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Networks – A Cooperative Approach to Environmental Management

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Abstract

Mainly due to an enforced legislation as well as an increased social demand, companies need to integrate ecological aspects into their corporate goals. Compliance to these goals often leads to the development of innovative approaches to environmental management by means of applying the fundamental principles of the “Circular Economy”. Additionally, intra and inter-organizational concepts of waste disposal and recycling are implemented.

Applied to ecological problems, networks of enterprises provide an innovative and promising approach to simultaneously satisfy the living needs of future generations as well as the economic needs of today’s businesses. Furthermore, the specific implementation of an environmental management network can be used as an effective instrument of regional politics.

This paper discusses the characteristics and implications of environmental management networks. It emphasizes the prerequisites of stability and the importance of integrated production/recycling planning and control systems for the successful implementation of networks. Additionally, it provides a detailed analysis of the ecological and economic implications of environmental management networks.

1 Introduction

Today, environmental problems are greater than ever before. Most of these problems are rooted in the growing gap between the continuously increasing degree of pollution and the constant capability of the environment to regenerate. One way to reduce this gap may consist of restricting the use of the environment as a media for resources supply and waste disposal. This would lead to a more economic use of natural resources as well as a reduction of the ecological consequences of global material flows.[1] Although the main target of restrictions is rather clear, working solutions to achieve it are rare. A possible approach is represented by the so-called “Circular Economy”.[2]

The concept of the Circular Economy aims at reducing the demands on the environment as a media for resources supply and waste absorption.[3] A first but only brief discussion of the idea to use waste as an input factor was provided by Gutenberg.[4] Possible ways of implementing this concept consist of recycling waste and reintroduce it into the economic process and/or of continuously reusing products.[5] Both ways lead to a significant quantitative reduction of waste per time period. Supporting measures are special organizational concepts and/or modern management approaches.

Generally, many companies face an increasing pressure from various sides to quickly apply the concept of the Circular Economy to their structure, processes, and products. However, many of them do not dispose of the core competencies required to take the necessary actions. Therefore, they are to an increasing degree depending on external resources. Additionally, the Circular Economy requires materials to continuously circulate within the economic process, either within a single company or between different companies. In most cases, for technological and economical reasons it will be rather difficult for a company to handle an intra-organizational circulation. Therefore, many companies try to implement the con-

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1 Schmidt-Bleek (1993), p. 48.

2 Stahlmann (1991), pp. 16, Kaiser/Maier (1991a), p. 47, Kaiser/Maier (1991b), p. 234, Kaiser/Maier (1991c), p. 7, Strebel (1991), pp. 4, Strümpel/Longolius (1991), p. 74, Kreikebaum (1992), pp. 13, Blecker (1998), pp. 97.

3 Kaluza/Pasckert (1997), pp. 105

4 Gutenberg (1983), p. 5.

5 Schmid (1996), pp. 170.

cept of the Circular Economy by means of inter-organizational partnerships and cooperations. In literature, networks of enterprises[6] are suggested as a promising form of an inter-organizational cooperation for implementing the Circular Economy. Although already discussed by some authors[7] as cooperative solutions to specific problems like the recycling problem, networks of enterprises have gained significant importance as comprehensive approaches to environmental management only during the last few years.[8]

2 Characteristics of Environmental Management Networks

2.1 Principles of Inter-Organizational Network Relations

By participating in a network of enterprises, companies generally aim at gaining competitive advantages.[9] Given today's complex and dynamic competitive environment, this form of an inter-organizational cooperation has been extensively discussed in recent literature. Also in business practice it has gained increased importance.[10]

In general, the term "network" describes a net of social, economic and/or political relations between individuals and organizations.[11] The specific connections of a number of companies (or company units) form a network of enterprises. However, a common terminology of networks of enterprises does not exist yet. This is mainly due to the heterogeneous nature of the different approaches to this concept.[12]

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6 Jarillo (1988), pp. 31, Jarillo (1993), Sydow (1991a), pp. 238, Sydow (1992a).

7 Jahnke (1986), pp. 46, Strebel (1987), pp. 104 and pp. 109, Walter (1990), p. 90, Götzelmann (1992), Götzelmann (1994), pp. 1101, Schneidewind (1995), pp. 16, Meffert/Kirchgeorg (1998), pp. 374.

8 Hansen et al. (1995), pp. 62, Kaluza/Blecker (1996a), pp. 379, Kaluza/Blecker (1996b), Kaluza/Blecker (1998b), pp. 263, Strebel (1995), Strebel (1996), Strebel/Schwarz (1994), Schwarz (1994), Wildemann (1996a).

9 Blecker (1999), pp. 14.

10 Backhaus/Meyer (1993), p. 330, Quinn/Hilmer (1995), pp. 48, Wildemann (1995), pp. 743, Moss Kanter (1995), pp. 33.

11 Schubert (1994), p. 9.

12 Araujo/Easton (1996), p. 84, Hinterhuber/Stahl (1996), pp. 90, Picot et al. (1998), pp. 293, Weber (1996), p. 90, Blecker (1999), pp. 15.

Sydow defines networks of enterprises as a way of organizing economic activities that aims at gaining competitive advantages. It is characterized by complex and reciprocal relations among legally independent but economically dependent companies.[13] These relations are more of a cooperative rather than competitive nature and, hence, relatively stable. Thus, networks of enterprises represent an intermediate form of organization and coordination between market and hierarchy.[14] They are established either by a pro-forma internalization or externalization of functional areas.[15] Depending on the goals pursued, these networks can be institutionalized in various forms like supply contracts, franchising, and joint ventures.

Possible goals[16] of participating in a network of enterprises – though they vary from case to case – comprise concentration on core competencies, realization of synergies, gaining of specialization and cost advantages as well as time advantages, and access to resource markets.[17] Frequently, companies also strive for increasing their flexibility by reducing their range of activities and, hence, the required resources.[18] Since these targets can also be achieved by other forms of inter-organizational cooperations, it is necessary to make a clear distinction between networks of enterprises and major other types like trusts, syndicates, strategic alliances, and alliance networks.[19]

Networks of enterprises differ from those types of inter-organizational cooperations listed above mainly in the following three respects:[20]

1. Rather than other cooperations, networks of enterprises allow relations to be established in all possible directions. While in most cooperations horizontal and vertical relations play a dominating role, networks of enterprises also cover lateral and diagonal relations. The latter two types of relations may even be considered as a characteristic advantage of networks of enterprises since

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13 Sydow (1992a), p. 79.

14 Sydow (1992b), pp. 246.

15 Sydow (1992b), pp. 263, Sydow (1992a), pp. 105.

16 Jarillo (1988), pp. 33, Murray/Mahon (1993), pp. 105, Welge (1995), co. 2402, Sydow (1992a), pp. 163, Sydow (1993), pp. 62, Sydow (1991b), p. 2, Sydow (1995a), p. 160.

17 Degenhardt (1992), pp. 118, Wildemann (1994), p. 7, Wildemann (1996c), pp. 20.

18 Jarillo (1988), p. 35.

19 Kaluza/Blecker (1998a), p. 29.

20 Blecker (1999), pp. 34.

complementary resources or – especially in case of environmental management networks – the required conditions for reintroducing waste into the economic process can only be found in other industrial fields.

