*, 24 (1): p 108.

To summarize, trust influences various aspects in networks, e.g., control, transaction costs, building of relationships, communication and exchange of information, conflict solving, and negotiations.

7.3 Trust and Knowledge Transfer

After having illustrated the basic concepts of trust including the psychological and organizational aspect, both on an individual and, organizational level, the paper now attempts to connect the concept of knowledge transfer with the construct of trust.

The trustworthiness of the knowledge source is crucial for the knowledge transfer. Generally spoken: the higher the perceived trustworthiness the higher the willingness to exchange information in an accurate way (Mayer et al. 1995; Szulanski et al. 2004). This is not always true. Wicks et al. (1999), as already discussed above, integrate the "perfect level" of trust (i. e., the perfect combination of trust and distrust) into their approach. Szulanski et al. (2004, pp601ff) demonstrate a negative effect of the perceived trustworthiness of the knowledge source on the accuracy of the knowledge transfer, especially when the knowledge source does not have "complete knowledge on how to obtain superior results" (Szulanski et al. 2004, p602). In this

case, high perceived trustworthiness of the source results in an inefficient knowledge transfer because the trustor relies on the source's advice without questioning the source (Szulanski et al. 2004; Lewicki et al. 1998).

Levin et al. (2002) examine the relationship between the degree of trust and the receipt of useful knowledge. They ask the question whether strong or weak ties foster the accurate transfer of knowledge. It is important to note that trust and strong ties cannot be used interchangeably. Tie strength is defined as the "closeness of a relationship between two parties (Levin et al. 2002, pp3ff; Granovetter 1973, Hansen 1999; Marsden & Campbell 1984). The results of their study show that generally, the receipt of useful knowledge is positively related to strong ties and that especially benevolence-based trust and competence-based trust serve as mediators between those two aspects. On the other hand, the survey points out that weak ties result in an accurate knowledge transfer process as well (Levin et al. 2002). Granovetter (1973) confirms this observation. Weak ties are characterized by distant and not frequent interactions between the involved parties where trust is not the important factor when transmitting non-redundant information (Levin et al. 2002, p4; Granovetter 1973). Furthermore, weak ties provide more "objective" conditions for gathering new information (Granovetter 1973; Levin et al. 2002).

In general, the amount of existing literature does not give a meaningful explanation of whether trust supports the transfer of tacit knowledge or the transmission of explicit knowledge. As pointed out by Albino et al. (1998) and Wathne et al. (1996) trust influences the knowledge transfer process as a whole because it influences the openness of the actors, thus facilitating the knowledge exchange, and it also reduces the costs of the knowledge transfer (Levin et al. 2002; Curral & Judge 1995).

8 Theoretical Model – Hypotheses

Based on the theory that was discussed in the previous sections of this paper, we now construct hypotheses that will be tested in the empirical part of this paper.

First, we study the influence of the characteristics of knowledge on the choice of the communication media. The categorization of knowledge into codified and tacit knowledge, as suggested by Polanyi (1966), requires the use of different knowledge transfer mechanisms. In this context, we take into consideration the concept of information richness (Lengel 1983; Daft & Lengel 1984). To transfer tacit knowledge communication channels of high information richness become necessary, whereas transfer mechanisms of low information richness encourage the exchange of explicit knowledge:

Hypothesis 1 (H1): The higher the explicit nature of knowledge the more transfer mechanisms of low media richness are chosen to transmit the knowledge.

Hypothesis 2 (H2): The tacit nature of knowledge requires the use of communication media of high media richness.

Second, hypothesis 3 describes the mutual exchange of knowledge amongst the cluster partners:

Hypothesis 3 (H3): The degree of knowledge transferred to a cluster partner is positively related to the degree of knowledge acquired from the partner company.

Finally, hypothesis 4 and hypothesis 4a refer to the influence of trust on the choice of knowledge transfer mechanisms. It is debated whether trust encourages the transfer of tacit knowledge or whether it fosters the transmission of explicit knowledge:

Hypothesis 4 (H4): The degree of trust is positively related to knowledge transfer mechanisms of high media richness.

Hypothesis 4a (H4a): The degree of trust is positively related to knowledge transfer mechanisms of low media richness.

9 Empirical Analysis

The purpose of the following sections of the paper is to present the empirical study that was made during the course of this diploma thesis. The first part concentrates on the sample of the study which is the Mechatronics cluster of Upper Austria. Next, the method of the empirical study is debated, including a description of the questionnaire and frequency analyses of the given answers. Finally, the results of the statistical tests of the hypotheses are discussed.

9.1 Mechatronics Cluster Upper Austria

The Mechatronics Cluster of Upper Austria is one of the biggest clusters in Austria. Currently, the cluster unites 280 companies with approximately 45,700 employees and total sales of 7,944 million € (as per 2009-07-28). The study of this paper was started in June, 2007. At that time, the Mechatronics Cluster consisted of 212 partners and total sales of approximately 5,400 million €. The results of the study are based on the data of 2007.

The Mechatronics Cluster was founded in 2003 and is headquartered in Upper Austria, in Linz, and is run by Clusterland Oberösterreich GmbH, which is owned by Technologie-und Marketinggesellschaft mbH, the Upper Austrian Chamber of Commerce and the Confederation of Upper Austria Industry (www.mechatronik-cluster.at). In addition, the Clusterland Oberösterreich GmbH administers various other clusters including the Automotive Cluster and Plastics Cluster, and other different networks. Most cluster partners are located in Upper Austria, a few other companies are settled in other parts of Austria, as well as in Germany, Italy, Slovakia, and the Principality of Liechtenstein. The Mechatronics Cluster combines mechanical engineering, electronic engineering, and software engineering activities. Figure 12 illustrates the fields of activity of the Mechatronics Cluster and gives an overview of how many companies operate in the different fields. As the Mechatronics Cluster emphasizes its “superordinated goal is increased competitiveness by means of enhanced innovative strength and the further development of key competences among partner companies” (www.mechatronik-cluster.at) where an important point to note is the intense collaboration between the various companies and R&D facilities. The objectives of the Mechatronics clusters are listed below:

- “Increase publicity
- Find appropriate cooperation partners
- Reduce market entry barriers
- Initiate and monitor know-how transfer
- Highlight trends
- Increase innovativeness and competitiveness
- Relevant and valid information”

(<http://www.mechatronik-cluster.at>)

The Mechatronics Cluster Upper Austria benefits from the cluster organization thus, gaining a competitive advantage. As noted in the list of objectives above know-how transfer and the exchange and creation of accurate information plays a pivotal role, all being part of an effective knowledge management which is the centerpiece of this paper.

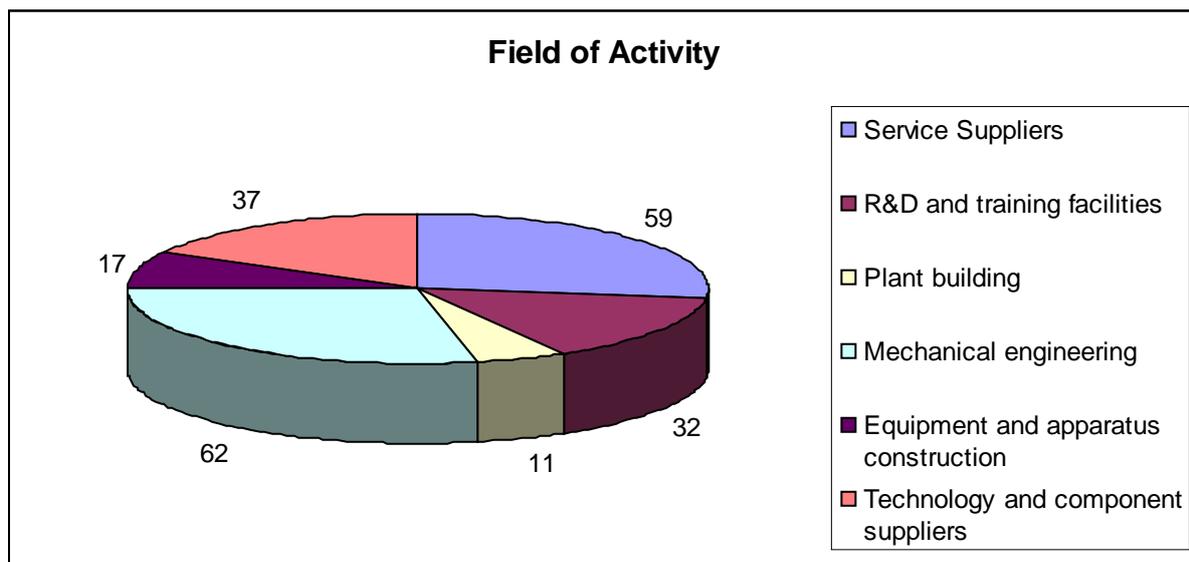


Figure 12: Partners of the Mechatronics Cluster per field of activity

(as per 2007-06-22)

(<http://www.mechatronik-cluster.at>)

The Mechatronics Cluster Upper Austria focuses on companies of small and medium size. Figure 13 shows the number of small, medium and large cluster partners where the concentration on SMEs is clearly observable. The companies are classified according to size:

