LAPPEENRANTA UNIVERSITY OF TECHNOLOGY
Department of Industrial Engineering and Management

Master´s Thesis

DEVELOPING OF SUPPORTIVE CONTEXT FOR ECO-INDUSTRIAL NETWORKS IN FINLAND

Examiners: Professor Anne Jalkala and Professor Ville Ojanen
Instructor: Samuli Patala

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Mikko Saloluoma

ABSTRACT

Author: Mikko Saloluoma

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The aim of the present thesis was to explore possible promotional actions to support the emergence of eco-industrial business networks in Finland. The main objectives were to investigate what kind of factors affect in the development of eco-industrial networks and further make suggestions in what kinds of actions this could be supported. In addition, since the active facilitation was discovered as one potential promoting activity, further investigation about facilitation process in Finnish context was conducted and also main characteristics of nationwide facilitation programme were identified.

This thesis contains literature review of network orchestration and eco-industrial networks. The latter consists of green supply chain management and industrial symbiosis, although the main focus of the study leans on the concept of industrial symbiosis. The empirical data of the study was obtained from semi-structured expert interviews. These interviews were analyzed using qualitative content analysis. The study identified four main promotional activities for eco-industrial networks: 1) building awareness, 2) incentives, 3) dismantling of legislative barriers and 4) active facilitation. In addition, a framework for facilitation activities in Finnish context was built and main characteristics of nationwide facilitation programme were identified.

TIIVISTELMÄ

Tekijä: Mikko Saloluoma

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Tämän työn tavoitteena oli tutkia mahdollisia tukitoimia, joilla pystytään edistämään ekoteollisten verkostojen kehitystä Suomessa. Tutkimuksen päätavoitteina oli selvittää millaiset tekijät vaikuttavat ekoteollisten verkostojen kehitykseen ja edelleen, tehdä suositukset tukitoimiksi. Lisäksi, koska aktiivinen fasilitointi havaittiin yhdeksi potentiaaliseksi tukitoimeksi, toteutettiin syvällisempi tarkastelu fasilitointiprosessista suomalaisessa kontekstissa sekä tunnistettiin kansallisen fasilitointiohjelman pääpiirteet.

Tutkimuksen kirjallisuuskatsaus keskittyi verkostojen orkestrointiin sekä ekoteollisiin verkostoihin. Näistä jälkimmäinen koostuu vihreistä toimitusketjuista sekä teollisesta symbioosista. Tutkimuksen pääpaino on kuitenkin teollisessa symbioosissa. Tutkimuksen empiirinen aineisto kerättiin puolistrukturoiduista asiantuntija-haastatteluista. Haastattelujen analysoinnissa hyödynnettiin kvalita-tiivista sisällön analyysiä. Tutkimuksessa havaittiin neljä tärkeintä tukitoimea ekoteollisten verkostojen edistämiseksi: 1) tietoisuuden kasvattaminen, 2) taloudelliset kannustimet, 3) lainsäädännöllisten esteiden purkaminen sekä 4) aktiivinen fasilitointi. Lisäksi tutkimuksessa rakennettiin fasilitointiprosessin viitekehys suomalaisessa kontekstissa sekä tunnistettiin kansallisen fasilitointiohjelman pääpiirteet.

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1 INTRODUCTION

In recent years, sustainability has become increasingly important concept as global resources become scarcer and changes in climate are becoming more and more noticeable. Human activities show dominance in accelerating these issues. According to the National Intelligence Council (2012), with ongoing global megatrends, in 2030 global population will reach 8.3 billion people while the demand for food, water and energy will grow by 35, 40 and 50 percent. Today humanity uses the equivalent of 1.5 Earths for providing our resources needed and absorbing our waste. United Nations moderate scenarios suggest that if current trends continue, by the 2030s humanity needs the equivalent of two Earths to support us (Figure 1). (Dyllick & Hockerts 2002; Global Footprint Network 2013; IPCC 2013; European comission 2012a)