2. Traditional types of inter-organizational cooperations are often set up for a limited period of time and dissolved once the common targets have been achieved. Networks of enterprises, however, are usually established without time restrictions. Sometimes, previously established relations provide the basis for further inter-organizational activities. In these cases, a permanent network with changing reciprocal functions is established.

3. Networks of enterprises are usually not dissolved, if one partner leaves the network. Rather, the remaining partners carry on and, if necessary, admit new companies to the cooperation.

Consequently, stability may be considered as the crucial factor determining the manageability and potential advantages of inter-organizational cooperations. In literature, two diverging requirements regarding network stability can be found: On the one hand networks of enterprises should dispose of a high degree of flexibility, on the other hand they have to be stable enough in order to guarantee the durability of the cooperation. The problems resulting from this divergence can be solved by using mechanisms of coordination based on mutual exchange of outputs. In this case, companies within the network cooperate very closely in a coexistence of cooperation and competition. Consequently, they exchange their goods and services via markets or other coordination mechanisms similar to market places. The relations established among customers and suppliers within the network are very intensive and, hence, stable.

Achieving and remaining the required stability depends on a number of prerequisites that are categorized into four groups.

The first group comprises *legal prerequisites*. When setting up a network, partners usually conclude basic agreements. Above all, these contracts stipulate the principles of how to share earned profits. Occasionally, they may also contain financial compensations for certain parties as well as clear definitions of the duties of all companies involved in the network. Design of these contracts is crucial for the functioning of the entire network. If they are composed in a too rigid way, it does negatively affect the flexibility of the network. Additionally, the desired intermediate position of the cooperation among market and hierarchy cannot be accomplished.

All types of *external prerequisites* are summarized in the second group. Certain configurations of these external conditions, like legal, social, and technological conditions, have positive implications on the stability of a network. For instance, a restrictive environmental legislation as well as a society sensitive to ecological problems significantly supports stability of an environmental management network. In reverse, missing or weak external conditions may contribute to the break up of the network.

Internal prerequisites represent the third group determining the stability of a network. Characteristic prerequisites of this group are, for instance, a high degree of mutual trust, reciprocal relations, a certain knowledge about the network and its participants, and a common network-specific identity. Particularly, mutual trust and reciprocal relations play a major role in achieving a high degree of network stability, as they largely prevent opportunism and a perception of only low benefits resulting from a participation in the network.

Finally, the fourth group comprises *organizational prerequisites*. In this respect, companies involved in the network can increase its stability by a continuous inter-organizational exchange of employees. In this way, possible frictions of the cooperation can be reduced accompanied by an increased trust between the respective companies based on established personal relations. This may also be achieved by a comprehensive and unrestricted flow of information among companies as long as it concerns the primary purpose of the network. Another organizational prerequisite is Networking. Networking represents a specific management task for all companies participating in the network. It aims at initiating change processes towards developing and pursuing common goals and duties.[21] Also the implementation and optimization of exchange relations can be attributed to Networking. Generally, the dynamic and company-spreading character of these processes enhances network stability.

However, network stability is significantly threatened by single participants aiming at maximizing their individual benefits.[22] These persons, groups, and/or organizations try to quantify the individual benefit resulting from their participation in a network of enterprises. The network will be stable, if this benefit turns out to be positive. In case the benefit happens to be negative, companies may leave the net-

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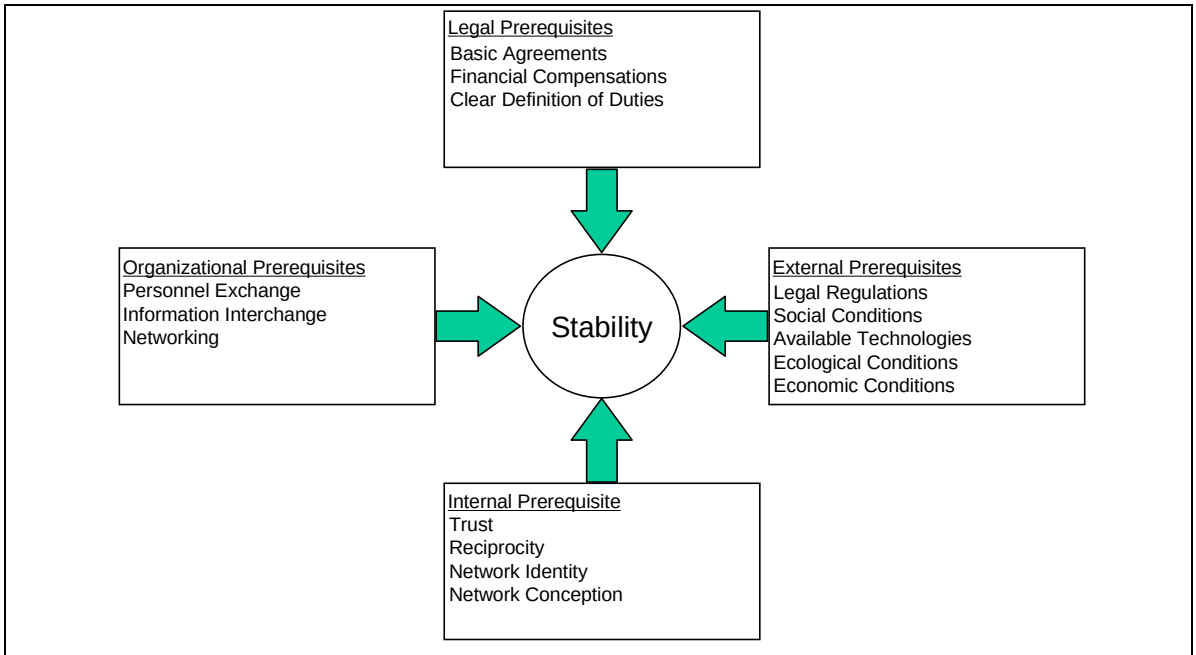
21 Männel (1996), p. 39.

22 Blecker (1999), pp. 43.

work. Since they stay legally independent, they may do so. Because of the high flexibility of the network, their functions are taken over by the remaining companies. Thus, a de-stabilization usually does not take place. The stability of a network is also highly susceptible to conflicts regarding the distribution of earned profits among network partners. To avoid these conflicts, obligatory rules and instruments for distributing commonly earned profits need to be stipulated. Another crucial factor for network stability is "boundary spanning",[23] which is a network-specific role that needs to be assumed by management. The participating company needs to be represented within the network, information from within and outside the network has to be gathered and distributed among network partners. Additionally, in the course of a cooperative production process, the partners involved have to be continuously motivated towards achieving the common goals. Assuming this role is rather difficult as it significantly differs from traditional management roles. To help managers to get acquainted with this role, adequate steps regarding personnel development need to be taken. Special emphasis has to be placed on imparting the cognitive capabilities for thinking in network dimensions and for grasping and mastering complex inter-organizational systems.