Smallest companies: < 10 employees

Small companies: 10-49 employees

Medium companies: 50-250 employees

Large companies: > 250 employees

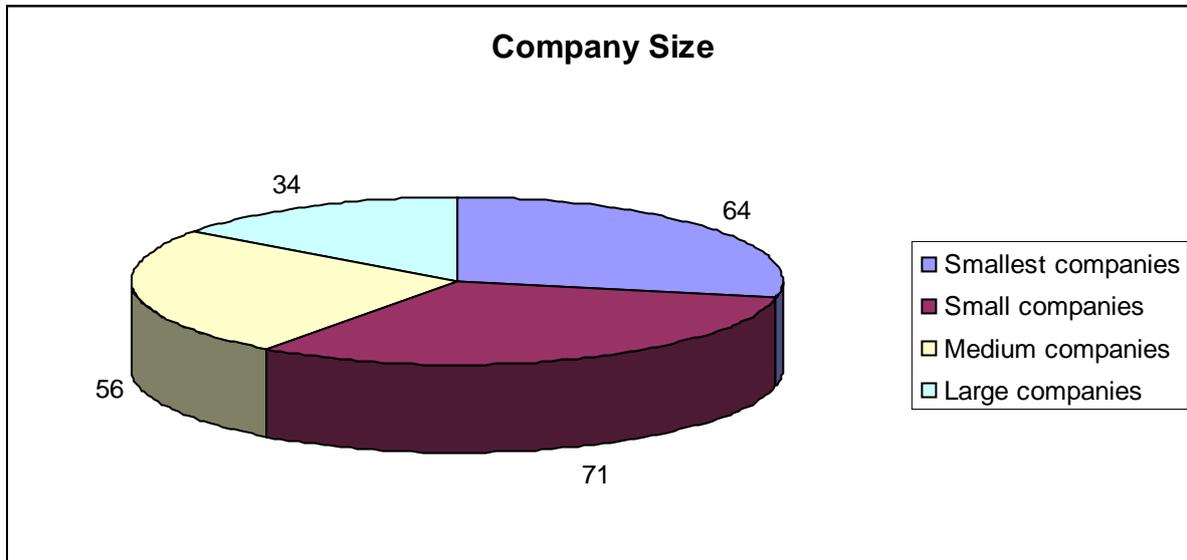


Figure 13: Number of Partners of the Mechatronics Cluster per company size
(as per 2007-06-22)
(<http://www.mechatronic-cluster.at>)

After having described the Mechatronics Cluster Upper Austria in the above section of this paper the next paragraphs concentrate on the method of the empirical study.

9.2 Data Collection

9.2.1 The Sample and Contact Method

The research instrument of this survey is a questionnaire. The questionnaire was sent to the partner companies of the Mechatronics Cluster Upper Austria, excluding universities and “Fachhochschulen” (universities for applied science). At the time of the beginning of this study the Mechatronics Cluster consisted of 212 partner firms. After having excluded the educational institutions a total of 188 companies received the questionnaire.

A mail survey was chosen as the appropriate contact method. The questionnaire was sent out two times by mail both to the national companies and international companies participating in the Mechatronics Cluster, and two times by electronic

mail. It was attempted to directly address the company managers or the contact persons indicated on the website of the Mechatronics Cluster (www.mechatronik-cluster.at). In addition, the Mechatronics Cluster supported an announcement of the study in the newsletter of the cluster. The whole distribution happened within six months. It takes around five to ten minutes to complete the questionnaire. A total of 46 usable questionnaires were received which leads to a response rate of approximately 24.5%. We conducted a non-response-bias test (Armstrong and Overton 1977) to examine differences in the results of early and late responders. Firms that responded to the first mail survey belong to the group of early respondents whereas the remaining companies form the nonresponding group. We could not observe a significant difference between the two groups.

9.2.2 The Questionnaire

The questionnaire (see Appendix) consists of three main parts:

- a. General questions about the company
- b. Specific questions about knowledge management between the partner companies of the cluster
- c. Specific questions about knowledge transfer and trust

The first part collects information about the company itself, investigating the sector in which the company is operating, the total sales and the number of employees. The second section asks questions about the knowledge management between the cluster partners, finding out which knowledge transfer mechanisms are used between the partner companies to exchange knowledge. Several transfer mechanisms are proposed where the degree of importance can be marked on a five item scale, choosing between not important at all (1) to extremely important (5). Finally, the third part concentrates on knowledge transfer and trust. In this respect, the media choice according to Daft and Lengel (1984) as well as details about the codifiability and teachability of the exchanged knowledge (Kogut and Zander 1993), and questions about trust between the partner companies are debated. All the questions will be discussed in more detail when analyzing the different questions and the hypotheses. The whole questionnaire can be found in the Appendix of this paper.

9.3 Analysis of the Questionnaire

The purpose of this part of the paper is to examine and analyze the different questions asked in the questionnaire. The analysis of the questionnaire is supported by the statistical analysis software SPSS. We start with a descriptive analysis of part one of the questionnaire that collects general data about the company. As already mentioned above these questions give information about the sector, sales and the number of employees of the cluster company.

The Sector

The interviewees were given the choice between the following sectors:

- Services sector: Consulting
- Services sector: Maintenance/ Service
- Services sector: Training facilities/ HR development
- Services sector: Miscellaneous
- R&D/ Educational institutions
- Mechanical engineering
- Plant building
- Equipment and apparatus construction
- Technology and component suppliers
- Miscellaneous: Which sector?

It is important to note that the companies could choose multiple answers.

Figure 14 illustrates the results of the analysis. As it is clearly shown, most of the companies operate in the mechanical engineering sector, namely approximately 34.8 %, followed by plant building, and equipment and apparatus construction, whereas a small number of firms work in the services sector. Again, the multiple choices have to be taken into consideration.

Sales

To continue, total sales of the company are examined. Sales are divided into five categories, which are demonstrated in Figure 15. It can be observed that the majority

of the companies have sales amounting between 3 and 20 mil € (37%). Two questionnaires show missing values for the amount of sales.

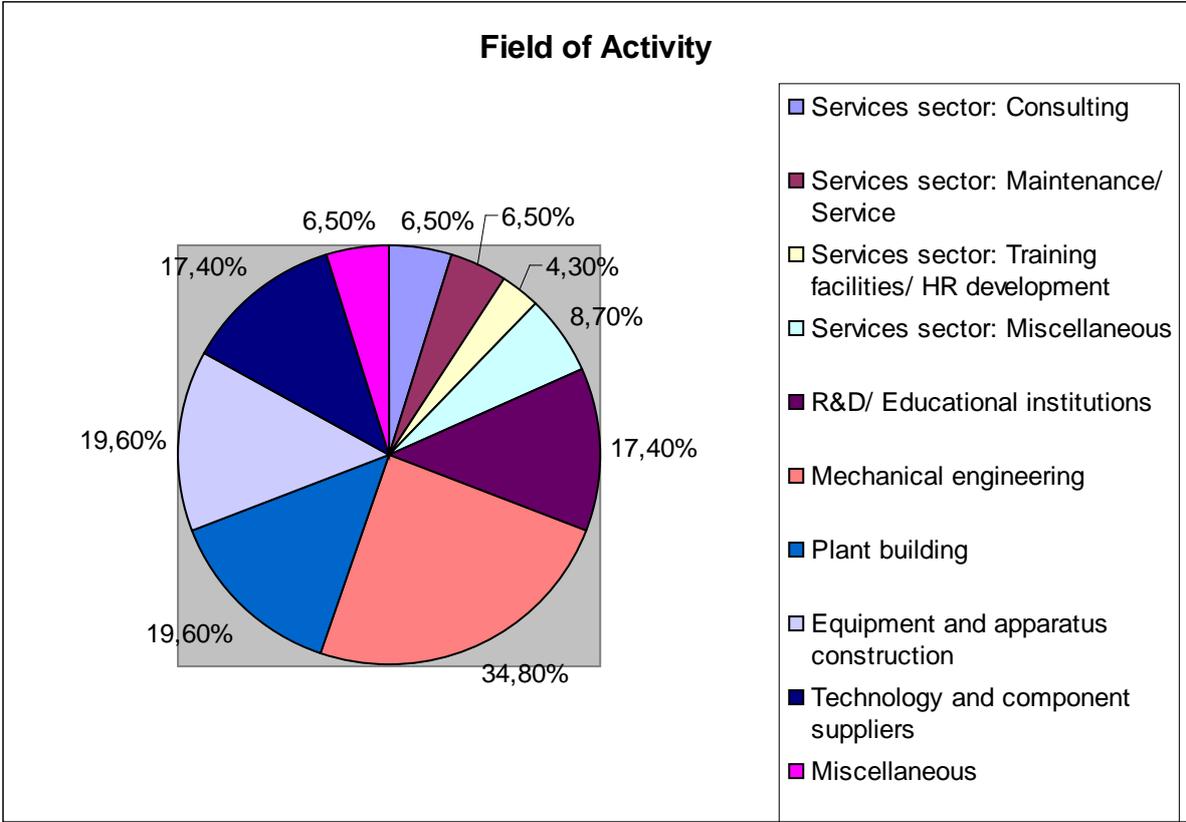


Figure 14: Partners of the Mechatronics Cluster per field of activity (empirical study)