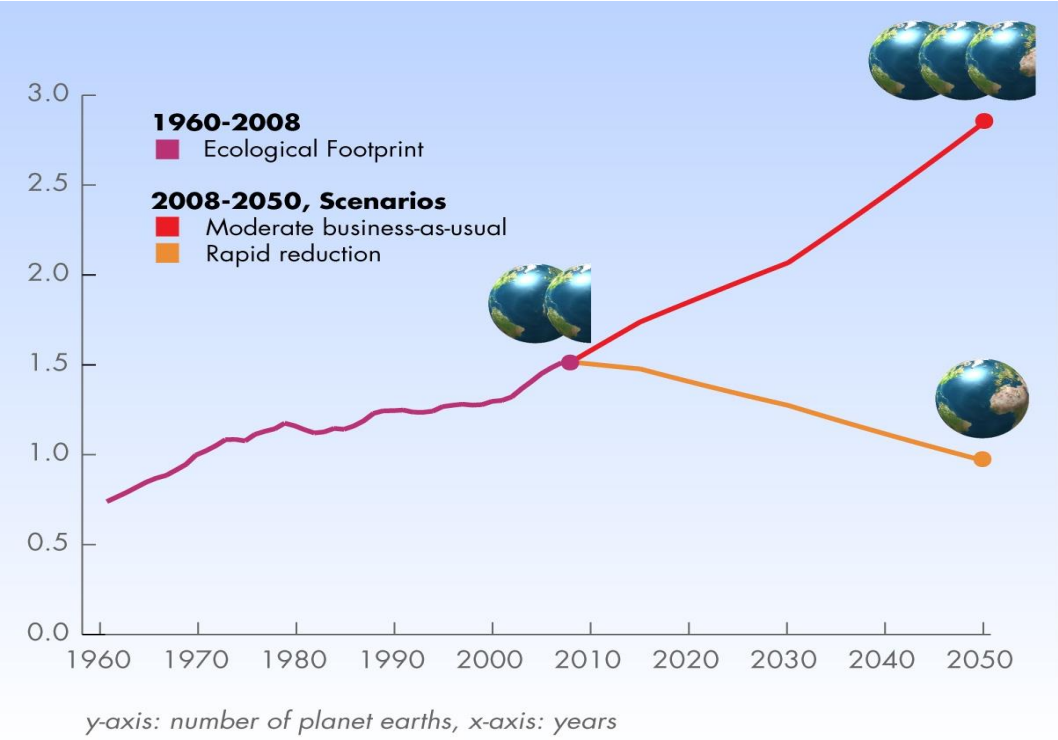


Figure 1. Global ecological overshoot (Global Footprint Network 2013)

As a result of resource scarcity, prices of many key resources have increased significantly. Due to this and pressure from customers force companies to further

streamline their processes in order to utilize resources more efficiently. To create a product, resources are needed for extracting raw-materials, transportation, primary and secondary production and distribution. If a product or material is disposed, so is the energy that has been used to produce it. A dramatic example of this is aluminum can where 95 percent of the energy that went into producing it, can be retained if recycled instead of disposing. Thus it is essential companies to move towards cyclical production models with better recycling and use of waste and side streams of their production. However, we need new policies in the management of resources as well. This brings us to eco-industrial networks which address these issues in close symbiotic relations between companies from different industries in order to decrease the environmental load but also to improve overall efficiency in companies thus enhancing the profitability. (Chertow & Ehrenfeld 2012; Van Ha et al. 2009, Chertow 2008)

This research takes a deeper look into eco-industrial networks that includes concepts of green supply chains and industrial symbioses. The research aims to shed light on the developing and facilitating processes of eco-industrial networks and examine the key promoting factors for further development in Finland. Combining the extent literature research and empirical data, the goal is to identify different milestones and build a roadmap with different actors for this development process.

1.1 Background of the study

This Master´s thesis is a part of the DemaNET research project funded by the GreenGrowth programme within the Finnish Funding Agency for Technology and Innovation (TEKES). The project is carried out in collaboration between Lappeenranta University of Technology, Technical Research Centre of Finland (VTT) and University of Jyväskylä. The goal of the research project is "to create future preparedness and knowledge for the Finnish industry about business concepts and networking models that advance de-materialization." (VTT 2014)

The project examines concepts and networking models that possess potentials in creating a major shift towards dematerialization requiring a radical change in current industrial production and design logics. The studied concepts include remanufacturing, strategic eco-industrial networks and sustainable business models whereas this thesis focuses on eco-industrial networks. (VTT 2014)

1.2 Objectives and research questions

The aim of this thesis is to find out ways how to support emerging eco-industrial business networks in Finland. The theoretical ground for this research is built by examining existing literature in the fields of eco-industrial networks and network orchestration. Combined with empirical research, the goal is to create an understanding about the case situation and knowledge to solve research problems. Table 1 exhibits the research questions.

Table 1. Research questions and objectives

	Research question	Objectives
1.	How business networking aiming to sustainable use of resources and reducing environmental load can be supported?	To identify main promotional activities to create more supportive context for this development.
2.	What phases and actors does active facilitation of eco-industrial networks include?	Build a framework of facilitation process in Finnish context.
3.	What kind of operating model for facilitation actions would be most eligible in the case of Finland?	To identify main characteristics of nationwide facilitation programme.

The first research question aims to identify different actions to support the development of eco-industrial networks in Finland. To tackle this problem, first different key factors affecting in the development process. These success factors and challenges work as a base in building propositions for corrective measures in order to create more supportive context for companies to start developing these concepts in their operations.

The second research question examines further the facilitation process and aims to identify the usual development path and stakeholders affecting in each step. The objective is to build a framework around the process. Although there are few existing frameworks found in the literature, this model examines the process from Finnish context.

The third research question continues from the previous questions and focuses on building a proposition of nationwide facilitation programme in Finland. The aim is to identify the main characteristics for an effective programme that would lower the threshold for companies and thus further support the development of eco-industrial networks.

In addition, one significant goal of the present research is to build awareness about concepts under study. The empirical data for research questions comes from interviews conducted in this study. As the nature of the studied concepts, the research is not restricted into any specific industry.

1.3 Structure of the study

This chapter describes the overall research process and the structure of the study. The structure including inputs and outputs is presented in the Figure 2. In addition, brief overview of each chapter is being presented in the following.

Figure 2. Structure of the thesis

Chapter One contains introduction of the study including the background and research questions. The aim is to explain the motives of the study and describe the research process in brief. The next two chapters focus on the literature overview of the area under study.

Chapter Two introduces eco-industrial networks. Two different forms of eco-industrial networks are being presented; green supply chains and industrial symbiosis. In the present study, these two concepts are referred as the main concept of eco-industrial network although industrial symbiosis is under special attention. This provides the background for the study and gives logical transition to the next chapter.

Chapter Three introduces the concept of network orchestration. The objective is to give the reader an understanding about business networking and network management. In addition, the chapter examines network orchestration from the eco-industrial network point of view.

Chapter Four describes the research methodology including case study method and different forms of interviews. The chosen interview method is also justified. In addition, the content analysis conducted in the study is presented along with the description about data sources.

