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Modeling Transfer of Knowledge in an Online Platform of a Cluster

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Abstract

Dealing with knowledge as a relevant resource and factor for production has become increasingly important in the course of globalization. This work focuses on questions about transferring knowledge when many companies work together in a cluster of enterprises. We developed a model of this transfer based on the theory of clusters from the New Institutional Economics' point of view and based on existing theories about knowledge and knowledge transfer. This theoretical construct is evaluated and adapted to praxis based on the online platform of the MAI Carbon Cluster in South-Germany.

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Keywords: Industrial cluster; knowledge transfer; modeling; collaboration

1. Introduction

For hundreds of years questions about knowledge have been discussed in various sciences. While knowledge had been reserved for philosophy since ancient times, business economics recognized the relevance of knowledge and its deeper exploration later. Knowledge has become increasingly relevant as important resource and factor of production. It is a widespread and undisputable opinion that using knowledge will be the major factor for competitiveness in the near future [1]. In the trade-off between competition and cooperation, companies are looking for ways of using the benefits from sharing knowledge and creating a common knowledge base with other companies but simultaneously protecting their knowledge. The basic idea of knowledge as a factor of success, which shall not be shared, is in contradiction to the assumption that the overall performance is higher when people work together. Out of this experience, many intermediate forms of organizations have been established. One of these forms is the collaboration of several companies in clusters: In the course of globalization of worldwide markets, companies have to meet new types of challenges and are forced to find new ways of organizational thinking and new forms of organizations emerge – like industrial clusters. Since the transfer of knowledge between the participating companies and their members has an outstanding importance. Working in such clusters requires sustainable management of knowledge and of knowledge transfer between the involved companies. We provide a model that describes the knowledge transfer in industrial clusters. It is based on theoretical principles of organizational theory and theory about knowledge. Furthermore, it is based on practical experiences with the MAI Carbon Cluster and its online platform "Carbon Connected". The MAI Carbon cluster is located in South-Germany focusing on the distribution and the usage of carbon-fiber-reinforced plastics for various industries and applications. For being competitive, linking the knowledge of all involved companies is absolutely essential. In order to encourage the required knowledge transfer between companies, the online platform "Carbon Connected" was introduced in 2012 and has been evolved since then. Investigating the processes in this online platform allows to build up a model for this kind of knowledge transfer and to learn about fundamental aspects and problems. Many literature sources investigate knowledge transfer in general (see section 2), however, there is no model that focuses on knowledge transfer in industrial clusters.

2. Creating a knowledge transfer model

2.1. Intention of modeling: clusters as the underlying original

In this chapter, we describe the original of our model – clusters of enterprises. The term of clusters has its origin in

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computer sciences, where it is used in cluster-analysis: aim of this procedure is to form groups with similar objects so that dealing with high volumes of data becomes less difficult [2]. Using this term in business science differs in the issue that not forming but discovering generates a cluster of enterprises: Regions involving a set of cooperating and successful companies of an industrial sector have a positive effect on those companies' businesses [3]. Economic sciences do not provide a clear definition for the term cluster, however, Porter [4] gives the most common one: A cluster is a certain amount of companies belonging to a particular industry that have agglomerated in a special region and that are in maintained constant contact. Typically, there are companies of all stages of the value chain from related industries as well as suppliers of appropriate infrastructures and institutions as universities that focus on R&D (Definition based on [4], [5]).

2.1.1. Enterprise clusters: advantages of new organizational forms

The emergence of enterprise clusters is caused in the globalization: For remaining successful against the competitors, companies have to constantly launch new and better products fulfilling the required standards of quality and technology. Only very innovative, flexible, and knowledge-based companies with sufficient knowledge about markets and products, with compliance and financial resources, can survive on the market. Today, companies of certain industries do not seem to be able to rank among the best in all of these categories. Concentration on core competencies becomes mandatory and leads to growing division of labor and increasing economical linkages as found in clusters of companies. The resulting competitive advantages are various: Linking different knowledge bases results in advantages in the competition of innovations. Successful novelties help the companies to differ from competitive offers and to successfully launch the products on the market [6]. Linking to other companies provides benefits in time: Due to increasingly rapid succession of innovations and product life cycles, early stages of development require simultaneous engineering instead of sequential engineering in collaborations with suppliers. In addition, the risk of quality deficiencies especially for quality-sensitive products can be reduced by integrating both earlier and later production stages. This risk arises from insufficiencies of the markets in terms of missing control of purchased goods [6]. Building steady structures between companies gives a competitive advantage concerning the costs, e.g. costs of coordination of collaboration. Moreover, costs can be reduced by sharing production facilities, by cross-company R&D activities of several sectors, by common procurement and sourcing and due to reducing the risk compared to an individual company [7].