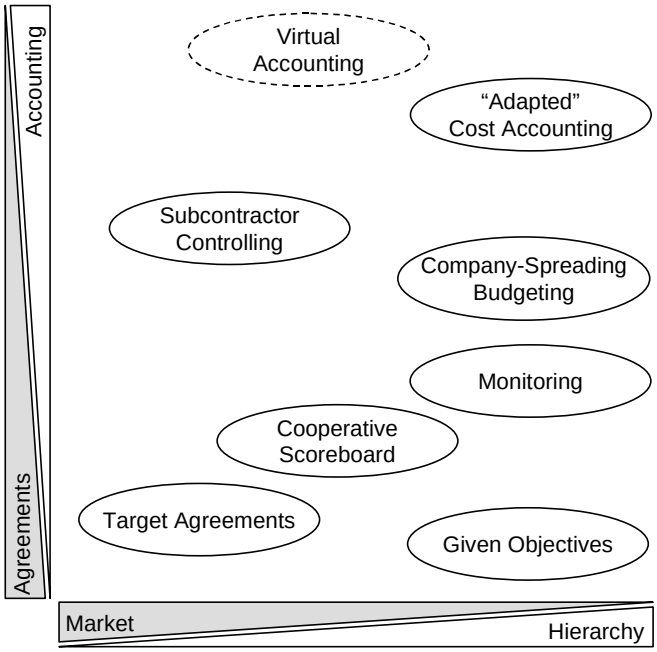
Source: Kaluza/Blecker (1998a), p. 31

Figure 1: Prerequisites determining the stability of inter-organizational network relations

[23] Sydow (1992a), pp. 308, Sydow (1995b), co. 1628, Sydow (1995c), pp. 631, Sydow (1995d), pp. 164, Reichwald (1997), p. 247.

In order to avoid malfunctions of inter-organizational relations within a network of enterprises, the implementation of a company-spreading controlling system and the coordination of these relations as well as of company-specific processes become crucial.[24]

A major challenge for companies participating in a network of enterprises consists of actively managing their relations and interactions with partners.[25] In this respect, attributing common achievements to individual partners and developing inter-organizationally applicable controlling tools are of major importance.[26] Tools especially tailored to controlling problems in networks have been extensively discussed in literature. Some of them are depicted in Figure 2.



Source: Kaluza/Blecker (1998a), p. 32

Figure 2: Controlling tools for inter-organizational network relations

Accordingly, Bellmann suggests a "Corporate Scoreboard" consisting of key performance indicators as a formal controlling tool which can be expanded to some sort of virtual accounting.[27] Other than the Corporate Scoreboard, which proc-

24 Kaluza/Blecker (1998a), pp. 32, Blecker (1999), pp. 44.

25 Blecker (1999).

26 Sydow (1992a), pp. 307, Sydow (1995c), pp. 631, Sydow (1995d), pp. 164.

27 Bellmann (1996), p. 58.

esses only quantitative data, virtual accounting can be applied to all economically relevant data. Thus, it allows a comprehensive inter-organizational controlling. Other working approaches consist of subcontractor controlling (Pampel),[28] common targets, trust, and monitoring (Wildemann),[29] a company-spreading budgeting system and an adapted cost accounting system. These instruments have in common that they are capable of keeping track of economic processes beyond corporate borders. However, they need to be distinguished regarding their attribution either to market-oriented or hierarchy-oriented coordination. Market-oriented controlling tools largely prevent external influence of network partners, thus, providing a high degree of network flexibility. Hierarchy-oriented tools facilitate the exact planning and control of the network by the controlling division.

As already mentioned, a network of enterprises represents an intermediate organizational form of cooperation that can be classified between the two extreme positions of market and hierarchy. Thus, for implementing controlling tools a combination of elements of both extreme positions can be considered as the most appropriate approach. Consequently, we opt for the complementary application of the Corporate Scoreboard and the Virtual Accounting. Generally, implementing adequate controlling tools represents a crucial step in setting up inter-organizational network relations, as they significantly determine the functioning and stability of these relations. Although complex, this problem can be solved as empirical evidence shows. For instance, there is a long tradition in applying similar concepts in the publishing industry.

The most important function of an inter-organizational controlling is coordination. Basically, coordination is the complementary function to specialization, as an increasing degree of specialization calls for more coordination.[30] Since diagonal and lateral relations lead to a high specialization of the companies involved, in most networks a high demand for coordination is implied. In order to meet this demand, several coordination systems can be applied, ranging from technocratic to personnel-oriented, from centralized to decentralized systems. Since networks are in most cases polycentric formations without a focal company as strategic leader, decentralized or technocratic systems promise to be more effective than others

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28 Pampel (1993), pp. 71.

29 Wildemann (1996b), pp. 193, Wildemann (1996c), p. 20.

30 Kieser/Kubicek (1983), pp. 103.

are. Furthermore, because of a missing focal company substantial coordination costs arise. These costs need to be minimized by means of bilateral coordination processes. Otherwise, only the individual cost position of single participants rather than that of the entire network is optimized. However, there is no universal approach towards the exact creation and implementation of coordination systems. Rather, they differ from case to case.

Inter-organizational network relations have various inherent functional mechanisms that facilitate the coordination of specific relations and processes. These mechanisms – according to the intermediate character of a network – range between market and hierarchy. As a consequence, participants within a network have to deal with both cooperation and competition simultaneously. For instance, in an environmental management network participants cooperate in reusing waste, whereas in any other area they are still competitors. Even within the established network boundaries there is still a coexistence of competition and cooperation. This may result in a few companies competing for a limited amount of waste from the partners. Still, they need to strive for a win-win-situation for all network participants involved. If this win-win-situation cannot be obtained for various reasons, some companies may feel discriminated and, consequently, tend to leave the network. In order to preserve the stability of the network, the benefits of the cooperation have to be equally shared among all participants.[31] This can be achieved e.g. by financial compensations. However, calculating fair compensation rates is rather difficult.[32] Additionally, companies showing opportunistic behavior need to be eliminated from the network. The flexibility required for doing so can be provided by redundant relations. The functions of the eliminated company are shifted to another company participating in the network.

Furthermore, continuous improvement of bilateral relations within the network is of major importance. For this purpose, companies need to foster an institutionalized company-spreading dialogue that aims at an improved coordination of intra and inter-organizational processes. Here, personal relations among top managers as well as other employees have proven to be very helpful. According to Sydow, private relations among persons do significantly promote the development of net-

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31 Porter/Fuller (1989), p. 378, Porter (1992), p. 88.

32 Schubert/Küting (1981), p. 140.

works.[33] An example supporting Sydow's thesis is given by the Industrial Symbiosis Kalundborg (Denmark).[34] In this particular case, previously existing private relations among the managers of the Industrial Symbiosis Kalundborg not only reduced transaction costs significantly, but also promoted the formation of this local network.[35]

2.2 Functionality of Environmental Management Networks

Environmental management networks represent a special type of a network of enterprises. Companies participating in an environmental management network do not only cooperate in the production area but mainly in the field of environmental management. Given the heterogeneous nature of environmental management, several types of environmental management networks can be distinguished.[36] For instance, Goetzelmann distinguishes among cooperations for standardization, R&D, operating of installations for waste disposal, and cooperations aiming at preventing, reducing and treating waste. All these networks have in common, that the partners perform certain environmental-related tasks together. Major targets consist of concentration on core competencies, risk reduction, and cost sharing.

A type of environmental management networks that has gained increased theoretical and practical importance during the last few years is the industrial recycling network.[37] Cooperations for common standardization, R&D, and operation purposes do not significantly differ from traditional cooperations, whereas industrial recycling networks do in terms of motivation for their formation and regarding the functions of the partners. In most cases, insulated reintroduction of waste into the production process is not desired or does not represent an economically or technically feasible alternative for a company. Therefore, waste sources and drains of different companies need to be combined to a company-spreading process of waste disposal and recycling.[38] This case especially applies, if companies make

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33 Sydow (1992a), p. 48.