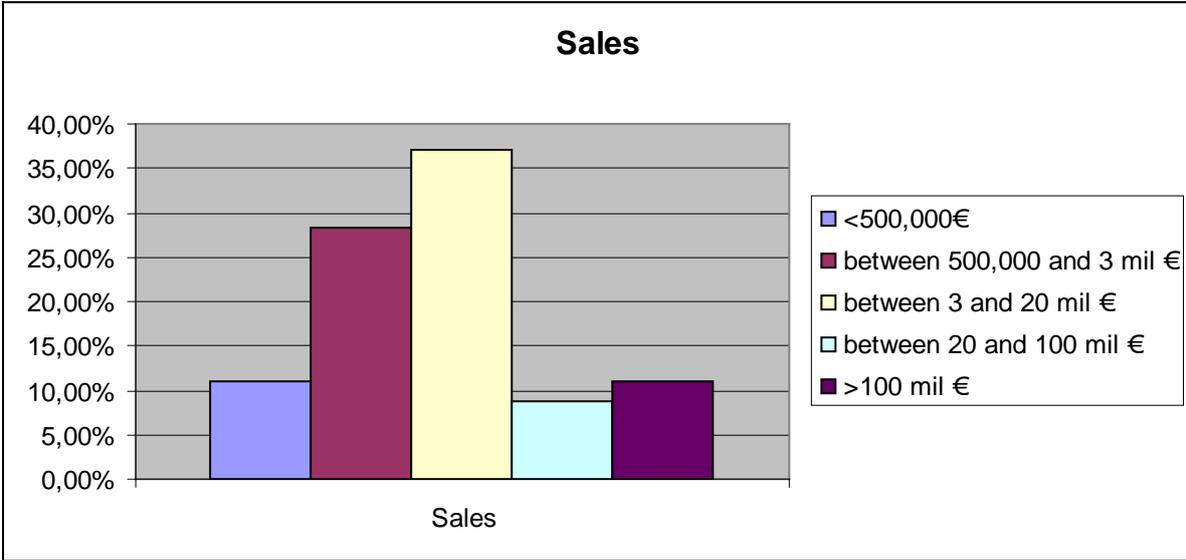


Figure 15: Partners of the Mechatronics Cluster per sales (empirical study)

Number of Employees

Number of Employees	Number	Percentage
Smallest companies	12	26%
Small companies	10	21.80%
Medium companies	11	23.90%
Large companies	6	13.10%
Missing Values	7	15.20%
Total	46	100%

Table 5: Number of Employees

The table above illustrates that most of the companies that have responded to the questionnaire are of small or medium size as pointed out earlier.

Knowledge Management

After having analyzed the components of part A of the questionnaire we link up with part B which focuses on knowledge management. This part gathers information about the importance of the different forms of knowledge transfer. The companies had to make the choice on a scale between not important at all (1) to extremely important (5). The types of knowledge transfer comprise the sharing of experiences, including meetings, discussions between the partners, chat systems, newsgroups, and online forum, continued with observation and imitation which refers to the rotation of employees between firms. Furthermore, documentary systems, such as joint databases, belong to the forms of knowledge transfer, as well as classification (evaluation of the market by observing the purchasing behavior, learning by doing, and work groups between the cluster partners. According to Nonaka (2003) documentary systems and classification are most suitable for transmitting explicit knowledge because explicit knowledge can be codified in formal language. The remaining types of knowledge transfer serve to transfer tacit knowledge. Figure 16 shows the frequency results of the questionnaires. The diagram illustrates the mean of the given answers. As we can observe the companies heavily use sharing of experience to transfer knowledge followed by learning by doing methods and work groups. The result emphasizes the importance of knowledge transmission tools that belong to the group of tacit knowledge transfer techniques. The question to ask here is whether the firms really transfer tacit knowledge to a larger extent than they

transmit explicit knowledge. This question will be the subject of discussion in later sections of this paper.

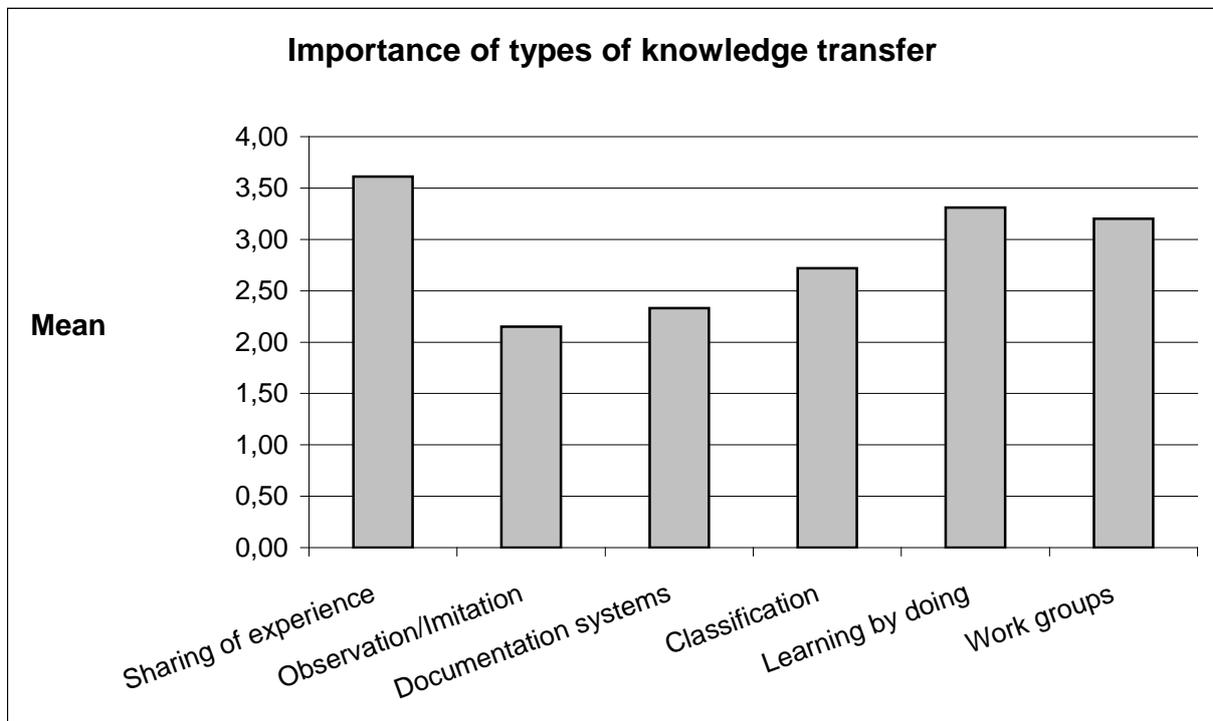


Figure 16: Importance of types of Knowledge Transfer

Knowledge Transfer and Trust

We continue with part C of the questionnaire which debates knowledge transfer and trust. The first question of this part deals with the media richness and media choice theory which goes back to Daft and Lengel (1984) and is also discussed by Büchel and Raub (2001). The proposed answers to this question range from the richest media that is face-to-face communication to the lowest media that are numeric documents, as classified by Daft and Lengel (1984). The media used for transmitting knowledge goes from face-to-face communication, including informal meetings between the employees, formal meetings between the partner companies, seminars and workshops, and committees, to videoconferencing, telephone, fax, chat conferences, online forum discussions, newsgroups, intranet, e-mails, other internet tools, and finally, formal letters and numeric outputs such as existing documents. Figure 17 highlights the output of the analysis. The media used most by the companies for exchanging information are e-mail, telephone, seminars and workshops and other internet tools. They tend to prefer face-to-face communication to transfer knowledge. Telephone and electronic mails are part of the lower media

richness category, and existing numeric documents are not rich at all. In addition, the results show that the firms seem to reject more modern forms of media, for instance videoconferencing, chat, or online forums.

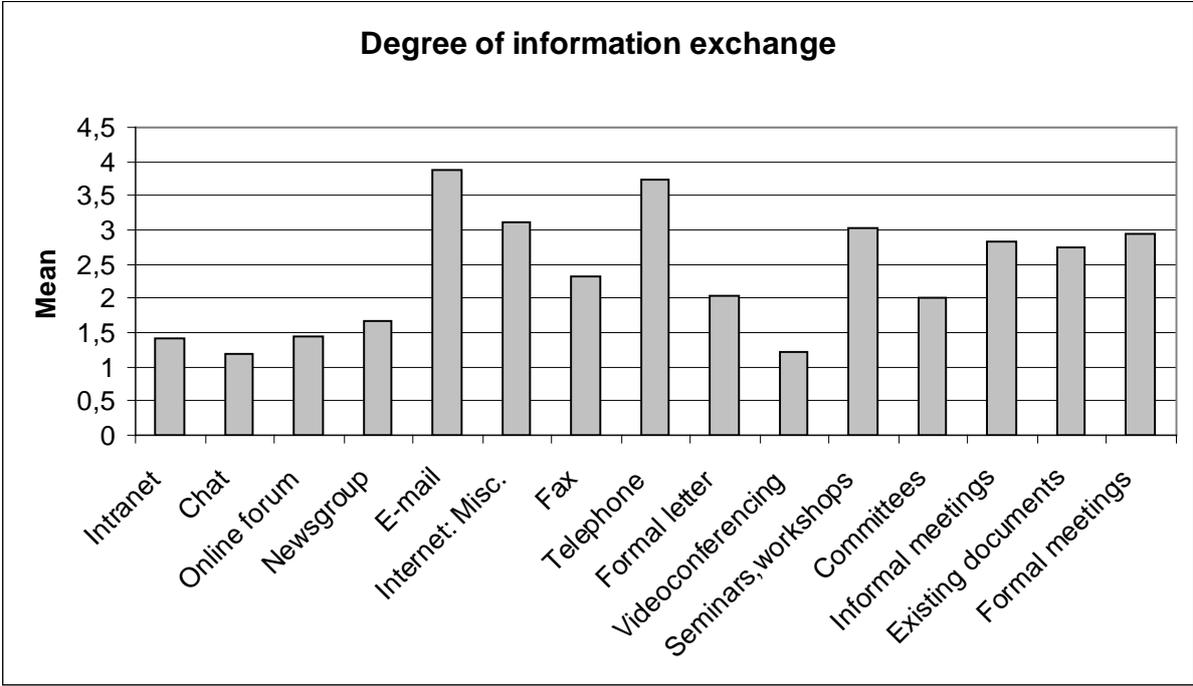


Figure 17: Degree of Information Exchange (Media Choice)

Next, we discuss how easily knowledge can be transferred to the partner companies, and on the other hand can be received by the cluster partners. The questions here focus on the transfer techniques that make the transmitted knowledge useful, which is pivotal as was already discussed in the theory part of this paper. This part investigates the mutual exchange of knowledge between the partner firms. When testing the hypotheses in the next big section of this paper we will split up the types of knowledge transfer into techniques that are codifiable and into techniques that are teachable (Kogut and Zander 1995). Figure 18 and Figure 19 present the findings of the analysis. The companies were asked to which extent they use existing manuals or documents and information technology that describe the processes between the cluster partners, as well as to which extent they apply an exchange of employees to transfer knowledge or organize seminars to train the partner employees, and finally to which degree they support personal meetings between the employees. It is important to note that the questions aim to find out how easily the knowledge can be transferred to or can be acquired from the partner companies of the cluster. Therefore, the answer “not important at all” refers to the difficulty of transferring the knowledge and the answer “very important” emphasizes that it is easy to transmit the

knowledge. For more details see the full questions of the questionnaire in the appendix of this paper. Figure 18 illustrates that the companies support personal discussions between their employees and the employees of the partner companies to transfer knowledge, followed by seminars for the partner employees and employee training. These types of knowledge transfer are considered to be most suitable to easily transfer knowledge to the partner companies.