2.1.2. Enterprise clusters from the view of The New Institutional Economics

To get a profound understanding of clusters, we classify the phenomenon within the scope of the existing organizational landscape. In terms of organizational theory, organizations occur as a reaction to the fundamental problem of shortage of demanded goods. In order to meet this challenge, division of labor and specialization emerge [8] including positive consequences: by executing a single task, the worker gets a higher level of skills, expertise, and experience, while his required qualification level and his recruitment costs decrease [9]. However, these increases in productivity are accompanied by the necessity of coordination and exchange of goods. Those aspects imply the organizational issue of coordination – information has to be distributed to all actors to overcome the unknowing of the individuals – and the issue of motivation – in order to overcome the unwillingness of the actors [8-10]. These problems also occur when several companies work together in a cluster. Hence, the closer examination of organizational theories delivers a basis for the classification and categorization and for the analysis of the phenomenon of enterprise clusters.

The theories of the New Institutional Economics as one of the organizational theories consider that institutions are built up in order to minimize the defects emerging from the lack of motivation and coordination [10]. The role of institutions now is to establish a system of rules showing the involved players' scope of action and expected consequences of the players' behavior. In the transaction cost theory – the partial theory of the New Institutional Economics that delivers an approach to illustrate the organization in clusters – the emphasis lies on the single transaction. The goal is to find the organizational form that minimizes the transaction costs arising with every exchange of services. This results in two extreme forms: Hierarchy and market. Within the concept of hierarchy – typically the organization in a company -, the collaboration is based on long-term contracts that determine the own action and make others' actions predictable. In contrast, the concept of markets is based on one-time, short-term relations and contracts, which lack further commitments [7]. Transactions costs in hierarchies mainly consist of fixed costs for building up the bureaucratic structure while variable costs are rising slowly due to a low level of uncertainty. In markets, the fixed costs are very low but since not knowing your transaction partner well causes a high level of uncertainty, variable costs rise quickly with the numbers of transactions [10].

The collaboration of several companies in cooperative connections tries to connect and use the advantages of both extreme forms by building an organization that is in the range between the extremes. So do networks of companies: Short-live changes on the market and in technologies resulted in a greater uncertainty and in a higher risk of unused capacities in companies. Thus, short-term transactions on the market were used more commonly – moving away from the hierarchical form of organization where all components were in the own company [11]. To avoid the disadvantages of the market, some hierarchical attitudes were maintained: Clusters of companies were born. They combine the advantages of both extreme forms of hierarchy and market: The benefits of markets on the one hand stem from the functional specialization: Corresponding to the situation on the open market, each member of a cluster performs the task for which it has the highest competence. Moreover, the efficiency pressure is adequate to the market situation: In order to survive in the enterprise cluster, the player has to be and to remain one of the best players. The main advantages of the hierarchy on the other hand lie in growing confidence and trust through cooperative behavior and through

making relevant information available. (Some authors have a different view, e.g. Powell [12], who sees a cooperation not as an intermediate but an independent form). For building up trust, spatial proximity plays an important role [13]. The knowledge of the individual actors is integrated in a common organizational knowledge base each player can benefit from [6]. Confidence and trust reduce uncertainty and thereby transaction costs.

Thus, the concept of clusters continues dealing with the shortage companies once solved through division of labor and specialization within their company, but raises the problem from one single company to a cross-company level. In terms of the transaction cost theory, clusters of companies try to use the advantages of the two extreme forms hierarchy and market by arranging in the spectrum between them and so including elements of both cooperation and competition.