Chapter Five and *Six* presents the detailed research findings gained from the empirical data. Chapter five includes the first research question about determining the main promotional activities for the development of eco-industrial networks. Chapter six focuses on the second and the third research questions of building a framework around facilitation process and identifying the main characteristics of nationwide facilitation programme suitable for the Finnish context.

Chapter Seven presents the conclusions that can be made based on the empirical research and the literature overview. The chapter contains the answers to each of the research questions. Also the reliability and validity of the research are assessed. Finally, the propositions for future study are being made.

2 ECO-INDUSTRIAL NETWORKS

During the last decades, industrial clustering has become a powerful way for local manufacturers and traders to change the balance of market forces and entering global markets. This consists of geographical agglomerations of companies that produce same or related products thus creating a network of service providers and component manufacturers nearby. This way companies can reach a mutual benefit that is overall greater than the singular benefit each company could achieve alone. It is also notable that environmental issues have varied from reactive concerns to legislation and regulatory pressures to more proactive concerns that include improving organizational competitive advantage and environmental image (Sarkis 2012). (Dimitrova et al. 2007)

From the sustainable development point of view, the most important type of industrial cluster is the "eco-cluster" where a group of businesses can be geographically separated while still working together to minimize the impact on the environment. The wider concept of industrial ecology has emerged as a new multi-disciplinary field at the nexus of environmental science, engineering, business and policy (Chertow 2008). It focuses to be a potential guide to create opportunities for improving environmental and business performance and for restructuring the industrial system to become more sustainable. Basically industrial ecology intends to transform the industrial system by learning from natural environment and its functions. In natural system, all of the components are integrated and the cycle is isolated were no waste is produced (Lambert & Boons 2002). (Elabras Veiga & Magrini 2008; Dimitrova et al. 2007)

Industrial ecology operates at three levels (Figure 3): global level, inter-firm level and individual facility level. The inter-firm level is on the focus of this study. Eco-industrial parks are considered as concrete realizations of the industrial symbiosis concept and both terms are used in the literature, whereas we prefer the latter. (Chertow 2000; Jacobsen 2006)

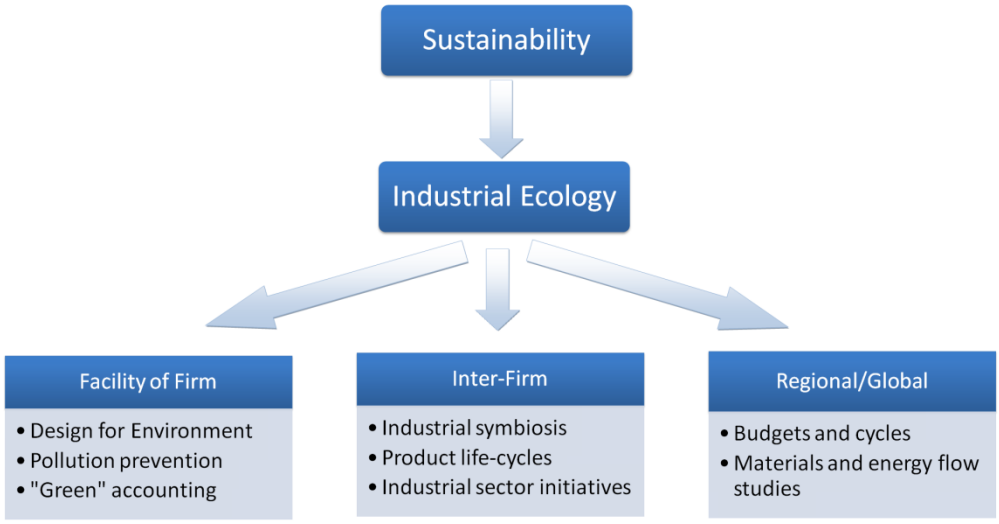


Figure 3. Industrial ecology operates at three levels (modified, Chertow 2000, p. 315)

In this study, we aim the focus into two types of eco-industrial networks. These are sustainable or green supply chains and industrial symbiosis whereas the latter one is under special inspection. Green supply chain management was selected also to this study because of many similarities to industrial symbiosis and as Tudor et al. (2007) and Sarkis (2012) state, green supply chain management is essential when developing effective industrial symbiosis. These two concepts are described in more comprehensive fashion in the following chapters.

2.1 Green supply chain management

Supply chain management has traditionally been in the limelight when improving company efficiency and there are extensive studies available in this matter. Inter-organizational relationships have gained significant importance and have caused companies building competitive advantage by management of their supplier and customer partnerships and networks. Also in the literature of supply chain management, the importance of cooperation and integration among partners is recognized. Close interaction between participant companies can ensure faster

cycle times and smaller product batches thus resulting significant value. (Bansal & McKnight 2009; Sarkis 2012)

Although conventional supply chains and industrial symbiosis both present inter-organizational relationships based on product flows, they also have significant differences. Whereas industrial symbiosis reuses, recycles and reprocesses by-products in business networks, conventional supply chains target to reduce waste within manufacturing processes and re-use end-of-life products. Furthermore, as the emphasis on supply chain research is waste reduction in a company, industrial symbiosis addresses waste reduction goals over the entire business network. (Bansal & McKnight 2009)