The same result can be observed when analyzing the types of knowledge transfer that are used for obtaining knowledge from the cluster partners. Additionally, Figure 8 shows the importance of information technology to easily co-operate with the partner companies.

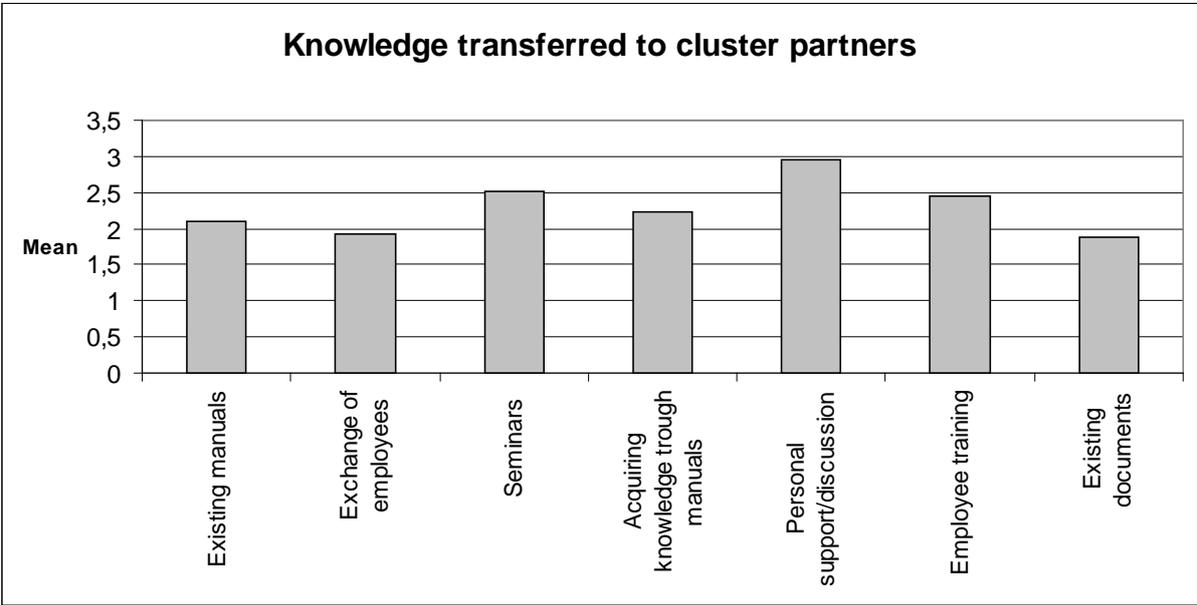


Figure 18: Knowledge transferred to Cluster Partners

Finally, the last question of part C concentrates on the relationship between the cluster partners. We examine the degree of trust that prevails between the companies. The companies asked had to give details about the degree of trust between them and their partners, as well as whether they observe an atmosphere of frankness and honesty between the companies. Furthermore, it is asked whether the firms exchange information beyond the extent that was agreed, whether they work together in a spirit of partnership, whether they keep oral agreements, and hear and discuss their partners' suggestions for improving the cooperation between the cluster partners or suggestions for innovations. The range goes from not true at all (1) to

completely true (5). The results are presented in Figure 20 and show a high degree of trust, except the degree of information exchange beyond the agreed extent.

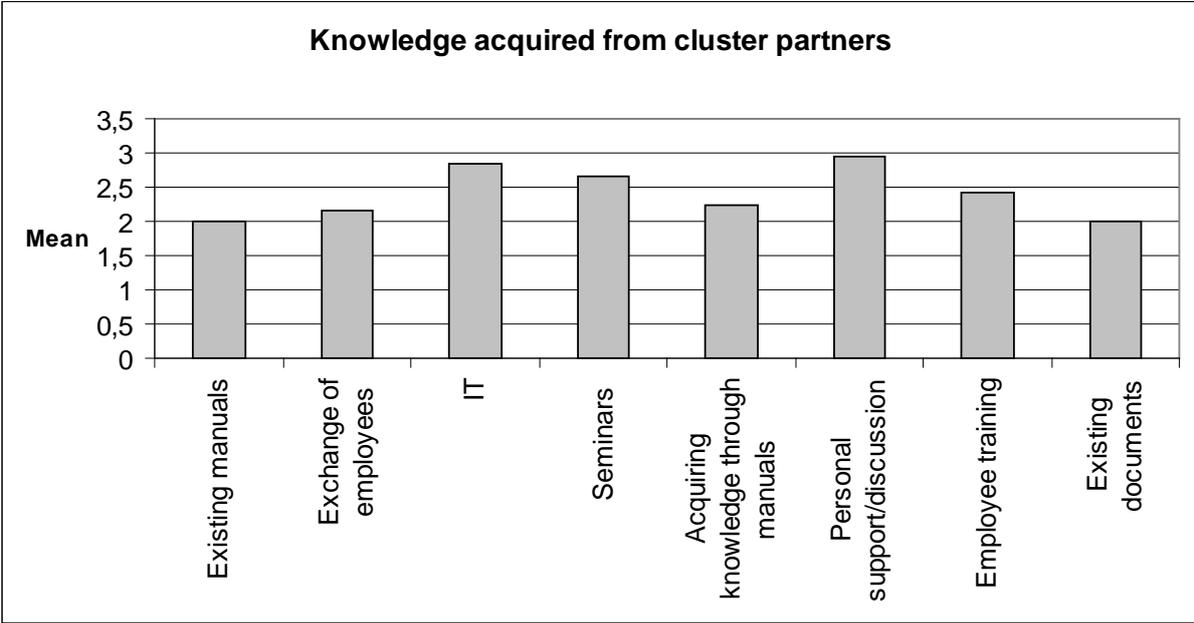


Figure 19: Knowledge acquired from Cluster Partners

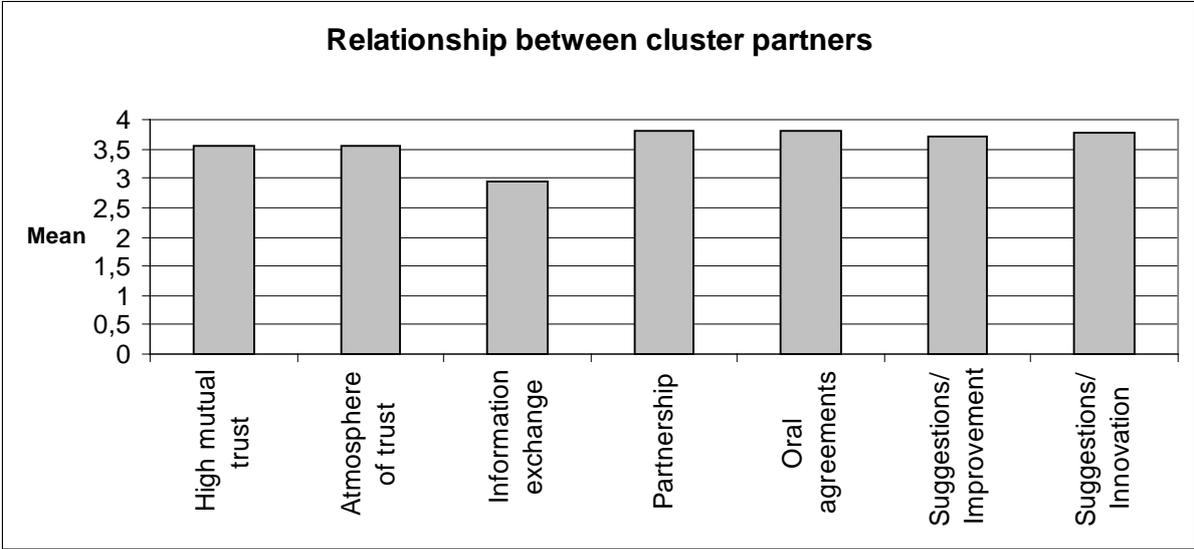


Figure 20: Relationship between Cluster Partners

After having completed the descriptive part of the empirical analysis, we continue with the testing of the hypotheses.

9.4 Statistical Method

Before starting to test the different hypotheses, we describe the statistical method that was used for this purpose. The analysis was done by using the statistical analysis software SPSS (Version 14). The following methods were applied:

- Factor Analysis: The factor analysis intends to reduce the amount of variables to factors, which means that variables are determined that rely on the same concept. Thus, variables with high correlation amongst each other build one factor. Therefore, the basis for the factor analysis is the correlation matrix, followed by computing the communalities (the variance of a test to be explained). To continue, the “Eigenvalues” (the amount of the variance the initial factors account for) of the factors are calculated. The amount of factors extracted is equal to the amount of “Eigenvalues” greater than one. The most common extraction method is the principal component analysis. To increase the amount of variance the factors are rotated. The rotation problem is solved by applying the orthogonal rotation supported by the Varimax method.