Another theory of the New Institutional Economics is the Principal-Agent-Theory. It focuses on exchange situations between principals and agents arising when one actor (principal) engages another (agent) for realizing his interests by assigning decision-making and implementation powers to the agent. The agent then takes decisions that not only concern him, but also the principal, who can not be assured whether the agent acts as he was told to: The principal only has imperfect information about the environment and the agent's acting. The agent can use this for opportunistic advantage and the information asymmetries make working together much more difficult. Building up trust – as it is an advantage on hierarchy in terms of transaction cost theory – can minimize this problem as demonstrated in paragraph 3.5.

2.1.3. Modeling the knowledge transfer

To model the transfer according to step 2 of our modeling process, we focused on existing approaches and adopted them subsequently. In the following, the resulting aspects needed for our model are summarized. Following Scheuble [14], we define knowledge transfer as the effective transition of knowledge from one actor to an other, containing two aspects: In addition to the actual transition of knowledge, the transferred knowledge has to reach the recipient in the right way. To make this possible, the transfer itself, the nature of knowledge and the prerequisites of its transfer have to be investigated.

2.1.4. The term of knowledge

Depending on the circumstances where it is used, the term "knowledge" is defined in different ways. With regard to the investigation of the transfer of knowledge, the term has to be differentiated from information. Knowledge emerges from information by purposeful combination of it and thus as a result of assimilating new information with the experiences of the individual. Information itself is a result of the combination of data: Data exists of elementary descriptions and objective facts existing in an unorganized way and without any interpretation. Brought into a context and given a meaning, data becomes information. This differentiation corresponds to the "pyramid of knowledge" [1, 15, 16]. In contrast to the transfer of information of data, the transfer of knowledge always includes some recognition, understanding and comprehension.

Furthermore, the term of knowledge covers explicit and implicit knowledge. Explicit knowledge is not bound to individuals but can be saved in data media and thus be transferred. In contrast, implicit knowledge cannot be articulated, verbalized, and transferred. It is bound to individuals and can only be acquired by own experiences. For transferring, it can be transformed into explicit knowledge by using metaphors, analogies and hypotheses (externalization). Afterwards, it can be transferred like explicit knowledge [17]. Implicit knowledge can also be transferred by imitation [18].

2.1.5. Logistics of the transfer of knowledge

The logistics of the transfer of knowledge describe the "way" knowledge takes being transferred from one individual to another. It can be divided into three stages:

1. Stage of initiation: The sender has to decide whether he wants to initiate the transfer or not, he has to choose a suitable recipient, a channel, and which knowledge he wants to transfer.
2. Stage of flow of knowledge: The chosen knowledge "flows" through the prescribed channel.
3. Stage of integration: This stage takes place on the side of the recipient: He has to learn about the knowledge and integrate it into his knowledge base [18].

The sophisticated consideration of the knowledge transfer in these different stages allows localizing problems and thus the directed development of possible solutions when analyzing a specific situation.

For the stage of knowledge flow, there are several methods on hand. Communication plays a pivotal role in the process of the transfer of knowledge: Without it, no flow of knowledge between sender and recipient is possible. Communication has to happen on three stages: On the level of syntax, data is transferred; on the level of semantics, information is transferred; on the level of pragmatics, knowledge is transferred (cf. the pyramid of knowledge, 2.3.1). Looking at this model illustrates the importance of similarities in knowledge bases for successful knowledge transfer: Data and information have to be transformed to knowledge in a similar way. Therefore, similar experiences, terminologies, and constructions of reality are necessary. Building up a common knowledge basis is mandatory for working together efficiently – particularly in a cluster of enterprises, where different companies merge their knowledge to work innovatively. For the transfer of knowledge between two individuals, many transfer methods are available. They can be arranged in a spectrum between the fundamentally contrary forms of personification and codification: Using the strategy of codification, knowledge is "carefully codified and stored in databases, where it can be accessed and used easily by anyone in the company (…)" [19]. Knowledge is therefore separated from the individual and can be transferred independently. This fits especially for explicit knowledge and its advantage is the high level of scalability: Codified knowledge can be transferred as often as required. At the other extreme of the spectrum is the strategy of personalization, where knowledge is "closely tied to the person who developed it and is shared mainly through direct person-to-person contacts." [19]. The scalability is low: Knowledge has to be provided separately for every transfer

process. Between the two extremes of complete codification on the one end and personalization on the other end is a wide range of intermediate transfer methods (as also shown in figure 1). They differ in their capacity to pass written, spoken and visual information, in their possibility to give direct feedback, and to reduce ambiguities [18].