In addition, one of the key differences between conventional supply chains and industrial symbiosis is in the coordination mechanisms between companies, whereas the latter emphasizes community, cooperation and deep symbiotic connectedness, supply chains are coordinated through information exchanges such as orders, forecasts, marketing and inventory information by the central company. Furthermore, participants of industrial symbiosis are more likely to uncover innovative and mutually beneficial responses to external threats because of the rich information exchanges and personal connections. Also, supply chains are rarely restricted by geography, often sourcing raw materials from the least expensive global supplier and selling products worldwide while industrial symbiosis is often characterized with close geographic proximity. (Bansal & McKnight 2009)

The integration of environmental issues within conventional supply chain management has evolved into a separate and growing field of research. In a sustainable supply chain or “green supply chain”, financial and environmental goals are aligned and sustainability can be seen as an integral part of one´s business and is incorporated in every aspect of the supply chain. Carter and Rogers (2008, p. 368) define sustainable supply chain management “as the strategic, transparent integration and achievement of an organization´s social,

environmental and economic goals in the system coordination of key interorganizational business processes for improving the long-term economic performance of the individual company and its supply chains". Central actors tend to seek for novel partners to bring new knowledge and opportunities into the chain. This kind of collaboration creates unique value to the product and service offerings, which protects the entire supply chain from commodity traps, enhancing financial value to the central company and suppliers. (Pagell & Wu 2009; Sarkis 2012)

The traditional view of supply chains describes them as linear flows of physical goods, information and funds between companies and end users where physical goods flow downstream, funds flow upstream and information on inventory and forecasts flow both ways. Figure 4 provides an overview of the central activities and relationships in a green supply chain with the focal organizational unit at the center. (Bansal & McKnight 2009; Sarkis 2012)

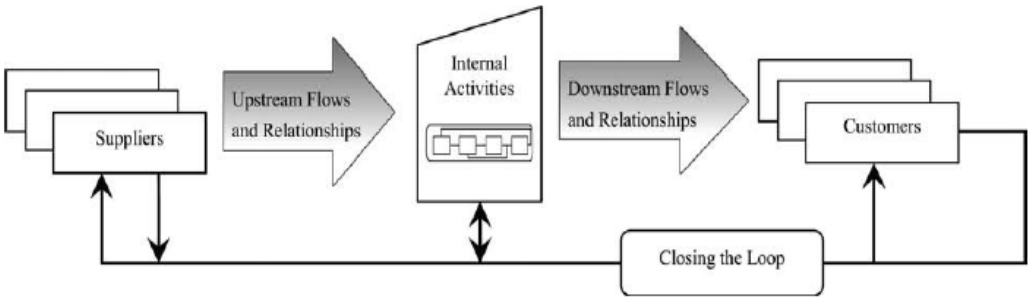


Figure 4. A green supply chain diagram with stages and relationships (Sarkis 2012, p. 204)

Upstream flows, relationships and activities include purchasing and procurement functions. Under these functions can be added outsourcing, vendor auditing, management and selection, supplier collaboration and supplier development activities. In addition, each of these upstream activities can be expanded to have greening components. Internal organizational supply chain activities are related to production and operations management activities and can also include activities such as research and design, quality, inventory, materials and technology

management where an organization could influence environmental characteristics. (Sarkis 2012)

Activities and functions in downstream may include outbound logistics, marketing, distribution, packaging and warehousing which are utilized by downstream customers. As Sarkis (2012) points out, a significant pressure for enhancing environmental performance comes from external groups and diffuses upstream the supply chain.

In "closing of the supply chain loop" approach, activities have been extended to include reverse supply chains and to utilize end-of-life materials that will eventually be consumed again in the system with for example reusing, recycling or remanufacturing. These closed-loop relationships may be direct between the organization, its suppliers and customers, or internal loops between suppliers, customers and within the organization. Thus the production of waste is aimed to reduce on every step of the process through better process and product design. (Sarkis 2012)

2.1.1 Triggers for adopting Green Supply Chain Management

Globalization has resulted wide business networks and working with huge amount of different suppliers to get raw materials and preliminary products (horizontal supplier structure) and these suppliers often depends on a multilevel supplier chain for their own production (vertical supplier structure). (Koplin et al. 2006)

Thun and Müller (2010) characterize the development of green supply chain management as mainly market driven while customers and competitors are seen as important drivers over the government. Although there seems to be great potential for improvements in green supply chain management, according to Thun and Müller (2010) they can be very difficult to obtain and often fulfill only legal

regulations and environmental protection, rather than further competitive advantage and cost savings.

Koplin et al. (2006, p. 1053) identified two triggers: “1) focal companies are held responsible for environmental and social problems caused by their suppliers, which become more and more important as 2) an increasing share of value is created at the supplier level”. In response, companies have to find ways to incorporate sustainable environmental and social aspects into their supply chain management.

Koplin et al. (2006) describe two different forms of environmental supply chain management: 1) Greening the supply chain which cover the integration of environmental criteria/standards into product and production related decisions inside the whole supply chain, 2) Product-based green supply which focus on the optimization of the environmentally compatibility of the purchased products. Thus purchasing functions inside the focal company is the key action to search for, evaluate and monitor suppliers. In the case of the integration of environmental standards into every purchasing decision, further information about the environmental performance of suppliers is required. In this, standardized environmental management systems such as ISO 14001 are helpful to ensure certain criteria are being used by the supplier. The second major option about greening of the product regards the whole life cycle. Thus purchased products can be improved by replacing it by other more environmental-friendly product. (Koplin et al. 2006)

2.1.2 Case example - Ford

Traditionally transaction costs have presented a limiting factor while making supply chains more flexible and global. The cost accumulated in coordinating with partners and transporting products and information around the world was more expensive than keeping the manufacturing within a single area or a factory.

