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# Knowledge Transfer in Recycling Networks: Fostering Sustainable Development

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**Abstract:** This paper reports on long-term research work of recycling networks in Germany and Austria from a knowledge-based perspective. Using data from expert interviews, we discuss the key determinants of inter-organizational knowledge transfer within networks. In particular, we highlight the factor of mutual trust as important determinant of knowledge transfer in company recycling networks. One important goal of our empirical research is the institutionalization of knowledge transfer through the implementation of a central recycling agency in order to build core capabilities and to create intellectual capital.

**Keywords:** knowledge transfer, knowledge taxonomies, company networks, knowledge networks, recycling agency, sustainable development
**Categories:** H.3, H.4, J.4

## 1 Introduction

Knowledge management has been the subject of growing interest by academics and practitioners over the last years, yet little empirical research has been conducted to investigate inter-organizational knowledge transfer concerning company networks with a common recycling strategy.

Our knowledge-based perspective of two regional recycling networks with a total of 53 companies (31 Austrian and 22 German companies) focuses on the transfer of existing knowledge about recycling practices of companies within these networks. In this paper we discuss some important empirical results of the long-term analysis of recycling networks which has been conducted by expert interviews since 1996. We primarily present data from the German network due to the latest empirical analysis. Furthermore, we concentrate on the organization of an effective knowledge transfer process by influencing key determinants such as mutual trust. As a result, core competencies are created within the networks strengthening the competitive position of the network members and decreasing the environmental burden in order to satisfy today's needs without risking the satisfaction of future generations, i.e. “Sustainable Development”.

Drawing upon the literature review of knowledge perspectives and their implications, we discuss knowledge as a process of applying expertise in recycling

networks. In this respect, we focus on the knowledge flow between the representatives of the networking companies and a central network institution, we call "recycling agency". Another important perception of knowledge in our empirical research is the view of building core capabilities and creating intellectual capital by the establishment of a recycling agency. Intellectual capital is defined as human capital and structural capital [Sullivan (00), 158]. The first type of capital focuses on getting individuals together to share knowledge, whereas the second one emphasizes moving knowledge from the individuals´ heads to a tangible company asset through the implementation of technology-based tools and techniques [McNurlin; Sprague (02), 444-445]. To succeed in leveraging intellectual capital in the long-term, the network members need to do both: using different approaches to grow in the human capital stages as well as in the structural capital stages. At present, the main activities of the two recycling networks are in the stages of generating new knowledge, creating a culture of sharing and encouraging innovation. Structural capital is developed by building up a data basis which will be fed into a Geographic Information System (GIS) in order to develop a planning tool for the recycling agency.

## 2 Knowledge Taxanomies

Attempts to classify knowledge generally focus on the communicability of knowledge in terms of the tacit/explicit dimension [Polanyi (85)]. Therefore, we posit that knowledge is information kept in the mind of individuals: it is personalized information, e.g. related to facts, interpretations, ideas and judgements ("tacit" knowledge). Consistent with this argumentation, knowledge becomes information once it is articulated and presented in the form of text, graphics or other symbolic forms ("explicit" knowledge).

The results of our empirical study provide evidence for the importance of the transfer of the following knowledge taxonomies:

| Knowledge Types | Definitions | Examples |
|---|---|---|
| Know how (tacit knowledge) | Procedural knowledge based on experiences and often embedded in practice, i.e. | Accumulated practical recycling skills and expertise of the network members, i.e. understanding |
| | - pragmatic like best practices, project experiences, etc. | - how to organize a specific recycling solution, e.g. the separation and storage of scrap oil in a company |
| | - time-dependent | - how to introduce it in a smooth and efficient way |

*Table 1 (part 1): Knowledge taxonomies and examples (Adapted from [Alavi; Leidner (01), 113; and Merali (00), 215])*

| Knowledge Types | Definitions | Examples |
|---|---|---|
| Know what (explicit knowledge) | Theoretical knowledge which can be codified and transmitted without loss of meaning | Specific knowledge about the processes used for a certain recycling alternative, i.e. understanding |
| | - declarative (know-about) | - what recycling alternative is appropriate for a certain waste, e.g. scrap oil from a company |
| | - causal (know-why) | - why the recycling solution works, e.g. material recycling of scrap oil |
| | - conditional (know-when) | - when to choose the recycling alternative, e.g. purification of scrap oil instead of incineration |
| | - relational (know-with) | - how this recycling alternative interacts with existing disposal solutions of the company, e.g. the reuse of scrap oil with the recycling of waste paper |