Furthermore, push-principles have to be distinguished from pull-principles. While push-principles are characterized by the opportunity and the obligation of the sender to decide which knowledge he wants to transfer in which way, the recipient has to ask for the needed knowledge in pull-principles. The advantages and disadvantages of both strategies are evident: Using the push-strategy holds the danger of information overload for the recipient. This may lead to less attention and to acceptance problems. However, innovations are often result of randomly merged knowledge bases. This merging is prohibited by pull-principles [1, 15, 18].

2.1.6. Result of modeling: Model of transfer of knowledge

The results of the modeling process – also containing the theoretical aspects of knowledge and the New Institutional Economics - are put together and visualized in figure 1.

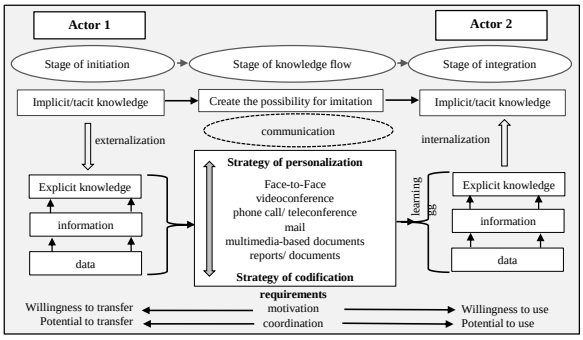

Fig. 1. Model of knowledge transfer

3. Ensuring and using the model: the model in the practical application of "Carbon Connected"

Reflecting the model – which main purpose is to connect different aspects of the process and the static framework and to give insight into the resulting structures of the connected processes – in different situations shows that the fundamentals of knowledge transfer are always the same, be it the transfer between individuals, groups, or in clusters of enterprises. This is traced back to the fact that the transfer of knowledge itself only can take place between individuals: The collective knowledge basis of an enterprise or a cluster of enterprises consists of the individual knowledge of the single members. Nevertheless, some characteristic aspects occur working with clusters as demonstrated below.

3.1. Knowledge transfers in clusters

Special characteristics of the knowledge transfer in enterprise clusters arise from the following aspects: Firstly, individuals have to come together to enable the transfer of knowledge. Therefore, coordination - in terms of the New Institutional Economics – between the companies of the cluster and their members plays a key role. This is even more important in clusters since many companies work together and the result of their work is mainly based on effective knowledge transfer. One approach to foster this coordination is setting up an online platform as it is done in the MAI Carbon Cluster and presented in the following paragraphs. Secondly, companies have to take appropriate actions to integrate the individuals' knowledge into their collective knowledge basis and to allow the actors to gain access to this collective knowledge [15, 18]. This can be found in all kinds of knowledge transfer between companies and is part of the area of learning and hence does not only concern clusters. Thus, it will not be discussed in this paper in detail. Nevertheless, it is absolutely mandatory especially for an effective work with many partners in enterprise clusters.

3.2. The MAI Carbon Cluster and "Carbon Connected"

MAI Carbon is a cluster of enterprises located in the southern area of Germany. Its goal is to establish high-tech fiber composite materials with their outstanding light-weight-properties in several industries like the automotive industry, the aerospace industry, and mechanical and plant engineering. In the cluster, members of all industries along the value-added chain are represented: well-known large German companies as well as specialized small and medium-sized companies and research institutions like universities. To improve the effectiveness of the cluster's work and of the knowledge transfer, the online platform "Carbon Connected" has been developed as a medium for communication and coordination. Users can read and write blog posts, they can find contacts and communicate with them, they can work in groups, etc. In the following section, we demonstrate the possibilities for knowledge transfer with "Carbon Connected" and its functions by means of the model. The sophisticated representation of the different aspects helps to recognize problems and to work out solution proposals more targeted. The obtained information can be used to improve the platform in accordance with the users' requirements. Therefore, we analyzed user data and launched a survey among the users in 2015: A questionnaire with 50 questions focusing on the steps of knowledge transfer and possible weaknesses of "Carbon Connected" was sent to the users and evaluated with n = 74 participants.