But since globalization, improved communications, computing and low-cost shipping reduced significantly transaction costs and supported the development of so-called borderless manufacturing. (Kleindorfer et al. 2009, pp. 13-14)

Back in the day, Henry Ford set up his famous assembly line for cars near Detroit, the most efficient way was to put everything under the same roof. After this, companies such as Toyota put their suppliers outside the gates, thus still the suppliers were geographically located on the same area but they were separate companies which gave leverage and possibility to focus more on the core competencies. Later Dell and other companies engaged in global sourcing, purchasing components from Asia. Further on, the Earth has "gone smaller" and today the phrase "just outside the factory" can mean practically anywhere on the planet. A great example of this can be seen Boeing´s 777 airplane which is assembled from three million different components produced by more than 900 suppliers from 17 countries around the world. (Kleindorfer et al. 2009, pp. 14-15)

2.2 Industrial Symbiosis

Based on the framework of industrial ecology, the sub-concept of industrial symbiosis demands resolute attention to the flow of materials, services and energy through local, regional and global economies (Chertow 2000). The concept of industrial symbiosis was originally introduced be Lowe and Evans (1995) on their research on self-organized industrial complexes where companies in different industries exchanged material flows on a large scale. The aim of industrial symbiosis is to minimize an industry´s impact on the environment by creating so-called closed cycles (Figure 5) of material and energy use within the industrial system (Posch 2010). Chertow (2007, p. 12) defines the concept of industrial symbiosis as: "Engaging traditionally separate industries in a collective approach to competitive advantage involving physical exchange of materials, energy, water, and by-products. The keys to industrial symbiosis are collaboration and synergistic possibilities offered by geographic proximity".

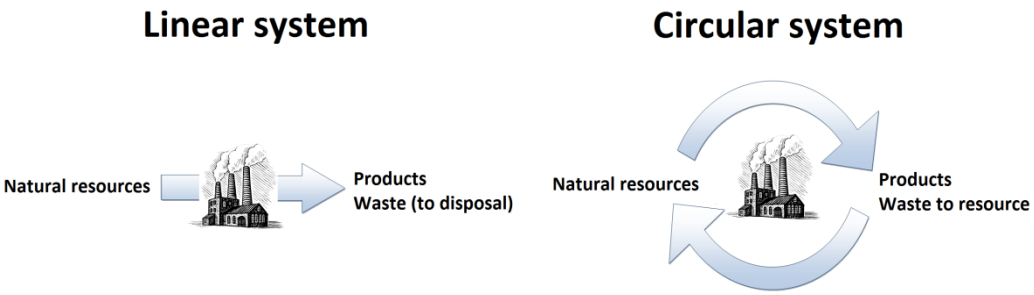


Figure 5. Circular industrial system (modified, Laybourn & Morrissey 2009)

However, as Ashton (2008) points out, this collaboration does not focus solely to physical materials, but companies can also share different ancillary services, such as logistics, waste collection and management utilities like different facilities and wastewater treatment (Ashton 2008). Chertow (2007) further suggest a 3-2 heuristic as a minimum criterion for industrial symbiosis concept where at least three different entities must be involved in exchanging at least two different resources. This model begins to reorganize complex relationships rather than linear one-way exchanges. A simple example of this is a wastewater treatment plant which provides cooling water for a power station and the power station supplies steam to an industrial user. (Chertow 2007)

A numerous studies can be found in the literature about how industrial symbioses emerge and how one can effectively enhance the business environment to nurture this development. Kilduff and Tsai (2003) distinguish two separate processes in network change or so-called trajectories: goal-directedness and serendipity. These processes differ fundamentally in operation structural dynamics whereas the latter describes process that involves connections through coincidences and capitalizes on opportunism in the absence of overarching goals (Kilduff & Tsai 2003). Furthermore on the industrial symbiosis point of view, Boons et al. (2011) argue that industrial symbiosis is best conceptualized as a process and can be divided into two forms of development: designed industrial symbiosis network and unplanned or emergent industrial symbiosis network. Designed industrial symbiosis networks refer to cases where an authority, such as governmental

organization is responsible for designing an eco-industrial park and locating suitable industrial companies there (Ryynänen & Patala 2013). Paquin and Howard-Grenville (2012) suggest a closely related approach to designed symbiosis referred to as facilitated industrial symbiosis, where the network is created around already existing business relations between industrial companies and where a coordinating organization is in charge of developing the network by sharing knowledge on new opportunities for industrial symbiosis.

The second main form, emergent industrial symbiosis networks refers to self-organizing systems where industrial symbiosis relations are gradually uncovered from existing business relationships. Also the awareness of the environmental benefits is spread in the network, leading to the formation of common goals and norms of the network. Especially emergent industrial symbiosis networks are often characterized by socially embedded relations between participants with similar values, leading to a community that enhance eco-innovation through knowledge sharing (Lombardi and Laybourn 2012; Ashton 2008; Ryynänen & Patala 2013).