34 Elkington et al. (1991), pp. 156, Strebel/Schwarz (1994), pp. 246, Kranendonk (1995), p. 11, Christensen (1998), pp. 323, Kaluza/Blecker (1996a), p. 23.

35 Schwarz (1994), p. 110.

36 Götzelmann (1992).

37 Schwarz (1994), Schwarz (1996a), Schwarz (1996b), Schwarz/Steininger (1997)

38 Strebel (1995), p. 114.

use of highly specialized service providers or return their waste to upstream stages in the value chain. Thus, companies take advantage of the resources of other companies in order to comply with environmental legislation (e.g. the rigid regulations of the German Circular Economy Law). Companies obliged to comply with the Circular Economy Law engage the resources of other ones for recycling and disposing of their waste. Often, undesired by-products of some producers represent a valuable input factor for another manufacturing company.[39] Thus, the economic incentive for the company absorbing other people's waste consists of securing the availability of critical input factors and/or reducing related costs. On their side, the only limitation for this mutually profitable situation consists of possible negative implications on product quality due to the inferior material quality of these secondary input materials.

Overall, there are still significant differences between environmental management networks and traditional networks. Figure 3 provides a comparison of the fundamental characteristics of production and supply networks to those of environmental management networks.

Network / Characteristics	Production and Supply Networks	Environmental Management Networks
Elements	• Manufacturers • Suppliers	• Manufacturers • Suppliers • Service / Recycling Providers
Relations	• Cooperation • Exchange of goods	• Common performance of environmental tasks
Geographical Dimension	• Local / regional • National • International • Global	• Predominantly local / regional • National • International
Directions of Relations	• Horizontal • Vertical • Diagonal	• Vertical • Diagonal
Pursued Goals	• Synergies • Cost reductions • Resources supply • Competitive advantages • Core competencies	• Environmental protection • Cost reductions • Core competencies • Secure waste disposal • Resources supply

Source: Kaluza/Blecker (1996a), p. 391 (modified)

Figure 3: Comparison of traditional networks and environmental management networks

[39] Strebel (1995), p. 114.

Unlike traditional networks, environmental management networks usually exchange uncomplex materials rather than complex goods. These materials are waste from the suppliers point of view while they represent secondary input materials for the recipient. Both parties may realize significant economic advantages from this exchange consisting of cost reductions, additional revenues, secure sources of supply, etc. [40]

From these advantages two major differences between traditional networks and environmental management networks derive. First, due to the low economic value of the materials exchanged, environmental management networks are restricted to relatively short distances. Otherwise, logistics costs exceed cost savings and other benefits from exchanging waste very quickly. Second, horizontal cooperations are relatively rare in environmental management networks, since there is usually a mismatch between material demand and supply on the same production stage. Rather, different stages in terms of materials supplied and required as well as different industrial processes are needed to form an environmental management network.

Particular goals for environmental management networks can be derived from those of traditional network concepts. Usually, they consist of securing waste disposal, reducing the related costs, concentrating on core competencies in R&D and the production area, and complying with environmental regulations.

For a thorough discussion of environmental management networks, it is necessary to distinguish among different directions of the underlying relations. In vertical environmental management networks companies of the same business field but different production stages cooperate. Examples for this type of environmental management networks are supplier-customer cooperations in the automotive and electronics industry. Here, producers take back used products, dismantle them and return the single components to their suppliers for further processing and recycling. Diagonal environmental management networks embrace companies from different businesses and production stages. The Industrial Symbioses Kalundborg gives a vivid example for these networks. In this local environmental management network power suppliers, the cement industry, and agricultural companies exchange their waste. Horizontal environmental management networks require companies of the same business field and the same production stage to cooperate. As

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40 Stölzle/Jung (1996), p. 35, Schwarz (1994), pp. 108.

these requirements usually do not apply to environmental management networks, we won't consider them in the following discussion.

Figure 4 illustrates the two major types of environmental management networks. However, they are of an idealistic nature, which will be difficult to find in practice. Rather, practical implementations of networks will contain relations of both types resulting in hybrid approaches to environmental management networks.

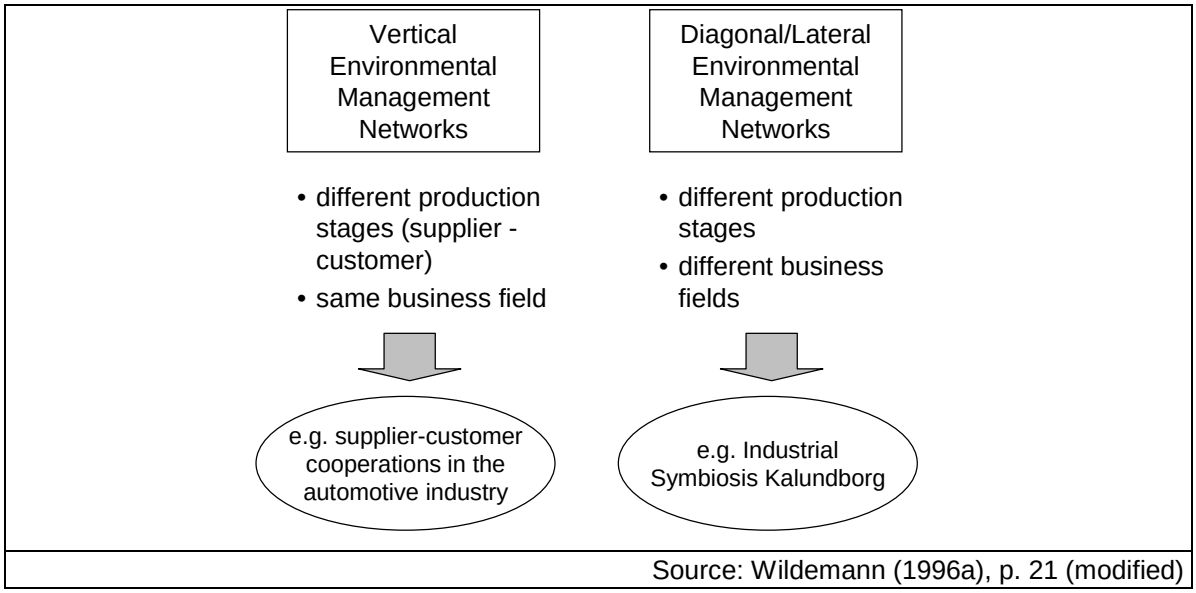

Figure 4: Idealistic types of environmental management networks

Environmental management networks can be further distinguished regarding parameters like type of companies involved, geographical dimension, duration and intensity of the cooperation.

The types of environmental management networks we refer to are basically open to manufacturing companies of all industries. In the course of our analysis of environmental management networks, we also consider service companies, especially those providing recycling services. Since their "products" consist of industry-oriented services, which are closely related to physical processes, they may behave like a manufacturing company when participating in an environmental management network.

Regarding the geographical dimension of the network, theoretically the whole bandwidth from local to global networks is possible. Global environmental management networks, however, require a comprehensive global coordination of waste generation and disposal as well as transportation over long distances. Due to these unfavorable requirements, global environmental management networks

can be considered as economically and ecologically questionable. We, therefore, focus on local, regional, national and international networks, with special emphasis on local and regional environmental management networks. This emphasis is based on the assumption that most environmental management networks are implemented following the local and regional approach. This is due to the threat of costs (transaction and logistics costs) exceeding the benefits from participating in the network. Especially large environmental management networks are highly susceptible to this threat.