- Reliability Analysis: The reliability analysis is applied to test the consistency of a measure, especially when analyzing multiple-item scales. The reliability analysis measures the quality of one feature in relation to the whole test. To compute this measure the reliability coefficient is ascertained using the Cronbach’s Alpha method. The value of the Cronbach’s Alpha lies between 0 and 1 where the higher the value the better the quality of the test. A correlation coefficient of 0.8 or higher guarantees reliability.

- Correlation: The correlation coefficient indicates the relationship between two variables. It can take values between -1 and $+1$, where -1 means that the two variables tested show a perfect negative correlation and a value of $+1$ shows a perfect positive correlation between the two variables. The correlation coefficient can be computed applying different methods, like the Pearson correlation, or the Spearman and Kendall correlation.

- Regression Analysis (Multiple Linear Regression): The regression analysis examines the sort of relationship between two variables and makes it possible to predict the value of a dependent variable derived by independent variables.

The multiple linear regression model involves more than one independent variables to compute the dependent variable.

(Bryman & Cramer 2005)

9.5 Hypotheses

9.5.1 Hypothesis 1 and Hypothesis 2

Hypothesis 1 and Hypothesis 2 examine the relationship between the nature of the knowledge that has to be transferred and the media choice for the transfer process. The nature of the knowledge refers to its tacit or explicit character.

9.5.1.1 Construction of Measures

LIR/HIR

As debated by Daft and Lengel (1984) the knowledge transfer mechanisms can be classified according to their media richness. Face-to-face communication is regarded as the richest communication medium as was already debated in the theory part of this paper. Analyzing the questionnaire informal and formal meetings between the cluster partners, committees, and seminars and workshops belong to the group of rich communication media. We add videoconferencing as rich communication medium as proposed by Büchel and Raub (2001). The remaining transfer mechanisms are considered to be of low media richness. Therefore, we a priori draw a distinction between communication media low in information richness (LIR) and high in information richness (HIR).

We test our assumptions (Table 6) by conducting a reliability analysis and a factor analysis for each of the factors.

Medium	Information Richness	
	LIR	HIR
Intranet	x	
Chat discussions	x	
Online forum	x	
Newsgroups	x	
E-mail	x	
Internet: misc.	x	
Fax	x	
Telephone	x	
Formal letter	x	
Videoconferencing		x
Seminars/Workshops		x
Committees		x
Informal meetings		x
Existing documents	x	
Formal meetings		x

Table 6: Media Richness of Knowledge Transfer Mechanisms (LIR/HIR)

LIR.....Low Information Richness/ HIR....High Information Richness

The factor analysis of the transfer mechanisms considered to be of high media richness confirms our classification by extracting only one factor. The reliability analysis of the transfer mechanisms building the HIR variable results in a Cronbach's Alpha of 0.7014.

We continue to examine our proposed classification of the low media richness variable, as listed in Table 6. When excluding the telephone item (It builds a separate factor.) the factor analysis of the group of low information media extracts two factors, that are knowledge transfer mechanisms of low information richness subdivided into "new" media (Intranet, chat, online forum) and "old" media (Fax, formal letter, existing documents, e-mail) as illustrated in Table 7. E-mails can be regarded as "old" media because they are already well established. We sum up the two factors to the variable LIR. The reliability analysis finds items with efficient high corrected item-total correlation and shows a Cronbach's Alpha of 0.7590 which is efficient high to be reliable.

	Component	
	1	2
c1 Intranet	.233	.682
c1 Chat	-.116	.762
c1 Online forum	.174	.807
c1 Newsgroups	.585	.567
c1 E-mail	.544	.422
c1 Fax	.852	-.064
c1 Formal letter	.748	.038
c1 Existing documents	.508	.192

Table 7: Rotated Component Matrix/LIR

Extraction Method: Principal Component Analysis.
 Rotation Method: Varimax with Kaiser Normalization.
 Rotation converged in 3 iterations.

To sum up, in the previous paragraphs we defined the two important variables for testing hypothesis 1 and hypothesis 2. To compute the variables HIR and LIR we use the mean of the data collected in our survey. The variables HIR and LIR will be the dependent variables of the empirical analysis.

CODE/TEACH

To continue, we focus on the variables CODE and TEACH (CODE....Codifiability, TEACH....Teachability). Zander and Kogut (1995) emphasize that a relation between the tacitness or explicitness of knowledge and the codifiability and the teachability of knowledge can be observed. Explicit knowledge is easy to codify whereas tacit knowledge demands to be transmitted, amongst other things, by teaching the knowledge.

We divided the different knowledge transfer mechanisms into techniques that belong to the category of codifiability or to the group of teachability. The classification includes both the questions of part C2 of the questionnaire (knowledge transferred to partner companies) and questions of part C3 (knowledge received from cluster partners). Table 8 presents our proposal.

Knowledge Transfer Mechanisms	CODE	TEACH
C2 Transferred Knowledge		
Existing manuals	x	
Exchange of employees		x
Seminars		x
Acquiring knowledge through manuals	x	
Personal support/discussion		x
Employee training		x
Existing documents	x	
C3 Acquired Knowledge		
Existing manuals	x	
Exchange of employees		x
IT	x	
Seminars		x
Acquiring knowledge through manuals	x	
Personal support/discussion		x
Employee training		x
Existing documents	x	

Table 8: Codifiability (CODE) and Teachability (TEACH) of Knowledge

The factor analysis of the variable CODE extracts only one factor which corresponds to our proposal. The reliability analysis results in a Cronbach's Alpha of 0.8682. Therefore, the scaling turns out to be reliable.

When testing the variable TEACH the factor analysis leads to the extraction of two factors. The exchange of employees builds a separate factor. The reliability analysis recommends to eliminate the item "exchange of employees" to get a better Cronbach's Alpha. After eliminating the above mentioned item the factor analysis extracts a single factor. A Cronbach's Alpha of 0.8961 is reached in the reliability analysis which is high enough to be reliable.

For computing the variables TEACH and CODE the mean of the results of the questionnaires is used.

Table 9 summarizes the different components of the variables TEACH and CODE.

The correlations between the independent variables CODE and TEACH are presented in Table 21.

Variable	Knowledge Transfer Mechanisms
CODE	Existing manuals
	Acquiring knowledge through manuals
	Existing documents
	IT
TEACH	Seminars
	Personal support/discussion
	Employee training

Table 9: Variables CODE (Codifiability) and TEACH (Teachability)

9.5.1.2 Empirical Results

After having described the variables necessary for the further empirical study we analyze the hypotheses we constructed. The question to answer is how the nature of knowledge, whether it is implicit or explicit, and the dimensions of knowledge, which refer to its codifiability or teachability, influence the media choice to transfer the knowledge. We assume that the more explicit the knowledge and therefore, easily codifiable, the more transfer mechanisms of low media richness are chosen. This leads to the first hypothesis.

Hypothesis 1 (H1): The higher the codifiability and the explicit nature of the knowledge the more transfer mechanisms of low media richness are chosen to transmit the knowledge. Thus, codifiability is positively related to LIR and teachability is negatively related to LIR.

We conduct a multiple regression analysis with LIR as dependent variable, CODE and TEACH as explanatory variables, and sales as the control variable. The significance level is set at 0.05. This leads to the following regression equation:

$$\text{LIR} = \alpha + \beta_1 * \text{CODE} + \beta_2 * \text{TEACH} + \beta_3 * \text{Sales}$$

The model as a whole is significant at a significant level of 0.05 with $p=0.00$, $R^2=0.469$ and $F=11.763$. The analysis of the separate components shows that the independent variable CODE is significant with $p=0.001$, whereas sales and TEACH have no significant influence on the dependent variable LIR. As we expected the variable CODE has a positive sign. Hence, the higher the codifiability of the

knowledge the more transfer mechanisms of low media richness are used. The results of the linear regression confirm hypothesis 1. Table 10 and Table 11 present the findings.

Model	R Square	F	Sig.
1	.469	11.763	.000

Table 10: H1: Linear regression results

Predictors: (Constant), CODE, TEACH, Sales
Dependent Variable: LIR

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig
		B	Std. Error	Beta		
1	(Constant)	.719	.324		2.219	.032
	TEACH	.104	.114	.142	.911	.368
	CODE	.442	.117	.588	3.775	.001
	Sales	.065	.063	.120	1,031	.309

Table 11: H1: Linear regression results/Coefficient model

Predictors: (Constant), CODE, TEACH, Sales
Dependent Variable: LIR

Hypothesis 2 examines the influence of the above stated independent variables on the dependent variable HIR (High Information Richness). We assume that the degree of teachability of the knowledge is positively related to the use of transfer mechanisms of high media richness. High teachability and low codifiability are characteristic for the transfer of tacit (implicit) knowledge.

Hypothesis 2 (H2): The tacit nature of knowledge requires the use of communication media of high media richness. Thus, teachability is positively related to HIR and codifiability is negatively related to HIR.

We draw up the following regression equation:

$$\text{HIR} = \alpha + \beta_1 * \text{CODE} + \beta_2 * \text{TEACH} + \beta_3 * \text{Sales}$$

As illustrated in the regression equation above the variable Sales is the control variable. The regression analysis confirms the negative relation between the variables HIR and CODE, and the positive relation between HIR and TEACH. Table

12 shows the high significance of the model ($p=0.001$, significance level = 0.05) with $R^2=0.317$ and $F=6.189$. Examining the different components of the model (Table 13), we find that only the variable TEACH is highly significant ($p=0.001$), whereas the variables CODE ($p=0.682$) and Sales ($p=0.214$) are not significant. The variable CODE seems to have no significant influence on the variable HIR. The whole model concurs with hypothesis 2 but regarding the results in detail, we find strong evidence only for the relation between the teachability of knowledge and the use of knowledge transfer techniques of high information richness.