There are many implications found in the literature that industrial symbiosis requires additional conditions to be fulfilled beyond the technical and economic feasibility of exchanges and many of these cases emphasize the social aspects. According to Paquin & Howard-Grenville (2012) while studying different concepts of the development of industrial symbiosis, in each model industrial symbiosis matures as trust and shared norms of interaction governing exchanges develop. In addition, it seems that opportunities for more complex exchanges and collaboration increase as these norms evolve. (Paquin & Howard-Grenville 2012; Boons & Spekkink 2012)

Boons and Spekkink (2012, p. 62) summarizes five factors that are proposed to be relevant in providing enabling conditions for industrial symbiosis to emerge:

1. *the need for a learning process and a strategic vision*

2. *issues related to the diversity of involved actors and its consequences for connectance and interdependency*
3. *the requirement of trust and ways to foster it*
4. *the presence of anchor tenants or coordinating bodies and the roles they can play in providing information, education, and a platform for communication*
5. *the presence of an enabling context, which may be defined in terms of policies, regulations, and other institutions, but also in much broader terms such as cultural, structural, spatial and temporal embeddedness (Boons & Howard-Grenville 2009)*

In empirical studies of the transmission mechanisms, policy programs from governmental agencies are generally referred to as a major conditioning factor. In the case of China, the influence of policies is considered as the most evident as a coercive mechanism. Also the United Kingdom is very well known of their public policies in the form of National Industrial Symbiosis Programme (NISP) and policy waste management, but there the government act as a facilitator, funding the activities of NISP. (Boons, Spekkink & Mouzakitis 2011)

The three main forms of industrial symbiosis mentioned above are being described more specifically in the next chapters. They are also demonstrated with the most famous business cases in order to get more comprehensive picture.

2.2.1 Self-organized industrial symbiosis

Kilduff and Tsai (2003) state, that when a network change is driven by serendipity, trajectories of the network develop haphazardly from the interactions of individual actors. These actors form ties or partnerships based on their own interests without guidance from any central network agent concerning goals or strategy. They also describe the serendipitous network process as dyadic matching

in an evolutionary process of random variation, selection and retention. (Kilduff & Tsai 2003)

When serendipitous network process, paralleling those of self-organizing industrial symbiosis, drive network evolution, companies are motivated to join and develop particular network ties to achieve individual rather than collective goals such as cost reduction, business expansion, revenue enhancement and to ensure the availability of a critical raw material. The initiative to begin resource exchange faces a market test and if successful, others may follow if there is a mutual self-interest. Thus these networks generally grow slowly but evolve relatively long-lasting, multi-connected networks where early entrants and central companies may influence interaction norms and hold privileged structural position (Powel et al. 2005). (Chertow 2007; Paquin & Howard-Grenville 2012)

As Sterr and Ott (2004) state, stable eco-industrial regions seldom emerge from ambitious planning by regional authorities, but rather develop form a solid foundation of comprehensive information transparency. In addition, they suggest that industrial symbiosis processes can be economically viable despite of strict environmental laws, i.e. without well-adjusted company internal regulatory requirements if the present market conditions are favorable (Sterr & Ott 2004; Behera et al. 2012).

The first and the most well-known example of self-organized industrial symbiosis is located at Kalundborg, Denmark. Over the decades, a number of independent energy and waste exchanges between collocated companies and the local municipality evolved into the area resulting in economic benefits for all the participants of the network (Figure 6). The process was driven by companies´ individual business interests. The main drivers in the process were potential cost reduction from waste avoidance/processing and savings on virgin raw material. In addition, revenues from by-products could also be earned in some cases. Further advantages of this kind of intercompany recycling activities were seen in the formation of stable and secure business relationships. (Posch 2010)

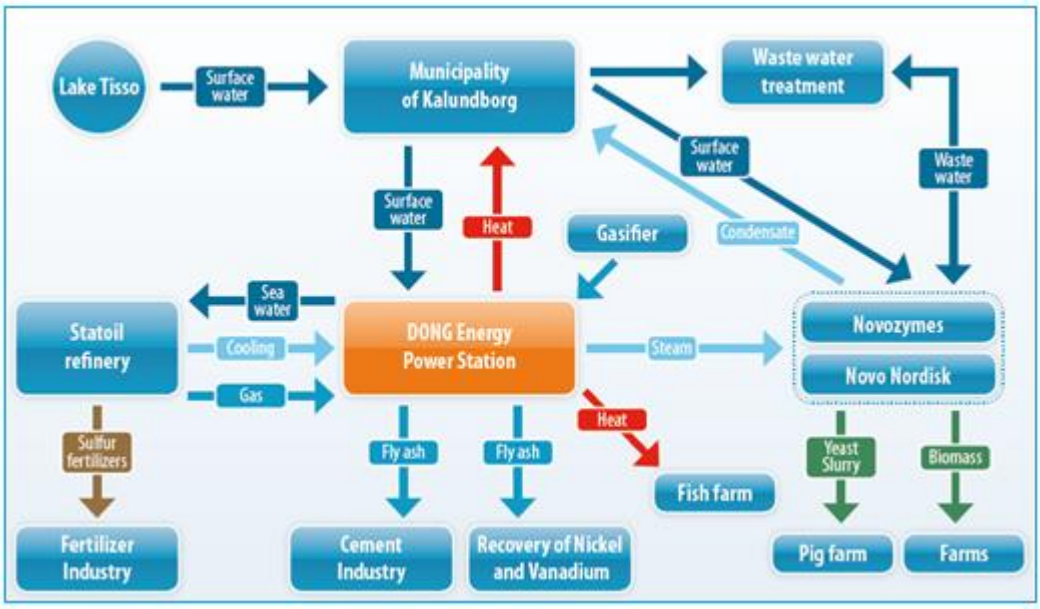


Figure 6. Simplified model of industrial symbiosis at Kalundborg (EU Commission 2012b, p. 38)