As already mentioned, goals of participating in an environmental management network range from cost reductions to input security. These underlying goals significantly influence the two remaining parameters: duration and intensity. Regarding their duration environmental management networks can be classified into approaches limited and those unlimited in time. Basically, limited networks are founded for accomplishing an a priori defined task or for a pre-determined period of time. Since environmental management represents a permanent challenge today, environmental management networks should be established for an unlimited period of time.

Intensity of environmental management networks ranges from rather loose connections based on mutual agreements to tight relations stipulated by legal contracts. Mutual agreements require only a low employment of the partners involved and, furthermore, are characterized by a high reversibility. Thus, they represent the connection with the lowest intensity but a high degree of flexibility for reactions to changes in the network environment. Unlike mutual agreements, legal contracts provide a higher intensity leading to a higher employment of the parties and a lower reversibility and flexibility.

A summary of possible options regarding determining the parameters for setting up an environmental management network is given in Figure 5.

Groups / companies involved	manufacturers	suppliers	service providers	third parties
Direction of relations	vertical	diagonal	lateral	
Geographical dimension	local	regional	national	international
Goals	input security	cost reduction	recycling security	
Intensity	agreements	contracts		
Duration	pre-determined period of time	upon task accomplishment	unlimited in time	

Source: Kaluza/Blecker (1996b), p. 394

Figure 5: Parameters of environmental management networks

3 Integrated Production/Recycling Planning and Control Systems as the Critical Factor of Environmental Management Networks

In environmental management networks transparency and optimization of material flows are of major importance. Planing, control, and coordination of these flows depend to a large extent on the availability of information. Thus, in an environmental management network all physical and managerial processes are overlaid by information and communication systems. Regarding the resulting information and communication relations three different types may be distinguished as illustrated in Figure 6:[41]

- Relations within companies participating in the network
- Relations between companies participating in the network
- Relations between the network and its environment

41 Kaluza/Blecker (1996a), pp. 39, Blecker (1999), pp. 46.

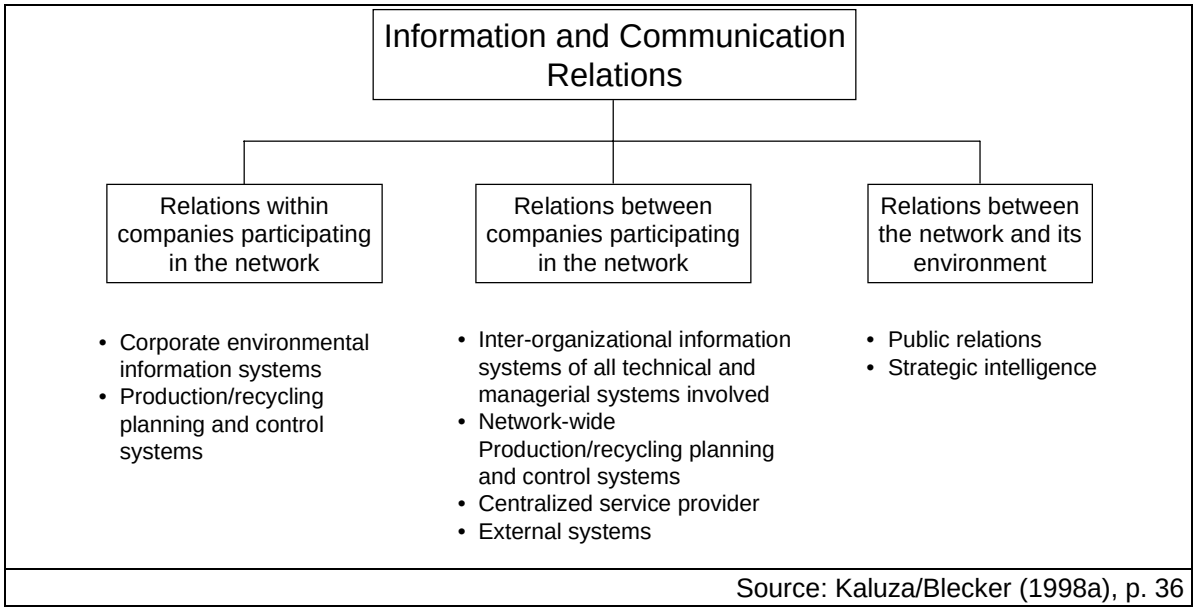

Figure 6: Types of information and communication relations in environmental management networks

Relations within companies participating in an environmental management network concern information regarding the logistic determination of waste, potential input materials and their composition. In addition to the conventional databases of the design and production area, special information systems need to be used for gathering ecological information. For instance, corporate environmental information systems can be employed for documentation, planning and control purposes concerning environmental management as well as for decision support. Today, most companies already have some sort of corporate environmental information system[42] in place or plan to implement one in the near future. These systems can provide a platform for planning and controlling company-spreading recycling processes. However, the required inter-organizational connections of these currently isolated systems have not been established yet. Therefore, existing insulated solutions of corporate environmental information systems need to be replaced by integrated solutions. Based on the information provided by these systems, integrated production/recycling planning and control systems can be developed.[43]

Relations between companies participating in a network aim at meeting the high demand for decentralized coordination. This can be effected by gathering and ex-

[42] Kaluza (1997), pp. 61.

[43] Corsten/Reiß (1992), p. 626, Kurbel/Rautenstrauch (1997), pp. 302, Blecker (1998), pp. 104.

changing information regarding composition and logistic determination of waste. However, in most cases this information is collected and stored decentralized and, hence, not commonly accessible. Therefore, various inter-organizational communication channels need to be established[44] in order to achieve and maintain a high availability[45] of this information. Unlike traditional communication channels between (not cooperating) companies, inter-organizational communication channels have to allow a more intensive and dynamic communication between the cooperating companies.[46]

Therefore, the companies participating in a network need to be connected regarding their information bases and flows in order to create inter-organizational information networks comprising all dislocated technical and managerial systems involved. The quality of these connections is crucial for the efficiency of the environmental management network.[47] Consequently, an optimization and standardization of the systems in place significantly reduces the time elapsing from the point of waste generation to that of its reuse, improves flexibility and provides the basis for an optimization of the entire network. Inter-organizational production/recycling planing and control systems are widely considered of being an effective approach. They allow a decentralized collection of information regarding waste, a network-wide planning and control of production and recycling processes, and an inter-organizational coordination of individual corporate processes. In practice, however, companies often do not dispose of the resources required to implement and operate such a comprehensive system. An alternative for overcoming these limitations consists of taking advantage of a centralized service provider, which does not necessarily has to be a network partner concerning physical processes. Rather, external systems are frequently used for this purpose. An interesting approach is represented by electronic market places for recycling on the Word Wide Web. One system called “Word Wide Wastemanagement Information System” was implemented by WARIS (Waste and Recycling Information System). Basically, this approach can be also applied to set up similar, but network-specific systems. Either way, these systems help to partially meet the individual demand

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44 Welge (1987), p. 424.

45 Wildemann (1996c), p. 33.

46 Kuhn (1996), p. 10.

47 Kaluza/Blecker/Sonnenschein (1996), Freichel (1992), Freichel (1993), p. 173, Wildemann (1996c), pp. 33.

for network related information and to simultaneously reduce the need for network-covering connections.