Model	R Square	F	Sig.
1	.317	6.189	.001

Table 12: H2: Linear regression results

Predictors: (Constant), Sales, CODE, TEACH
 Dependent Variable: HIR

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.871	.429		2.030	.049
	CODE	-.064	.155	-.073	-.413	.682
	TEACH	.520	.151	.610	3.444	.001
	Sales	.106	.084	.167	1.262	.214

Table 13: H2: Linear regression results/Coefficient model

Predictors: (Constant), Sales, CODE, TEACH
 Dependent Variable: HIR

To sum up, the transfer of tacit knowledge is influenced by its degree of teachability. The regression results confirm our assumption that the transmission of tacit knowledge is supported by transfer mechanisms that show high information richness.

9.5.2 Hypothesis 3

9.5.2.1 Empirical Results

In addition to hypothesis 1 and hypothesis 2, hypothesis 3 debates the relation between the knowledge transferred to a partner company and the knowledge acquired from a partner firm. This mutual knowledge exchange is documented in part C2 and C3 of the questionnaire (see Appendix).

Hypothesis 3 (H3): The degree of knowledge transferred to a cluster partner is positively related to the degree of knowledge acquired from the partner company.

To verify hypothesis 3, we carry out a Pearson correlation. The analysis computes the correlations between the different knowledge transfer mechanisms that have already been defined in the discussion above. The results stress the high significance of the correlation as highlighted in Table 14. It is evident that the mutual degree of knowledge exchange between the partner firms is very high.

Variable	Knowledge Transfer Mechanisms	Pearson Correlation	Sig.
CODE	Existing manuals	.748	.000
	Acquiring knowledge through manuals	.714	.000
	Existing documents	.888	.000
TEACH	Seminars	.640	.000
	Personal support/discussion	.757	.000
	Employee training	.630	.000

Table 14: Pearson correlations

Significance level (Sig.) = 0.01 (2-tailed)

9.5.3 Hypothesis 4

We now involve the aspect of trust into our considerations which leads to the analysis of part C4 of the questionnaire (see Appendix).

9.5.3.1 Construction of the Measures

First, the aim is to define the variable “Trust”. We run a factor analysis to check the different items that characterize trust. The factor analysis extracts two factors (Table 15).

	Component	
	1	2
c4 High mutual trust	0.870	0.328
c4 Honesty & Frankness	0.906	0.241
c4 High information exchange	0.783	0.162
c4 Partnership	0.692	0.461
c4 Oral agreements	0.323	0.690
c4 Suggestions/Improvements	0.229	0.918
c4 Suggestions/Innovation	0.242	0.933

Table 15: Rotated Component Matrix/Trust

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.

Rotation converged in 3 iterations.

High mutual trust, an atmosphere of frankness and honesty, high information exchange, and a relationship based on partnership characterize trust. The remaining components seem to belong to another dimension that concentrates more on agreements, and not on the atmosphere of trust. Therefore, the variable Trust takes into consideration the above mentioned components. A reliability analysis of the factor trust with a Cronbach's Alpha of 0.891 shows the high reliability of the variable Trust. The variable Trust is computed using the mean of the results of the questionnaire. Table 16 illustrates the details of the variable Trust.

Trust	Mean	SD
High mutual trust	3.540	.959
Honesty & Frankness	3.540	.936
High information exchange	2.960	.918
Partnership	3.800	.957
Variable Trust	3.517	.737

Table 16: Variable Trust
SD...Standard Deviation

The correlations between the independent variables CODE, TEACH and Trust are presented in Table 21.

9.5.3.2 Empirical Results

To continue, we examine the relation between trust and the application of knowledge transfer mechanisms of high or low media richness. The question to ask is whether a high degree of trust leads to the application of high media richness techniques or vice versa.

Hypothesis 4 (H4): The degree of trust is positively related to knowledge transfer mechanisms of high media richness.

Additionally, the analysis contains the variables TEACH and CODE as dependent variables and Sales as control variable which results in the following regression equation:

$$\text{HIR} = \alpha + \beta_1 * \text{Trust} + \beta_2 * \text{CODE} + \beta_3 * \text{TEACH} + \beta_4 * \text{Sales}$$

The results of the multiple regression analysis are presented in Table 17 and Table 18. The model as a whole is significant with $R^2=0.370$, $F=5.737$, $p=0.001$ (significance level = 0.05), but regarding the different components (Table 18) the significance is based on the variable TEACH. Furthermore, the model shows that trust is positively related to high information richness. Here, the model is slightly significant (significance level = 0.1).

Model	R Square	F	Sig.
1	.370	5.737	.001

Table 17: H4: Linear regression results
 Predictors: (Constant), Trust, Sales, CODE, TEACH
 Dependent Variable: HIR

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig
		B	Std. Error	Beta		
1	(Constant)	.184	.563		.327	.745
	Trust	.249	.137	.259	1.819	.077
	Sales	.126	.082	.199	1.534	.133
	CODE	-.123	.154	-.140	-.799	.429
	TEACH	.478	.149	.561	3.216	.003

Table 18: H4: Linear regression results/Coefficient model
 Predictors: (Constant), Trust, Sales, CODE, TEACH
 Dependent Variable: HIR

Consequently, we modify hypothesis 4 and attempt to make a connection between trust and knowledge transfer techniques of low media richness.

Hypothesis 4a (H4a): The degree of trust is positively related to knowledge transfer mechanisms of low media richness.

Hypothesis 4a leads to the regression equation below:

$$\text{LIR} = \alpha + \beta_1 * \text{Trust} + \beta_2 * \text{CODE} + \beta_3 * \text{TEACH} + \beta_4 * \text{Sales}$$

With $R^2=0.570$, $F=12.918$ and $p=0.000$ (significance level = 0.05) the model turns out to be highly significant as illustrated in Table 19.

Model	R Square	F	Sig.
1	.570	12.918	.000

Table 19: H4a: Linear regression results

Predictors: (Constant), Trust, Sales, CODE, TEACH
Dependent Variable: LIR

The analysis of the coefficient model (Table 20) identifies the significance of Trust ($p=0.007$) and of the variable CODE ($p=0.003$). Thus, trust has a positive influence on the decision to apply knowledge transfer mechanisms of low media richness.

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig
		B	Std. Error	Beta		
1	(Constant)	.096	.398		.240	.812
	Trust	.274	.097	.333	2.829	.007
	Sales	.085	.058	.157	1.458	.153
	CODE	.341	.109	.453	3.121	.003
	TEACH	.110	.105	.151	1.047	.302

Table 20: H4a: Linear regression results/Coefficient model

Predictors: (Constant), Trust, Sales, CODE, TEACH
Dependent Variable: LIR

Table 21 shows the correlations between the independent variables. The correlation between TEACH and CODE is significantly positive and shows the highest value.

	CODE	Trust	TEACH	Sales
CODE	1			
Trust	.408 (.005)	1		
TEACH	.672 (.000)	.387 (.009)	1	
Sales	-.137 (.376)	-.190 (.216)	-.157 (.307)	1

Table 21: Correlation between Independent Variables

(Values in parentheses: p =significance)

The findings of the regression analysis demonstrate that the higher the level of trust the more knowledge is transferred using low media richness. That is, hypothesis 4a is accepted. The important point to note is that trust positively influences knowledge transfer mechanisms of high information richness and therefore, encourages the transmission of tacit knowledge. At the same time, trust is slightly related to low information richness which results in using communication media to transfer codified knowledge.

10 Conclusion

The paper focuses on the importance of an effective knowledge management in clusters. The characteristics of clusters, especially the geographical proximity, guarantee an access to a huge amount of knowledge and lead to the creation of new knowledge. The previous sections of this paper debated the concept of knowledge, identified the knowledge dimensions and explained the knowledge creation process and the knowledge transfer process. In addition, different knowledge transfer mechanisms were introduced. The aim of the paper was to examine the relationship between the nature of knowledge and media choice. Finally trust was included into our considerations.

The purpose of the empirical study was to observe the knowledge transfer process in the companies of the Mechatronics Cluster Upper Austria. Most of the companies are operating in the mechanical engineering sector followed by plant building, and equipment and apparatus construction. The majority of the firms are of small or medium size and have sales amounting between 3 and 20 mil €.

As it can be observed, the companies heavily use sharing of experience to transfer knowledge followed by learning-by-doing methods and work groups. The result emphasizes the importance of knowledge transmission tools that belong to the group of tacit knowledge transfer techniques. The analysis of frequencies shows that the communication channels used most by the companies for exchanging information are e-mail, telephone, seminars and workshops, and other internet tools. Thus, they tend to rely on transfer mechanisms that allow the transmission of explicit knowledge and are considered to be low in information richness. As far as communication media of low information richness are concerned, seminars and workshops are used. In addition, the results illustrate that the firms seem to reject “new” communication media (e.g.: videoconferencing, chat, online forum) to transfer knowledge. Furthermore, the companies regard a high level of trust between the cluster partners as very important.

We constructed several hypotheses that should examine the influence of the nature of knowledge (whether it is tacit or explicit knowledge) on the choice of different knowledge transfer mechanisms. We categorized the communication channels into transfer mechanisms of low information richness (LIR) and into mechanisms of high information richness (HIR). We assumed that the transmission of explicit knowledge required communication media of low information richness whereas the transfer of

tacit knowledge demanded high information richness. We measured the tacitness and explicitness of knowledge defining the variables CODE (codifiability refers to explicit knowledge) and TEACH (teachability refers to tacit knowledge) as independent variables. The regression analysis demonstrates the high significance of the models which leads to the acceptance of the hypotheses. Taking the degree of trust into our considerations, we observed the impact of trust on the knowledge transfer process. The question to ask was whether trust fostered the use of transfer media of low information or of high information richness, thus, encouraging the transfer of explicit or tacit knowledge. We defined the variable Trust as independent variable. The results propose that trust is positively related to both low information richness and high information richness. The results of the regression analysis propose a higher significance of the model that assumes a positive relationship between trust and knowledge transfer mechanisms of high information richness. Thus, it can be observed that trust influences the choice of communication media. It has to be noted that the paper just covers a small amount of the literature that exists about knowledge management and that it focuses on the knowledge transfer process in clusters.