*Table 1 (part 2): Knowledge taxonomies and examples (Adapted from [Alavi; Leidner (01), 113; and Merali (00), 215])*

## 3 Knowledge Transfer

The above described types of knowledge determine the knowledge transfer mechanism within a recycling network. In this context, the understanding of knowledge implicates the existence of a certain knowledge base, shared by the members of a network. In our case, the networking individuals are both the representatives of the companies (waste managers, work safety officers, managing directors, heads of departments, etc.) - we call them “gatekeepers” - and the agents of the central recycling institution. There is empirical evidence that the individual (i.e. gatekeeper of a company) is unlikely to accept the recommendation of the informant (i.e. recycling agent) if he does not understand the underlying reasoning processes [Milchrahm (01), 109-110].

The content and the structure of the inter-organizational knowledge transfer is also determined by the relationships between the individuals of the network. At the individual level, the relationship is a filter for relevance: the value attached to the piece of information by the recipient is affected by the credibility with which he perceives the informant. This perception of the informant is influenced by the factor of mutual trust between the members of the network [Merali (00), 219]. Trust has its basis in individuals, however, there also exists a collectively-held trust orientation by organizational members toward the exchange partner. Drawing on the previous literature, we define trust in general as “one party´s confidence that the other party in the exchange relationship will not exploit its vulnerabilities” [Dyer; Chu (00), 260)].

Based on [Shapiro; Sheppard; Cheraskin (92)], Ba argues that in the beginning of a business relationship, trust is often deterrence or calculus based [Ba (01), 325; see also Ratnasingham (98), 315]. This behaviour was also shown in the early stages of recycling networking. Companies had asked for extensive information about the other partners of the network before they took part in the analysis of their waste management activities. They only provided a minimum amount of data about their disposal activities which they thought to be essential for joint recycling programs. They also requested that their data had to be published only within the network. With the development of the relationship, the members of the networks gain more information about each other through their experiences. This so-called "information-based trust" describes the level of trust, growing over repeated communication between the network members. At this stage, network members have provided a lot of information about their disposal activities which they believe is helpful for the planning of joint recycling action. They also have given advice to other waste managers in the quarterly network meetings. In this way, information asymmetries have decreased. Consequently, uncertainty about the partners has been reduced.

The above two types of trust provide the foundation for the highest level of trust: transference based trust. This stage occurs when the individuals have taken on a common task considering joint goals. In both networks this level of trust is represented by the establishment of joint recycling for selected kinds of waste since 2001. Increasing complexity of the network interactions and local distances between the partners require the further development of mutual trust by the recycling agency.

As highlighted above, trust is an important determinant of knowledge transfer in company networks due to the presence of uncertainty and incomplete company information. In the context of company networks, confidentiality and privacy of company data are important requirements for the establishment of trust. It has to be warranted that key data about waste disposal activities are only revealed to network members. Besides, company data must be protected from indecent and unauthorized disclosure. Because of this, the whole data base about the network is centralized at the recycling agency to limit its accessibility.

On the foundation of trust, one of the main goals of recycling networking is set: the institutionalization of knowledge transfer through the implementation of a central agency in order to use the recycling expertise of the individual gatekeepers more effectively and to create new recycling knowledge.

According to [Nonaka; Takeuchi (95)] knowledge is transferred through processes of (1) socialization, (2) externalization, (3) combination and (4) internalization. Therefore, we state that the following core processes are essential for the knowledge transfer in a recycling network:

(1) bringing the recycling experts together in meetings initiated by the recycling agents in order to exchange experience about their recycling practices,
(2) transforming this knowledge in a formal and explicit form,
(3) amalgamating the explicit knowledge about various aspects (organizational, technical, etc.) of inter-company recycling systems for specific kinds of waste such as scrap oil,
(4) transferring the explicit knowledge back to the gatekeepers.

The gatekeepers are responsible to put the recycling solutions into action on the level of the individual company. By doing so, they gain experiences which are shared again with other gatekeepers of the recycling network.