Relations between the network and its environment are the third category of relevant information and communication relations. This type of relations may aim at communicating achievements in the area of environmental management and protection. Thus, a major disadvantage of cooperative solutions to environmental problems, that of an insufficient unique environmental position, can be overcome.[48] Accordingly, administrative obstacles and legal regulations may be lifted for participants of environmental management networks. Additionally, they may increase customer loyalty and reduce potential conflicts with their environment.[49] However, this can only be achieved by a congruent public relations policy that actively communicates structure, functions, and advantages of networks as cooperative solutions to today's environmental problems. Additionally, networks partners need to be aware of changes in their environment in order to adjust their processes accordingly. Within the scope of strategic intelligence, changes in the social and legal environment, e.g. amendments of the Circular Economy Law and new regulations, need to be identified as early as possible.

Most information and communication relations within network companies can be mastered by applying traditional concepts and systems.[50] Network-wide production/recycling planning and control systems, however, represent a major challenge, with only few existing solutions yet. In order to facilitate the company-spreading coordination of production and recycling processes, recycling planning and control should always be effected in close connection to traditional production planning and control systems. These integrated systems need to be tailored to the specific needs of the companies participating in a network.[51] Therefore, individual rather than standardized solutions may be more effective. In the course of the developing process two major questions need to be addressed: first, the development of a recycling planning and control tool, and, second, the design of respective network-wide approaches.

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48 Meffert/Kirchgeorg (1998), p. 378.

49 Kaluza/Blecker (1996a), p. 42, Kaluza/Blecker (1996b), pp. 403, Kaluza/Blecker (1998b), p. 290.

50 Kaluza/Blecker (1998), pp. 40.

51 Corsten/Reiß (1992), pp. 615, Kurbel/Rautenstrauch (1997), pp. 299.

The base functions of recycling planning and control systems are similar to those of traditional production planning and control systems. Thus, they may be developed following traditional approaches. However, in case of recycling cost information is often incomplete. Consequently, cost goals cannot serve as the basic optimization criteria for the planning process.[52] Therefore, it is necessary to replace traditional cost goals with substitutive goals.[53]

Goals \ Object	Capacity	Order
Time-based Goals	Security of recycling capacities, optimization of recycling and production capacity usage	Substantial reduction of lead time, meeting shipping dates despite the reuse of waste
Quantitative Goals	Coordination of the production and recycling capacities available	Reduction of demands for raw materials and of waste inventory

Source: Corsten/Reiß (1992), p. 618 (modified)

Figure 7: Goals of Production/recycling planning and control systems

As Figure 7 shows, basically time-based and quantitative goals may serve as substitutes for cost goals. Relevant goals for recycling planning and control processes consist of securing recycling capacities, minimizing idle times of recycling capacities, coordinating the capacities available, and reducing lead time for waste materials. In case of a full integration with production planning and control systems, further goals need to be considered. They usually comprise meeting shipping dates regardless of the reuse of waste, reducing demand for raw materials, and reducing waste inventory. Since the basic principles of these systems are very similar to those of traditional production planning and control systems, obstacles during the implementation process should be rare.[54] Currently, basic research in this field is conducted by projects at the Technical University Berlin and at the Europe-University Viadrina at Frankfurt/Oder trying to develop working prototypes

52 Kurbel/Rautenstrauch (1997), pp. 305.

53 Corsten/Reiß (1992), p. 618, Kurbel/Rautenstrauch (1997), p. 306.

54 Blecker (1998), p. 104, Steinaecker/Kaiser/Pillep/Schieferdecker (1997), pp. 77, Rautenstrauch (1997).

of integrated production/recycling planning and control systems.[55] However, there is no empirical evidence on an entirely integrated system in place in real business practice yet.[56] To overcome this empirical deficiency, a two-year research project at the University of Klagenfurt (funded by the Austrian Federal Reserve Bank) will try to assess the current state and to show possible future developments of inter-organizational production/recycling planning and control systems in the Austrian Economy. The second stage, consisting of follow-up projects, aims at developing a system especially tailored to the requirements of regional environmental management networks.

The major difficulty for the implementation consists of connecting the individual production/recycling planning and control systems of the companies involved in order to come up with an inter-organizational system.[57] The systems of the network partners have to be compatible in order to allow a mutual information interchange. For this purpose, an intra and inter-organizationally applicable system needs to be created, based on the concept of company-spreading interconnectivity. However, in practice, the systems in place can meet these requirements only partially, since they focus on company-specific rather than company-spreading processes. A promising approach to solving this problem consists of the concept of convertible production networks,[58] which basically aims at optimizing the core functions of the network: production and recycling. According to this concept the companies participating in an environmental management network may be considered as a bunch of control layers, processes and resources.[59] Based on comprehensive process models and logistically characteristic curves this concept establishes a connection of individual systems and, hence, allows a combined coordination of all production, recycling, and environmental management capacities throughout the network.

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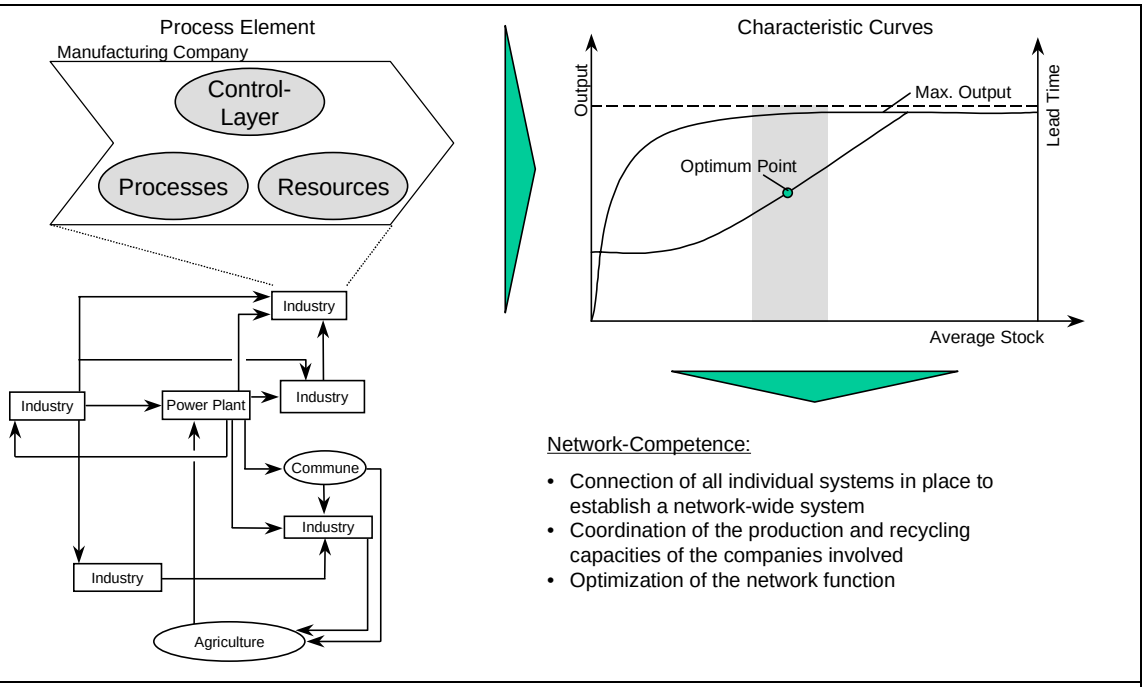
55 http://www.tu-berlin.de/sfbs/demontage/pb_c/tp_c2g.htm and http://viadrina.euv-frankfurt-o.de/wi-www/fp_demo-leitst.html, Blecker (1998), p. 105.