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APPENDIX

Deutsche Zusammenfassung/ Abstract

Deutsche Zusammenfassung

Die vorliegende Arbeit beschäftigt sich mit Wissensmanagement in Netzwerken, wobei das Hauptaugenmerk auf dem Wissenstransfer zwischen Unternehmen in Clusterbeziehungen liegt. Ein effizientes Wissensmanagement kann Unternehmen in einer globalen Welt einen entscheidenden Wettbewerbsvorteil verschaffen (Nonaka). Die Funktion des Wissensmanagements liegt nicht nur darin bereits vorhandenes Wissen zu nutzen, den Informationsfluss innerhalb des Unternehmens zu optimieren, neues Wissen von außen zu beziehen, sondern besonders darin neues Wissen zu erschaffen. Clusterbeziehungen stellen vor allem für Klein- und Mittelbetriebe eine Möglichkeit dar effektives Wissensmanagement zu betreiben. Durch die räumliche Nähe wird der Wissensaustausch erleichtert und zeitlich verkürzt und die Clusterpartner können auf eine gemeinsame Wissensbasis zurückgreifen. Zusätzlich wird durch diese Form der Organisation die Generierung von neuem Wissen gefördert, da gemeinsame Forschungseinrichtungen genützt werden können und ein gewisses Maß an Konkurrenzdenken zu Innovationen führt. Vor allem Porter prägte in seinen Arbeiten den Begriff des Clusters und die damit verbundenen Wettbewerbsvorteile.

Der theoretische Teil dieser Arbeit, der auf umfangreicher Literaturrecherche basiert, behandelt die grundlegenden Konzepte des Wissensmanagements. Zu Beginn liegt der Fokus auf der Definition des Wissensbegriffs, der Einteilung in zwei Wissensarten, nämlich implizites und explizites Wissen (Polanyi), und der Wissensattribute von Kogut und Zander. Im Anschluss wird der Prozess der Wissensgenerierung (Nonaka, Nonaka & Takeuchi) und des Wissenstransfers diskutiert. Der Wissensaustausch erfolgt unter Verwendung verschiedener Mechanismen. Diese umfassen Kommunikationskanäle auf persönlicher Ebene bis hin zu unpersönlichen numerischen und schriftlichen Transfermechanismen (Daft & Lengel, Büchel & Raub). Die unterschiedlichen Wissensarten beeinflussen die Wahl der Kommunikationskanäle. Des Weiteren wird auf die Vor- und Nachteile von Clusterbeziehungen im Zusammenhang mit Wissenstransfer und Wissensgenerierung eingegangen. Der letzte Abschnitt des theoretischen Teils

beleuchtet den Einfluss von Vertrauen auf den Wissensaustausch zwischen den Unternehmen in einem Cluster. Anhand der theoretischen Grundlagen werden Hypothesen erstellt, die den Zusammenhang zwischen den einzelnen Wissensarten und der Wahl von Transfermechanismen unter Einbeziehung von Vertrauen untersuchen sollen.

Im empirischen Teil dieser Arbeit werden die aufgestellten Hypothesen am Beispiel des Mechatronik-Clusters Oberösterreich überprüft. Der empirische Teil stützt sich auf die Befragung der Unternehmen des Mechatronik-Clusters, die mittels Aussendung von Fragebögen erfolgte. Zu Beginn werden Daten und Fakten des Mechatronik-Clusters präsentiert. Die Auswertung der einzelnen Hypothesen zeigt, dass alle Modelle eine hohe Signifikanz aufweisen und somit die Wahl der Kommunikationsmittel von der Art des Wissens beeinflusst wird, wobei auch Vertrauen einen wesentlichen Aspekt darstellt.

Abstract

The aim of this paper is to discuss the knowledge transfer process in networks, presenting the case of the Mechatronics Cluster Upper Austria. To define the functions and elements of knowledge management, a profound understanding of the nature of knowledge is required. The theoretical part of this paper concentrates on the fundamental principles of knowledge management including knowledge creation and knowledge transfer. In this context, based on the knowledge dimensions and the categorization into explicit and tacit knowledge, the various knowledge transfer mechanisms and the concept of information richness are presented. The paper analyzes whether the choice of specific communication channels depends on the nature of knowledge and how trust affects the transmission of knowledge. The above mentioned assumptions are examined in the empirical part of the paper which is based on empirical evidence gained from the Mechatronics Cluster Upper Austria.

Curriculum Vitae

Persönliche Daten

Name: Melanie HOLLNTHONER
Geburtsdatum/Ort: 21.06.1984, Wien
Staatsbürgerschaft: Österreich

Ausbildung

Oktober 2002 – Februar 2010 Studium der **Internationalen Betriebswirtschaft**, Betriebswirtschaftszentrum der Universität Wien; Kernfächer: „*Corporate Finance*“ und „*Internationales Management*“

September 2005 – Jänner 2006 **Auslandsstudium** an der Ecole Supérieure de Commerce (ESCP-EAP), Paris

September 1994 – Juni 2002 **AHS**, GRG 3, Schützengasse 31, 1030 Wien, September 2002 Schulübersiedlung nach 1110 Wien, Gottschalkgasse 21 (Matura mit ausgezeichnetem Erfolg bestanden)

Berufserfahrung

Seit Jänner 2007 **Team Beyond, Young Enterprises**

Oktober 2008 – Dezember 2009 **Bacardi-Martini GmbH**

August 2006 (Praktikum) **Europ Assistance Gesellschaft m.b.H.**

Oktober 2004 – August 2005,
September 2004 (Praktikum)

Juli 2003 (Praktikum)

November 2003 - Mai 2004 **Generali Gruppe**

Juli 2001 (Praktikum) **VA TECH HYDRO GmbH & Co**

Besondere Kenntnisse und Fähigkeiten

Fremdsprachen Englisch (fließend), Französisch(sehr gut), Spanisch (gut); **Sprachaufenthalt** in Barcelona (Juli 2004)

IT-Kenntnisse MS Office, MS Outlook, Internet Explorer, SPSS

Questionnaire



WISSENSMANAGEMENT IN CLUSTERBEZIEHUNGEN

UNIV. PROF. DR. JOSEF WINDSPERGER (UNIVERSITÄT WIEN)
MELANIE HOLLNTHONER (UNIVERSITÄT WIEN)
BETRIEBSWIRTSCHAFTSZENTRUM
UNIVERSITÄT WIEN
BRÜNNERSTR. 72, A-1210 WIEN
TEL. 0043-1-4277-38180; FAX: 0043-1-4277-38174
E-Mail: josef.windsperger@univie.ac.at

Ihr Name und Aufgabenbereich:

Firmenname und Adresse:

Tel. Nr.

E-Mail:

Ziel des Fragebogens ist es, das Wissensmanagement österreichischer Clusterunternehmen zu untersuchen: Der Fragebogen besteht aus drei Teilen:

- A) Allgemeine Fragen zu Ihrem Unternehmen
- B) Spezifische Fragen zum Wissensmanagement zwischen Clusterunternehmen
- C) Spezifische Fragen zu Wissenstransfer und Vertrauen

Nach Möglichkeit bitte ich Sie alle gestellten Fragen zu beantworten. Für etwaige Probleme beim Ausfüllen des Fragebogens stehe ich Ihnen gerne persönlich zur Verfügung: E-Mail: josef.windsperger@univie.ac.at; 004314277-38180

Bitte kreuzen Sie jenes Feld an, das aus Ihrer Sicht der Unternehmenssituation am besten entspricht.

Ein BEISPIEL:	Überhaupt nicht		In sehr großem Ausmaß		
In welchem Ausmaß nutzt Ihr Unternehmen das Internet beim Informationsaustausch mit anderen Clusterunternehmen?	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>	4 <input type="checkbox"/>	5 <input type="checkbox"/>

Je nachdem wie intensiv Ihr Unternehmen das Internet nutzt, kreuzen Sie bitte eine Zahl auf der Skala 1-5 an, wobei **1 überhaupt nicht** und **5 in sehr großem Ausmaß** bedeutet.