This strategic knowledge network is a long-term purposeful arrangement among related organizations which allows them to gain competitive advantage vis-à-vis their competitors outside the network. There are a number of important distinctions between our emerging knowledge networks and other models of institutional collaboration (e.g. internal knowledge management networks). The spectrum of collaborations models ranges from networks of individuals within a single organization to networks of many different organizations [Creech; Willard (01), 10-17]. Our knowledge networks are characterized by the following determinants:

- scope: recycling of waste from companies in order to create sustainable advantages for middle-sized companies and for the region itself,
- membership: project team, networking companies, recycling agency,
- structure: based on joint recycling initiatives for selected kinds of waste,
- communications: telephone, fax, email and regular network meetings.

Within a wide portfolio of collaboration models, the Austrian and the German networks can be classified by three characteristics:

- number of organizations: limited amount of participating companies (31 in the Austrian network, 22 in the German network),
- transferred knowledge: narrowly focused on waste disposal and recycling activities of the networking companies,
- stakeholders and audience: closed group of gatekeepers.

In order to understand the nature of the recycling driven knowledge transfer it is necessary to take a closer look on these networks.

## 4 Recycling Networking

The networks are very effective instruments to create sustainable development [Strebel (00)]. Distinguishing features are the cooperative efforts of independent companies from diverse branches with one common goal: to reemploy waste derived from the production and consumption areas within the regional industry as a replacement for raw materials and also as a substitute for primary energy sources [Schwarz (94), 359-360].

In the following, we give a chronological overview of the institutionalization of the Austrian and the German recycling networks from a knowledge-based perspective.

The first scientifically researched and most developed recycling network, the Industrial Symbiosis Kalundborg, is located on the Danish island of Seeland. Primarily, the expected restrictions by environmental law [Elkington; Knight; Hailes (91)] lead to “a broad based cooperation between industry, government and citizens” [Little (91), 167]. The remarkable economic and ecologic benefits [Christensen (98), 107-108] inspired in 1993 the Institute for Innovation and Environmental Management to a systematic search for industrial networks in Styria (Austria). This research work came to the conclusion, that no recycling networks existed in this region.

As a result, the project "Recycling Networks in the Field of Production" was started in the region of Upper Styria in 1996. Until project end in 1997, the Styria Recycling Network had been established in close cooperation with 31 middle- and large-sized companies from different branches. An analysis of the knowledge transfer within the network came to the conclusion that almost all the networking gatekeepers avail themselves of three different types of networks [Schwarz; Hasler et al. (96), 73-77]. In a personal network (e.g. professional associations) privately maintained relationships of the decision-makers are simultaneously used to exchange expert knowledge [Strothmann; Prüser; Ginter (94), 3-19]. The transfer of recycling expertise also occurs within a communicative company network. Here, the links between individual companies serve to transport knowledge about recycling alternatives. If companies work together in other areas beyond that of knowledge exchange – particularly that of production – a technically determined network is in place. This type of networking is represented by the Industrial Symbiosis Kalundborg: the network members are not only linked by close knowledge channels, but in many cases also by pipelines to transport different residues like steam or gas. Despite these networks, the empirical results concluded that the gatekeepers of the Austrian as well as of the German network do not have sufficient information on hand to assist them in their decisions.

As a consequence, the project "Implementation of an Idea-Supported Recycling Innovation Center (r.i.c.)" was launched in 1999. One important project goal was to foster the transfer of knowledge about recycling alternatives for specific kinds of waste within the recycling network.

The very positive empirical experiences from the Styrian network left one important question open: Is the knowledge about recycling-oriented networking transferable to other regions? In order to answer this question, the Institute initiated the international research project "Protection of Resources in the Region of Oldenburger Münsterland (RIDROM)" in northern Germany. The project run from 1997 until 1998 and was co-financed by the German Federal Foundation for the Environment. Project partners were the Private Technical College for Economy and Technology in Vechta/Diepholz, the Waste Disposal Society of the Vechta Region and Steinbeis-TZ Transfer Marketing in Vechta. All three institutions have well established knowledge channels with the regional industry. The corporate members of the planned recycling network were selected within a radius of 50 kilometres to the project office in order to lower the distance barrier of knowledge transfer and to foster the "mental vicinity" of the gatekeepers. This vicinity is considered to be a key factor of their successful recycling cooperation [Schwarz (94), 110]. It also enabled in the Oldenburger Münsterland Recycling Network the exchange of recycling expertise in regular project meetings and expert interviews conducted by the project team. An important precondition for this vicinity is the mutual trust of the gatekeepers. In order to overcome the transfer barrier of mistrust and to guarantee an intensive company care by the project team, the number of network members was kept small. In addition, the know how transfer was supported by the flat hierarchy of the recycling network.