56 Kurbel/Rautenstrauch (1997), p. 319.

57 Blecker (1999), pp. 298.

58 Wiendahl et al. (1996), pp. 23.

59 Wiendahl et al. (1996), pp. 24.



Source: Wiendahl et al. (1996), p. 25 (modified)

Figure 8: Production/recycling planning and control systems in environmental management networks

However, according to its authors the concept of convertible production networks is definitely not a substitutive centralized production/recycling planning and control system, that leaves the respective companies little space for individual planning and control. Rather, competence and responsibility for production/recycling planning and control should remain at a company level as far as possible.[60] In order to put each company in this position, extensive modifications of all components of the individual systems in place are required. For instance, every company has to be capable of explicitly considering external resources in the production/recycling planning and control processes, coordinating materials requirement plans among partners, and accounting for orders placed with partners in their sequencing and scheduling processes. If these modifications are adopted by all partners and supplemented by an adequate planning concept, an intra- and inter-organizational production/recycling planning and control system can be implemented successfully.

60 Wiendahl et al. (1996), p. 27.

4 Implications of Environmental Management Networks

Besides positive ecological implications environmental management networks also make good business sense. Compared to individual approaches they represent a promising alternative for obtaining significant reductions of materials costs on the recycling company's side as well as for securing waste disposal from the viewpoint of the waste generating company.[61] In some cases, companies reintroducing recycled materials into their production processes may even increase their product quality because of secondary input materials having a relatively higher quality than conventional raw materials.[62]

Generally, recycling quantities are higher compared to traditional solutions, since, besides an increasing knowledge of the system, institutionalized waste and information flows are established.[63] Furthermore, participants are provided with a much wider range of managerial options, since they have instant access to the environmental resources and competencies of their partners. Participants usually show a high commitment, are highly sensitive to ecological problems and dispose of an increasing knowledge regarding alternative approaches to recycling. This results in the generation of additional recycling flows. In this way, environmental management networks allow to recycle waste in industrial systems to a larger extent and prevent it from being returned to the ecosystem. Additionally, higher amounts and a steady accrual of waste do significantly facilitate the management of the underlying processes.[64]

Besides a short-term reduction of recycling and materials costs an ecologically oriented management in an environmental management network also enables a company to gain and sustain competitive advantages[65] that significantly influence long term economic success on the market. Mastering environmental issues as well as the production planning and control processes that come along with them becomes an increasingly important critical success factor, that provides a long-term security of the company's recycling resources and sales opportunities. Thus, it will gain more and more importance for further reductions in recycling costs and

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61 Strebel (1995), pp. 116 and pp. 122, Strebel (1987), pp. 111.

62 Strebel/Schwarz (1997), pp. 321.

63 Strebel (1995), pp. 122.

64 Hansen et al. (1995), pp. 65.

65 Zahn/Schmid (1992), pp. 48.

for meeting the challenges of tomorrow's competition. In our opinion, especially by participating in environmental management networks, the still existing trade-off between ecology and economy can be finally overcome.

Despite the advantages of environmental management networks discussed so far, there are still some unsolved problems. Naturally and technically determined limitations regarding the ability to recycle certain types of waste cannot be lifted.[66] Many types of waste cannot or only with considerable efforts be reintroduced into the production process. Companies need to identify and separate their waste from inner-company or company-spreading material flows in order to have it recycled or dumped. Thus, the technical impossibility to totally close the network results in a still ongoing use of natural resources as input factors for industrial processes. These negative impacts on the natural environment need to be related to the savings from the reduced demand for waste disposal and primary input materials. The goal is the simultaneous optimization of all these factors.

Regardless the above-mentioned restrictions, most recycling processes do still make good business sense. However, also most processes for acquiring and applying the resources needed for recycling purposes have negative impacts on the environment. In total, they may even lead to higher environmental impacts than, for instance, thermal dissipation or traditional waste disposal. From an ecological viewpoint, the main target of recycling processes consists of reducing overall environmental impacts. Consequently, those recycling processes negatively affecting the environment need to be eliminated. Additionally, existing examples of environmental management networks reveal that this concept is not universally applicable. Rather, it is still limited to exchanging relatively simple types of waste. If complex products and pre-assembled goods are supposed to circulate within the network, considerable technical and organizational preparations need to be made in order to make mutual recycling work.

In addition to economic and ecological restrictions, also legal problems play a major role in establishing and participating in an environmental management network. For instance, de jure a traditional manufacturing company may become a company specialized in recycling,[67] once its input quota of waste and other secondary input materials exerts a certain level. Frequently, reintroduction of certain

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66 Schmidt (1994), pp. 317, Schwarz (1994), pp. 91.

67 Schwarz (1996a), Schwarz (1996b), p. 361, Schwarz (1994), S.134.

types and quantities of waste into the production process needs to be approved by local, regional or federal authorities and requires special technical and organizational facilities.

Large obstacles may also consist of import and export bans as well as anti-trust legislation. In the foundation process of an environmental management network these potential legal restrictions need to be addressed as early as possible. For instance, an environmental management network may be feasible for economic and ecological reasons, which then are significantly lowered or even set off by legal restrictions.

Also the underlying network model has some major drawbacks which reduce the advantages of environmental management networks. According to Sydow, inherent risks of the network model consist of an only partial control of the system, the threat of losing competencies and the possible dependency from network partners.[68]

Especially the fact that a single company only has partial (and very limited) control over the entire network represents a major risk that needs to be addressed in the decision making process for joining the network. Malfunctions caused by this only partial control may result in harmful impacts on the environment. Although the risk of legal liabilities can usually be neglected, this situation can still lead to significant economic problems, for instance, because of negative publicity.

Potential loss of (core-) competencies and know-how represents a second major risk coming along with the participation in a network.[69] A decision solely based on cost considerations is inevitably flawed by neglecting the security of company-specific resources. Consequently, the company loses control over major environmental management processes, suffers from a growing lack of respective competencies, and becomes heavily dependent on other network partners.[70] If this situation occurs, the company is capable neither of taking care of its own environmental management matters nor of those of others, anymore. Its position in the network as an equal partner deteriorates and finally ends up in a relationship of

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68 Sydow (1995c), pp. 633, Sydow (1995d), pp. 167.

69 Rasche (1994), pp. 362.

70 Sydow (1995d), pp. 167.

subordination.[71] Thus, it becomes nearly impossible for the company to participate successfully in the environmental management network and, hence, to take advantage of the strategic success factor of environmental management. In conjunction with the ever more restrictive regulations stipulated by the Circular Economy Law, a high degree of dependency on other network partners may not only lead to a considerable increase in costs but even to an elimination from the market.

An additional threat to environmental management networks is imposed by a high probability of tight network structures, which are very similar to monopolistic market structures. This type of structure is highly questionable from an ecological viewpoint, since it is very reluctant to replace traditional (and still working) approaches to environmental management by innovative ones. From an economic viewpoint, this situation may lead to a sub-optimal state of the entire economy due to monopoly rates realized by these networks.

Therefore, it is essential to assess if the requirements of an optimal corporate environmental management can be met by participating in environmental management networks. In literature, four characteristics are postulated to be of a fundamental nature to environmental management: multi-dimensional corporate goals, interdisciplinary and inter-organizational character, and a proactive behavioral tendency. These four fundamental principals need to be supplemented by a consequent market orientation.