Many analysis of the Kalunborg´s successful industrial symbiosis have emphasized the importance of short mental distance, trust, openness and communication among company managers (Chertow 2000; Jacobsen and Anderberg 2005; Ashton & Bain 2012). Jacobsen and Anderberg (2004) concluded three factors that contributed the success in Kalundborg: 1) existing network of formal and informal relationships between industrial actors and regulatory authorities, 2) Danish waste legislation is developed at the municipal level and is based on a negotiation process with local companies instead of fixed technological and emissions standards, 3) Danish government has introduced several regulations and economical instruments, such as landfill tax, that aim emission reductions, pollution control and resource efficiency. This context made industrial symbiosis as a viable solution in companies´ waste management. (Costa & Ferrão 2010; Costa et al. 2010)

Chertow (2007) points out two fundamental conclusions concerning the Kalundborg case. First was the fact that the business network emerged

spontaneously from the desire to achieve certain goals and to perform in the market. Secondly, once a revelation of network was made, a coordinative function was found to be helpful in further developing the network. This suggests that different forms of development are not entirely mutually exclusive. (Chertow 2007)

2.2.2 Designed industrial symbiosis

Numerous scholars have discussed and highlighted the success of self-organized symbiosis networks. As mentioned, self-organized inter-organizational networks tend to build upon pre-existing ties. Although existing literature argue that these networks are more instrumentally assembled, according to recent studies in the field of supply chain networks, research consortia and innovation networks, Paquin and Howard-Grenville (2013) suggest that also intentionally formed inter-organizational networks are pervasive and can be robust in their structure. (Paquin & Howard-Grenville 2013; Mirata & Emtairah 2005)

Kilduff and Tsai (2003, p. 92) state that a goal-directed network development process exhibits purposive and adaptive movement towards an envisioned end state and new members are attracted to the network by the promise of goal-fulfillment. Therefore pre-selection process is needed to screen possible members on the bases of fit with the goals of the network. One of the significant features of goal-directed network change is the emergence of an administrative entity that acts as a broker (or an orchestrator) in order to plan and coordinate the activities of the network as a whole. The coordinator tends to hold disproportionate influence over the network´s structure and norms of engagement. They influence the network´s common goals, shape collective norms and play significant role in deciding whether and how particular other participants join the network (Doz et al. 2000; Powel et al. 2005). In practice, serendipitous and goal-directed network development processes are not fully exclusive of each other. (Kilduff & Tsai 2003, 89-92; Paquin & Howard-Grenville 2012)

On form of intentionally developed industrial symbiosis is designed or planned industrial symbiosis, where there are clear objectives to form new eco-industrial park by relocating potential companies into selected area. This development is often coordinated external authority such as governmental organization. The development can be further divided into two groups according to the baseline of the area: brownfield and greenfield development. Greenfield development refers to cases where new eco-industrial parks are planned from scratch whereas in brownfield development aims to redevelop current area by bringing complementary companies into the area that have potential symbiotic relations with current companies. (Sterr & Ott 2004)

A great example of a larger scale designed industrial symbiosis practices can be found in China where the development of eco-industrial parks has been rapid in the recent years. In China, the thrust for developing industrial symbiosis reflects the severe conflict between natural resource depletion, heavy environmental pollution and the continuing increase of population. China´s national leadership has understood that continuing the development in the traditional linear manner is simply no longer feasible. At the end of the 1990s, China promoted eco-industrial parks as a significant component of implementing the strategy of the Circular Economy which was first introduced by the State Environmental Protection Administration as an environmental strategy. Also, in 1st January 2009, the Law for the Promotion of the Circular Economy came into effect, which is considered to be the first in the world to make circular economy a national strategy of social and economic development. The law provides a framework within which incentives and disincentives are being developed to promote companies and municipalities taking eco-industrial initiatives. (Zhang et al. 2009; Mathews & Tan 2011)

In order to promote this development, two governmental agencies, the Ministry of Environmental Protection and the National Development and Reform Commission are engaged in promoting national pilot programs of eco-industrial

parks. The initiatives are taken at three levels, where first targets single enterprise or group of enterprises, enhancing energy and resource efficiency through cleaner production. Companies are either required or encouraged to conduct cleaner production auditing according to their pollution generation. In addition, companies are encouraged to design more sustainable products and adopt cleaner technology in their manufacturing processes. (Zhang et al. 2009; Mathews & Tan 2011)

The second level targets cluster level or supply chain level, where a group of collocated companies share streams of resources and energy to enhance their collective energy and resource efficiency. The development of these eco-industrial parks are planned and coordinated by environmental professionals, local governments but some clusters are developing it proactively. (Mathews & Tan 2011; Yuan et al. 2006)

The third level involves a whole city or a municipal area where recycling and interconnected processes are supported by economic and administrative incentives. In addition, failures to recycle and to make industrial connections are penalized. At this level, both sustainable production and consumption are key elements. One of these designed eco-industrial parks is located in Guigang (Figure 7). (Mathews & Tan 2011; Yuan et al. 2006)