3.3. Extension of the model of knowledge transfer

There are diverse requirement for an effective and successful initiation of the knowledge transfer in "Carbon Connected": It starts with the registrations and a sufficient active use of the platform of a critical mass of members. This activity is fundamental for building an effectively working platform and can only be motivated by delivering a surplus for the users. The survey showed that more than 20% of the users can not see a surplus in using "Carbon Connected". This was underlined by a moderate interest in the platform in general: Only 30% of the respondents state a full approval to their existing interest. This leads to the conclusion that – since today's world offers lots of communication tools and similar platforms and since especially young generations are well interconnected and use many forms of technical features to simplify their work and so do not need the same functions in an additional platform - you especially have to ensure offering and concentrating on special functions and tools similar platforms do not fulfill satisfactorily. In "Carbon Connected", this seems to be achieved by the group function, where users can

communicate in a more private atmosphere. According to the results of the survey, 60% of the respondents actively take part in groups, i.e. they are writing comments or up- and download documents. For more than one quarter of the respondents, the group activities are the surplus of using "Carbon Connected" and thereby one of the reasons for using it (28.33%). Hence, creating an intuitive, less time-consuming and transparent usage of the group function is of primary interest when developing the platform.

A further requirement for the transfer of knowledge is the connection with other users as possible transfer partners. A quarter of the respondents sees the platform as an instrument for finding contacts and for staying in touch with them. New contacts are found by the search tool (20%), by following recommendations of the platform (8.33%), of other contacts (20%), or of colleagues outside the platform (16.67%) as well as in groups (23.33%). Nevertheless, an alarming high number of users states that they do not find any new contacts; 22% of the respondents do not have a single contact, 46% have less than 4 and 68% less than 11 contacts. Based on the survey, it can be rejected that this is caused by weaknesses or the incomprehensibility of the contact request function: The search function in the platform is neither assessed especially positive nor negative. Other reasons for the low numbers of contacts mentioned by users with less than four contacts are a general low interest in the platform and the lack of users they would like to be connected with. To improve this situation, events with opportunities for personal face-to-face contact could be organized so that the function of the platform is more to keep in touch than to get new contacts. It is in any case to be noted that motivation and coordination do not start with the initiation of the knowledge transfer – they also include the preparing steps of active participation and connecting with other users in the platform.

3.4. Ways of knowledge transfer in "Carbon Connected"

The transfer of knowledge on the online platform "Carbon Connected" takes place in different ways, which can be distinguished depending on their processing. Subsequently, occurring problems can be analyzed systematically – to find solutions that bring a benefit for the users and thereby help to increase the quantity of actors using of the platform as medium for knowledge transfer. This is exemplarily done for two different kinds of knowledge transfer.

3.4.1. The platform as medium for delivering information

The simple delivering of information from administrators to users takes place in the blog: Administrators provide information about different fields – e.g. the development of the platform - for all users. Only 6% of all users see the blog as a surplus of "Carbon Connected" – only 40% of the respondents know the blog and only one third of those reads the blog, mostly to gather new information about new functions of the platform (71.43%) or about new developments of it (85.71%). Reasons for not reading the blog are the low number of interesting posts (41.42%, n=12) as well as the way the information is presented: There is too much information (16.67%) with too little structure (33.33%). This problem might occur in several kinds of using push-principles, where the sender decides which knowledge he wants to transfer. An information overload has to be avoided to catch the reader's attention. This can be done by structuring the blog posts – as agreed by the respondents in the survey: They can be categorized with regard to the fields they concern (33.33% of the respondents would take this for an improvement) or to the kind of the post - as 44.44 % of the respondents confirm.

3.4.2. Transfer of knowledge between users: Getting in contact by using profile information

The second way of transferring knowledge in the platform we want to demonstrate is the transfer of knowledge between two single actors. In a first step, the transfer partner has to be found. Therefore, a search request based on the information each user gave when registering on the platform can be started. Investigations of the users' profiles in a run-up to the survey showed an obvious inconsistency in the given specifications among the users. The personal details regarding the fields of action are based on different views. Without consistent profile contents, finding the transfer partner with the required knowledge gets very difficult. However, the hypothesis that unstructured specifications in the user profiles influence the low numbers of contact findings could not be confirmed. A possible improvement might nevertheless be an input assistance in the form of options with given differentiations for the field of action.