For our discussion of the implications of environmental management networks we, in reverse, consider these five characteristics as the fundamental criteria to be met by approaches to environmental management.[72] However, they represent only the minimum requirements and, hence, do not necessarily imply a successful implementation of these approaches. Still, for assessing the effectiveness of environmental management networks an examination needs to be conducted whether they comply with these five basic requirements on environmental management concepts depicted in Figure 9.

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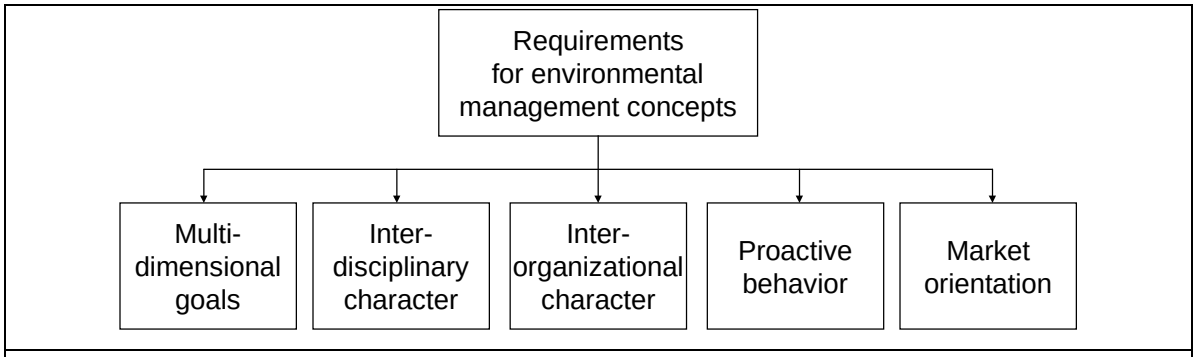
71 Schubert/Küting (1981), pp. 138.

72 Kaluza/Blecker (1998b), pp. 228.



Source: Meffert/Kirchgeorg (1998), pp. 17

Figure 9: Requirements for environmental management concepts

The first requirement for environmental management concepts is multi-dimensional goals. Accordingly, ecological effectiveness still remains the major target of every concept. However, a total reduction of all corporate environmental impacts is not an adequate goal. Rather, also economic goals need to be taken into account. Basically, environmental management networks fulfil this first requirement. Like any others, also environmental management networks are established for enhancing the competitiveness of participating companies. Its participants strive for waste recycling not for its own sake but for gaining some economic advantage deriving from using waste as relatively cheap input material, an anticipation of upcoming legal regulations or securing cost-effective ways of waste disposal. For instance, participants of the Industrial Symbiosis Kalundborg were able to generate cost reductions amounting to more than 15 Mio. DM each year based on a 95 Mio. DM investment.[73]

Unlike many other scientific examinations which are often conducted as a partial analysis, in the field of environmental management all functional areas as well as linking functions need to be commonly analyzed. Environmental management represents a discipline that goes beyond functional areas. To what extent this requirement is internally met by companies, is rather difficult to assess, since there is usually no direct context to the concept of environmental management networks. However, one may suppose, that companies participating in this type of network have realized the economic impact of ecological problems and consider them accordingly.

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[73] Christensen (1998), p. 328.

In order to achieve a lasting reduction in environmental impacts, generally, the whole value chain ranging from raw material suppliers to final consumers needs to be thoroughly analyzed.[74] In addition to vertical approaches also branch-specific horizontal and eventually lateral approaches may be implemented. Thus, these approaches to environmental management are of a company-spreading nature. Since networks, according to their definition, consist of a number of companies, they require substantial coordination efforts in order to prevent malfunctions. Consequently, a partial consideration in the meaning of optimizing only the recycling processes of one company is not sufficient. Examples of environmental management networks already in place – like that of the Industrial Symbiosis Kalundborg, provide evidence that processes and interfaces of all companies involved are commonly optimized. Thus, environmental management networks meet the requirement of an inter-organizational nature of the concept.

Regarding its time horizon environmental management is of a rather long-term nature, since a relatively long time elapses between cause and effect. The planning process must not be effected after important conditions have changed and/or environmental damages have occurred. Rather, environmental management has to be proactive aiming at preventing potential environmental damages. This requirement is particularly met by an environmental management network. Establishing and operating such a network requires long-term trust-generating efforts as well as substantial resources. Thus, the time horizon of an environmental management network can only be of a long-term nature. Additionally, one may suppose that participants in an environmental management network show a proactive behavior in most cases. This assumption is based on the fact that, given the economic advantages of keeping (waste) materials circulating in the system, a reactive behavior were not based on reason. These economic advantages, e.g. generating income from disposing of or recycling waste as well as securing recycling resources in the long term, can only be obtained by being proactive. Additionally, as shown by the Industrial Symbioses Kalundborg, companies compete on the basis of their network participation and, thus, actively communicate their ecological commitment to their economic environment. Reactive behavior of one participating company would inevitably damage the credibility of the entire network. All companies involved would incur losses. Therefore, the other partners would negatively sanction non-conformant behavior. Still, prevention of future environmental damages does

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74 Blecker (1998), pp. 101.

not represent the main theme of corporate behavior in an environmental management network. Rather, economic goals may play a dominant role. Indirectly, the requirement of a proactive behavior is fulfilled by the economic importance of the concept discussed above.

Approaches to environmental management, despite their interdisciplinary character, gain strategic importance only because of a consequent market orientation. This requires a paradigm shift from perceiving environmental management as a cost factor or just an undesirable necessity to considering it as a source for economic success. For this purpose, frequently existing conflicts among ecological and economic corporate goals need to be reduced or even eliminated. Successfully implemented approaches to environmental management do significantly contribute to achieving economic goals by reducing the company's ecological problems and their negative economic impacts. Additionally, relations among network partners are established on a market base. Since products and services exchanged a priced with transfer prices, additional revenues are generated, increasing the companies' bottom lines.

In summary, environmental management networks meet all the postulated requirements of environmental management systems. Additionally, they allow to simultaneously pursue and achieve ecological and economic goals. Thus, they represent a promising approach to environmental management.

5 Conclusion

Because of the ever-increasing challenges in the area of environmental management, innovative approaches are urgently required. One major theme for such approaches consists of transforming value chains into value circles. Companies may not solely focus on internal cycles but need to strive for company-spreading solutions. Environmental management networks represent a solution, which considers both ecological and economic aspects. The high ecological and economic effectiveness of this inter-organizational approach to environmental management derives from utilizing external resources for establishing a Circular Economy. In practice, most of the networks have been implemented as industrial recycling networks. However, the range of possible activities for environmental management networks is much broader, as it covers the whole area of environmental management.

In the process of establishing an environmental management network, companies need to particularly focus on the factors determining network stability. Additionally,

in order to guarantee the smooth exchange of goods and services and the respective cash flows and to coordinate the decentralized processes an inter-organizational controlling system has to be in place.

Regardless the specific scopes of environmental management networks special problems derive from the fact that companies only have limited environmental information available. This is mainly due to inadequate environmental information systems. This drawback especially applies to tools for tracing and depicting corporate materials end energy flows. Thus, development and implementation of integrated production/recycling planning systems still represent a major challenge.

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