The branch mix of the networking companies (plastic-processing industry, (rubber-)metal-processing industry, agricultural and food industry, wood-processing industry, etc.) was grouped in view of the industrial structure of the region. This network arrangement enabled the integration of a variety of different waste materials

into the network and created a portfolio of new recycling potentials. Table 2 gives an overview of the branch mix of the network. Category "unknown" means that the interview partner had no data, "no statement" indicates that the person was not willing to provide data.

| Branches | Network members |
|---|---|
| plastic-processing industry | 6 |
| (rubber-)metal-processing industry | 5 |
| agricultural and food industry | 4 |
| construction materials industry | 2 |
| wood-processing industry | 2 |
| service industry | 2 |
| chemical industry | 1 |
| unknown | 0 |
| no statement | 0 |
| total of networking companies | 22 |

*Table 2: Branch mix of the Oldenburger Münsterland Recycling Network*

Figure 1 shows the size of the companies which was another important selection criterion for network membership. Data represented by the inner circle were gathered from April 1997 to June 1998 in accordance with the expansion of the network. The outer circle shows data of an empirical analysis undertaken from November 2001 until February 2002.

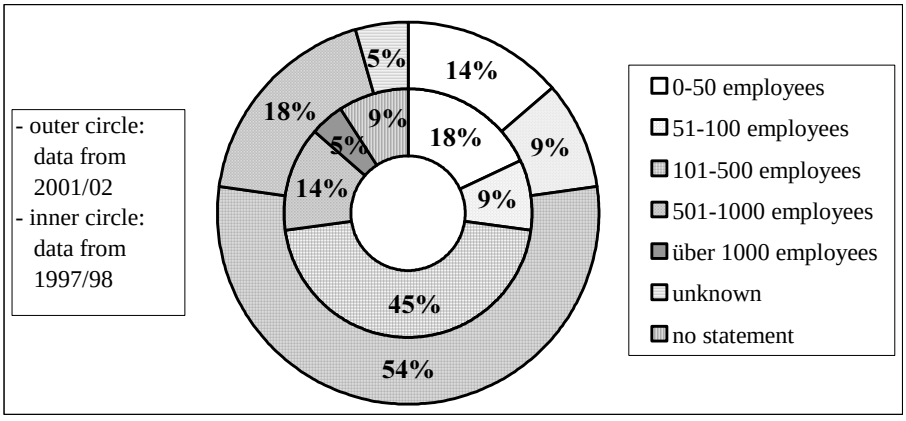


*Figure 1: Number of employees of the networking companies*

The number of employees was chosen to measure company size because many companies were not willing to provide turnover figures at the beginning of the

project. In addition, these data are also better indicators for the total amount of company waste than sales figures.

As shown in figure 1, medium-sized companies are the main target group of the project team. The reason is that they often have - in comparison to small companies - a more effective waste management which is another precondition for recycling networking. On the other hand, they do not own the bargaining power of large companies regarding waste disposal services. Therefore, they have great interest to collaborate in the field of waste management. The only large firm of the network was restructured to a medium-sized company after the first expert interview because of economic restraints. In the first analysis two companies were not willing to provide data which lead to a share of 9 % of the category "no statement". In the second analysis all firms delivered data due to the development of a trustful atmosphere within the network.

This atmosphere has lead to the increasing transfer of recycling knowledge within the German network. Again, as shown by the Styrian networking experiences, recycling potentials had been raised in a remarkable way until project end in 1998. For example, ash from an incinerator was successfully tested as raw material in a cement production plant. Another important result of the German networking project was a dramatic increase in the readiness of the gatekeepers to provide recycling expertise.