3.5. Trust as prerequisite for an effective knowledge transfer

Trust and confidence are fundamental for the transfer of knowledge. As seen in chapter 2.2.2, trust is one of the hierarchic attributes of a cluster of enterprises: It has its origin in cooperative acting and providing useful and success relevant information. Knowing other members of the cluster without any face-to-face-contacts makes building up trust more difficult or even impossible and hinders the transfer of knowledge. An "atmosphere of trust" ([Rimkus 2008]) can improve this situation: Information asymmetries as introduced in the Principal-Agent-Theory can be reduced and the transfer of knowledge gets more effective. Trust allows considering inadequate information – from the view of decision-theory – to be sufficient for practical action. Information asymmetries based on missing information are still remaining but trust creates a basis on which they seem to be minimized. Building mutual trust depends on the duration of business relations, personal communication, common R&D activity etc. Actors are not willing to transfer their knowledge without trust in their transfer partner and their transfer channel. Since trust in transfer partners can only be built up in personal meetings etc., it is questionable whether an online platform like Carbon Connected is suitable for creating trust. Evaluating the survey, the group function seems to be important here: Working in a group creates a more familiar atmosphere with a higher level of trust and of and fosters the transfer of knowledge.

3.6. The adapted model for the online platform

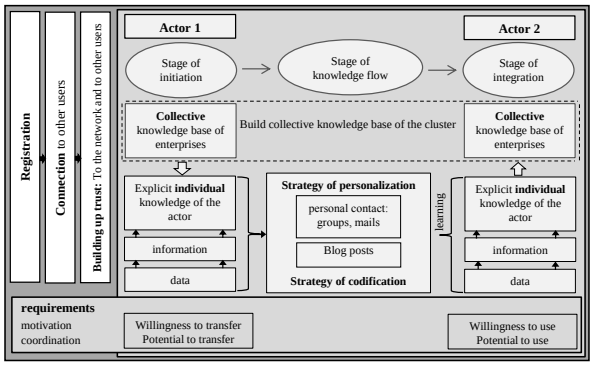

Fig. 2. Adapted model of knowledge transfer

The demonstrated adaptions of the preceding paragraphs are summarized in figure 2. The adapted model leaves out aspects that are not decisive when working with online platforms like “Carbon Connected”, e.g. the distinction between explicit and implicit knowledge since, which can only be transferred with very personalized strategies like face-to-face-contact. Instead, the differentiation between the collective knowledge bases of the involved enterprises, which all together build the knowledge base of the cluster, and the knowledge of an individual actor, which is the only one to be transferred, is represented. Moreover, the model includes the described required further steps of creation a fitting framework and the steps of registration, interconnection with other users and building up trust. Coordination and motivation, as introduced in the New Institutional Economics, accompany these previous stages as well as the knowledge transfer itself.

4. Conclusion

The development of any sort of model trying to explain processes including aspects of knowledge has to deal with the diversity of the term. For applying it to a special situation, focusing on the most relevant aspects is inevitable. In this case, the facets included in the formed model refer to issues of the New Institutional Economics as well as to the basic aspects of knowledge. When investigating the online platform “Carbon Connected” with regard to the built model of knowledge transfer, some adaptions concerning the special situation of the transfer without personal contact in the World Wide Web had to be made (cf. figure 2). Adopting the theoretical basic model to praxis and evaluating it with integration of the users was not as useful as desired since the involved actors often had a too subjective perspective. This made a statistical evaluation of the survey difficult and most often only led to general information about existing tools and results that were not unambiguous.

The model can serve as a basis for further investigations in the field of knowledge in clusters. Problems occurring during the process can be allocated to single steps and solutions can be generated goal-oriented. In doing so, the fundamental requirements of motivation (of the transfer partners to transfer knowledge) and coordination (like the design of the transfer tools) are always central aspects and have to be adjusted to the single steps.

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