A) Allgemeine Fragen zu Ihrem Unternehmen					
A1. Zu welchem Sektor innerhalb des Mechatronik-Clusters gehört Ihr Unternehmen?					
<input type="checkbox"/> Dienstleistung: Unternehmensberatung <input type="checkbox"/> Dienstleistung: Instandhaltung / Service <input type="checkbox"/> Dienstleistung: Training / Schulung / Personalentwicklung <input type="checkbox"/> Dienstleistung: Sonstige <input type="checkbox"/> Entwickler / F&E / Bildungsinstitution <input type="checkbox"/> Maschinenbau <input type="checkbox"/> Anlagenbau <input type="checkbox"/> Geräte- /Apparatebau <input type="checkbox"/> Technologie- /Komponentenzulieferung <input type="checkbox"/> anderer Sektor. Welcher?					
A2. Wie hoch war ca. Ihr Umsatz in Euro im Jahre 2006?					
<input type="checkbox"/> unter 500.000 € <input type="checkbox"/> zwischen 500.000 und 3 Millionen € <input type="checkbox"/> zwischen 3 und 20 Millionen € <input type="checkbox"/> zwischen 20 und 100 Millionen € <input type="checkbox"/> über 100 Millionen €					
A3. Geben Sie bitte die Anzahl Ihrer Mitarbeiter an:					
B) Wissensmanagement					
B1. Wie wichtig sind die folgenden Formen des Wissenstransfers zwischen Ihrem und den Partnerunternehmen im Cluster?	Überhaupt nicht			Sehr wichtig	
Erfahrungsaustausch (z.B.: Meetings/ Diskussionen mit den Partnern, Chatsysteme, Onlineforen, Newsgroups)	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>	4 <input type="checkbox"/>	5 <input type="checkbox"/>
Beobachtung und Nachahmung (z.B.: Mitarbeiterrotation zwischen den Unternehmen)	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>	4 <input type="checkbox"/>	5 <input type="checkbox"/>
Dokumentationssysteme (z.B. Gemeinsame Datenbanken)	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>	4 <input type="checkbox"/>	5 <input type="checkbox"/>
Klassifizierung (z.B.: Bewertung des Absatzmarktes durch gemeinsame Beobachtung des Kaufverhaltens)	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>	4 <input type="checkbox"/>	5 <input type="checkbox"/>
Learning by doing	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>	4 <input type="checkbox"/>	5 <input type="checkbox"/>
Arbeitsgruppen zwischen den Clusterunternehmen (z.B. R&D Teams...)	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>	4 <input type="checkbox"/>	5 <input type="checkbox"/>
B2. Andere Arten der Wissensgenerierung, die Ihr Unternehmen nutzt:					

C) Wissenstransfer und Vertrauen					
C1. In welchem Ausmaß erfolgt der Informationsaustausch zwischen Ihrem und anderen Clusterpartnern mit Hilfe der folgenden Maßnahmen?	Überhaupt nicht			In sehr großem Ausmaß	
Intranet	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>	4 <input type="checkbox"/>	5 <input type="checkbox"/>
Chat-Systeme	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>	4 <input type="checkbox"/>	5 <input type="checkbox"/>
Onlineforen	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>	4 <input type="checkbox"/>	5 <input type="checkbox"/>
Newsgroups	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>	4 <input type="checkbox"/>	5 <input type="checkbox"/>
E-mail	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>	4 <input type="checkbox"/>	5 <input type="checkbox"/>
Internet: sonstiges	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>	4 <input type="checkbox"/>	5 <input type="checkbox"/>
Fax	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>	4 <input type="checkbox"/>	5 <input type="checkbox"/>
Telefon	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>	4 <input type="checkbox"/>	5 <input type="checkbox"/>
Briefverkehr	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>	4 <input type="checkbox"/>	5 <input type="checkbox"/>
Videokonferenz	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>	4 <input type="checkbox"/>	5 <input type="checkbox"/>
Seminare, Workshops	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>	4 <input type="checkbox"/>	5 <input type="checkbox"/>
Ausschüsse	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>	4 <input type="checkbox"/>	5 <input type="checkbox"/>
Informelle Treffen zwischen den Mitarbeitern	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>	4 <input type="checkbox"/>	5 <input type="checkbox"/>
Rückgriff auf existierende Dokumente (z.B. Statistiken, Artikel, Flyer)	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>	4 <input type="checkbox"/>	5 <input type="checkbox"/>
Formelle Treffen der Clusterunternehmen (z.B. Top-Manager, Abteilungsleiter)	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>	4 <input type="checkbox"/>	5 <input type="checkbox"/>
Sonstiges:	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>	4 <input type="checkbox"/>	5 <input type="checkbox"/>
C2. Welche der folgenden Aussagen treffen auf das von uns an die Partnerunternehmen weitergegebene Wissen zu?	Überhaupt nicht			In sehr großem Ausmaß	
Ein Handbuch, das die Prozesse/Tätigkeiten zwischen uns und den Partnerunternehmen beschreibt, kann erstellt werden bzw. ist bereits erstellt worden.	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>	4 <input type="checkbox"/>	5 <input type="checkbox"/>
Durch Austausch von Mitarbeitern zwischen den Partnerunternehmen und uns können sich diese leicht Wissen von uns aneignen.	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>	4 <input type="checkbox"/>	5 <input type="checkbox"/>
Die Mitarbeiter des/der Partnerunternehmen können sich durch Schulung neues Wissen über uns schnell und einfach aneignen.	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>	4 <input type="checkbox"/>	5 <input type="checkbox"/>
Die Mitarbeiter des/der Partnerunternehmen können durch das Lesen von Handbüchern neues Wissen über uns leicht erlernen.	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>	4 <input type="checkbox"/>	5 <input type="checkbox"/>

Mitarbeiter des/der Partnerunternehmen können durch persönliche Unterstützung/Gespräche mit unseren Mitarbeitern die wichtigsten Prozesse/Tätigkeiten leicht erlernen.	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>	4 <input type="checkbox"/>	5 <input type="checkbox"/>
Das Training der Mitarbeiter der Partnerunternehmen zum Erwerb von neuem Wissen ist eine schnelle und einfache Aufgabe.	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>	4 <input type="checkbox"/>	5 <input type="checkbox"/>
In unserem Unternehmen gibt es detaillierte Aufzeichnungen über die Prozesse/Tätigkeiten zwischen uns und den Partnerunternehmen.	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>	4 <input type="checkbox"/>	5 <input type="checkbox"/>
C3. Welche der folgenden Aussagen treffen auf das von uns vom Partnerunternehmen erworbene Wissen zu?	Überhaupt nicht			In sehr großem Ausmaß	
Ein Handbuch, das die Prozesse/Tätigkeiten zwischen uns und den Partnerunternehmen beschreibt, kann erstellt werden bzw. ist bereits erstellt worden.	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>	4 <input type="checkbox"/>	5 <input type="checkbox"/>
Durch Austausch von Mitarbeitern zwischen uns und den Partnerunternehmen können sich diese leicht Wissen von den Partnern aneignen.	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>	4 <input type="checkbox"/>	5 <input type="checkbox"/>
Große Teile der Geschäftsprozesse/Tätigkeiten zwischen uns und den Partnerunternehmen können mit dem Einsatz der Informationstechnologie durchgeführt werden.	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>	4 <input type="checkbox"/>	5 <input type="checkbox"/>
Unsere Mitarbeiter können sich durch Schulung neues Wissen über die Partnerunternehmen schnell und einfach aneignen.	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>	4 <input type="checkbox"/>	5 <input type="checkbox"/>
Unsere Mitarbeiter können durch das Lesen von Handbüchern das Wissen über die Partnerunternehmen leicht erlernen.	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>	4 <input type="checkbox"/>	5 <input type="checkbox"/>
Unsere Mitarbeiter können durch persönliche Unterstützung/Gespräche mit erfahrenen Mitarbeitern der Partnerunternehmen die wichtigsten Prozesse/Tätigkeiten leicht erlernen.	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>	4 <input type="checkbox"/>	5 <input type="checkbox"/>
Das Training der Mitarbeiter zum Erwerb von neuem Wissen über die Partner ist eine schnelle und einfache Aufgabe.	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>	4 <input type="checkbox"/>	5 <input type="checkbox"/>

In unserem Unternehmen gibt es detaillierte Aufzeichnungen über die Prozesse/Tätigkeiten zwischen uns und den Partnerunternehmen.	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>	4 <input type="checkbox"/>	5 <input type="checkbox"/>
C4. Bitte geben Sie an, ob folgende Aussagen auf die Beziehung zu Ihrem Partner zutreffen:	Trifft überhaupt nicht zu	Trifft teilweise zu	Trifft vollständig zu		
Es herrscht großes Vertrauen zwischen uns und dem (den) Partner(n).	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>	4 <input type="checkbox"/>	5 <input type="checkbox"/>
Es herrscht eine Atmosphäre von Offenheit und Ehrlichkeit.	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>	4 <input type="checkbox"/>	5 <input type="checkbox"/>
Der Informationsaustausch geht über das vereinbarte Ausmaß hinaus.	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>	4 <input type="checkbox"/>	5 <input type="checkbox"/>
Die Zusammenarbeit beruht auf partnerschaftlicher Basis.	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>	4 <input type="checkbox"/>	5 <input type="checkbox"/>
Wir halten uns an mündliche Vereinbarungen, auch wenn es zu unserem Nachteil sein könnte.	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>	4 <input type="checkbox"/>	5 <input type="checkbox"/>
Die Vorschläge der (des) Partner(s) zur Verbesserung der Zusammenarbeit werden gehört und diskutiert.	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>	4 <input type="checkbox"/>	5 <input type="checkbox"/>
Die Vorschläge des (der) Partner zu Neuerungen werden gehört und diskutiert.	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>	4 <input type="checkbox"/>	5 <input type="checkbox"/>

Wir möchten uns für Ihre freundliche Unterstützung recht herzlich bedanken. Bei Interesse übermitteln wir Ihnen nach Abschluss der Untersuchung gerne die Ergebnisse. Wenn Sie dies wollen, dann geben sie bitte hier Ihre **Email-Adresse** an:

Bitte übermitteln Sie den ausgefüllten Fragebogen an:

<p>UNIV. PROF. DR. JOSEF WINDSPERGER (UNIVERSITÄT WIEN) MELANIE HOLLNTHONER (UNIVERSITÄT WIEN) BETRIEBSWIRTSCHAFTSZENTRUM UNIVERSITÄT WIEN BRÜNNERSTR. 72, A-1210 WIEN TEL. 0043-1-4277-38180; FAX: 0043-1-4277-38174 E-Mail: josef.windsperger@univie.ac.at</p>

Sie finden den Fragebogen auch unter folgendem **Link**:

<http://www.univie.ac.at/IM/de/index.html> → unter NEWS