All these projects described above come to the conclusion, that the current communication networks do not suffice to provide gatekeepers with all the relevant information concerning waste materials and their recycling. Even the existing waste exchanges can only provide decision making assistance in a small number of cases [Strebel; Schwarz; Farmer et al. (97), 121]. The research work in Oldenburger Münsterland underlines this conclusion.

## 5 Recycling Agency

The discussed knowledge gaps are considerable obstacles to the realization of advantageous economical and ecological recycling solutions. They could be closed by the creation of a recycling-oriented service business following the concept of AMICA (Agency for Marketing, Information, Coordination and Advice) [Hasler (98), 320-321]. AMICA highlights the core functions of a recycling agency which we argue are essential for the establishment of the Styrian as well as of the Oldenburger Münsterland network. Eighty five % of the gatekeepers within the Styrian network and ninety % within the Oldenburger Münsterland network would like to cooperate with such an organization.

As a consequence, the implementation of a central recycling institution is a focus of the project „Institutionalization of the Information Exchange between Companies Concerning Avoidance, Reduction and Disposal of Industrial Residues". This two year project has been started in the region of Oldenburger Münsterland in March 2001 by the project partners of RIDROM and is co-financed again by the German Federal Foundation for the Environment.

The intensifying of the knowledge transfer between the network members has lead to a dramatic decrease in the uncertainty of recycling alternatives among the gatekeepers. Figure 2 highlights this shift from forty % of very often perceived lack of specific knowledge at the beginning of recycling networking in 1997/98 to zero % in

2001/02. Correspondingly, the share of rarely experienced knowledge deficits raised from five % to seventy seven %. The drop of the share of never experienced knowledge gaps from thirty two % to nine % can be explained by the increasing awareness of knowledge deficits because of the networking activities of the gatekeepers. Again, all companies provided data in the latest survey.

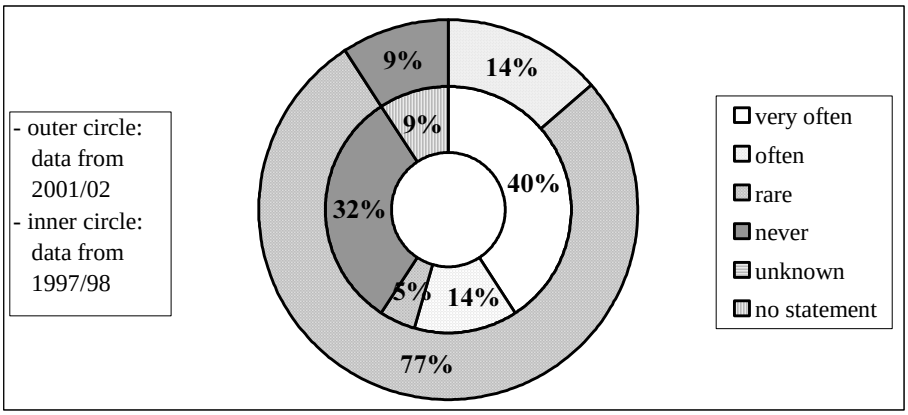


*Figure 2: Frequency of perceived knowledge deficits in recycling alternatives*

At this advanced stage of knowledge transfer one important task of the project team is the amalgamation and transformation of existing recycling expertise into explicit knowledge to build up a Recycling Information System (RIS) for the recycling agency. The key data of the individual recycling processes will be entered into a Geographic Information System (GIS). This system will support the planning and organization of inter-company recycling systems for waste materials such as scrap oil or waste foils.

## 6 Conclusion

The results of our empirical study provide evidence that knowledge transfer in recycling networks decreases the subjectively perceived high degree of uncertainty among gatekeepers. They are encouraged to tread new recycling paths which are coordinated and promoted by recycling agencies. Consequently, their companies reap advantages such as cost and risk reduction because of a staple stance on waste disposal and supply. The improvement of the company´s image is another important reason for recycling activities of networking companies. In this way, mutual interest can be established in business-authorities and business-public relations.

The region as a whole benefits from the minimized use of harmful and scarce resources. In addition, the ecological dangers caused by the emitted waste materials are kept to a minimum [see also Strebel (98), 3-4]. Taking this into consideration, recycling-oriented knowledge transfer bridges the gap between economy and ecology in a sustainable way.

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