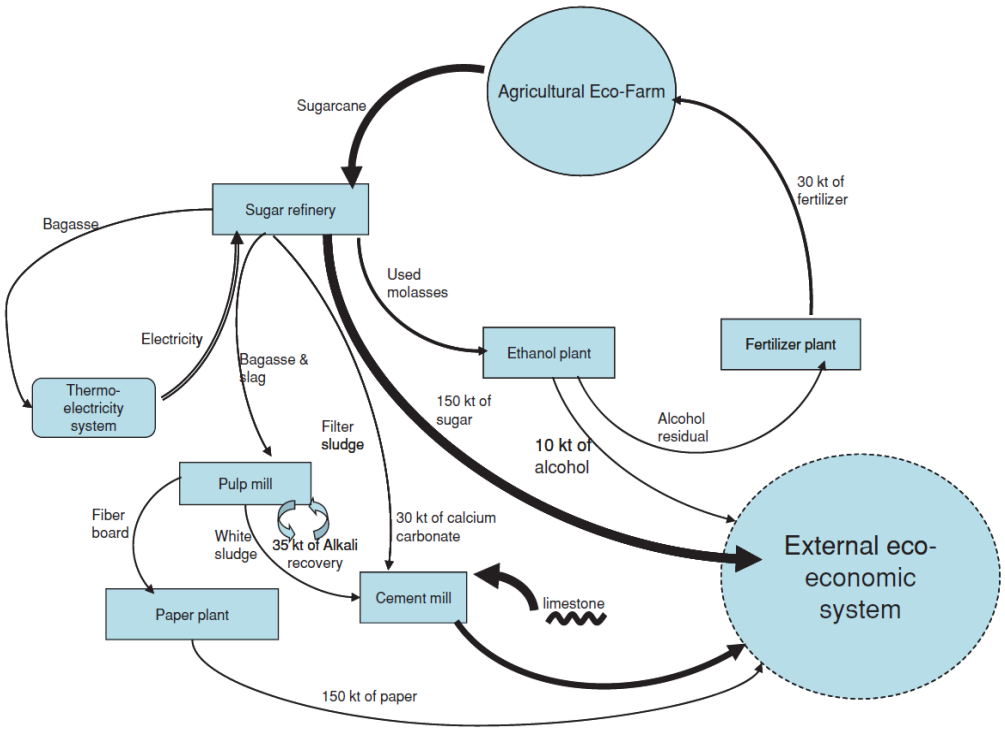


Figure 7. Industrial symbioses in the Guitang Group, Guiang City (Mathews & Tan 2011, p. 440)

Over the years, the park has been built around the Guitang Group sugar manufacturing company which have bring many new facilities and synergies into the area. The sugar process is linked to an ethanol production facility which in turn alienates its waste for a fertilizer plant where it recycles back to the sugarcane farms. Another main side stream chain is concerned with paper, where the crushed sugar cane is used as a raw material of pulp, which is then turned into paper. Furthermore, bagasse is also used as fuel for the production of heat and power, which is used in other industrial processes of the area. As the businesses expand, group extends its value chain into the surrounding economy which can be seen as the essence of circular economy evolution. (Mathews & Tan 2011)

2.2.3 Facilitated industrial symbiosis

Boons and Baas (1997) claim, that evolution toward industrial symbiosis is not a spontaneous process, but rather requires deliberate and intentional action. Also the

majority of current operational industrial symbiosis networks are results of organic developments, driven by companies´ individual business interests mainly economic prerogatives. However, there is general assumption that there are various other regions where the significant potential for gains through inter-organizational synergies are present or could be created, but remain unexploited due to the lack of necessary production processes or organizational settings. This motivates many ongoing programmes around the world goal in developing new industrial symbiosis networks. These voluntary instruments can enhance the information availability, facilitation and assistance for companies to get involved of industrial symbiosis development projects and act as an active orchestrator among companies in local or regional areas (Costa et al. 2010). (Mirata & Emtairah 2005)

Facilitation differs from designing industrial symbiosis by the fact that facilitator aims to generate new symbioses among companies in a specific area whereas designing symbiosis requires relocating potential companies and further redevelopment of the area. Facilitator can be either external coordinating organization or the hub firm of the network which sees the existing potential and takes a proactive approach in developing relationships.

An example of large scale facilitation efforts of industrial symbiosis can be found in the United Kingdom and their National Industrial Symbiosis Programme (NISP). It was launched in April 2005 and became the first national-level industrial symbiosis development program in the world. NISP was developed “to help businesses in various sectors and of various uses come together to find uses for unwanted materials, aiming to divert significant waste loads from landfill and produce bottom line benefits for companies through reduced disposal costs and new commercial opportunities, by sharing assets, resources, logistics and expertise” (European Commission 2009). In addition, NISP also identifies export opportunities for those companies that provide solutions through new environmental technologies to pressing environmental issues. (Paquin & Howard-Grenville 2013; Laybourn & Morrissey 2009)

NISP´s funding is mostly based on UK government funds that are addressed for organizations which help companies find ways to remain economically competitive under increasingly stringent environmental regulations. NISP´s performance measures are tied to its ability to create aggregate environmental and economic benefits for example diverting landfill waste and reducing energy consumption through industrial symbiosis projects. The services that NISP offers used to be free for companies but at the moment, due to the cuts of public funding, the programme has introduced membership fees. In 2009 (when the programme was still free for companies) there were over 12,500 companies participating in NISP programme. Members are from all sectors and comprise companies of all sizes, whereas small and medium size enterprises and micros make up over 90% of the total membership. (Paquin & Howard-Grenville 2013; Laybourn & Morrissey 2009)

NISP has a nationally coordinated focus but operates as a contingent of 12 semi-autonomous regional offices across the UK and these offices are working directly with organizations of their regions to identify wastes and by-products for potential industrial symbiosis projects. The regional teams consist of expert practitioners from technological, academic and industry backgrounds across all sectors. Though regionally oriented, offices are regularly communicated across regions to share information and facilitate new projects that cross regional boundaries thus the practitioners´ skills and expertise are available to the entire network. The information system, they have developed, helps with this information sharing but also in resource mapping and identifying potential matches in the facilitation process (Figure 8). (Paquin & Howard-Grenville 2013)

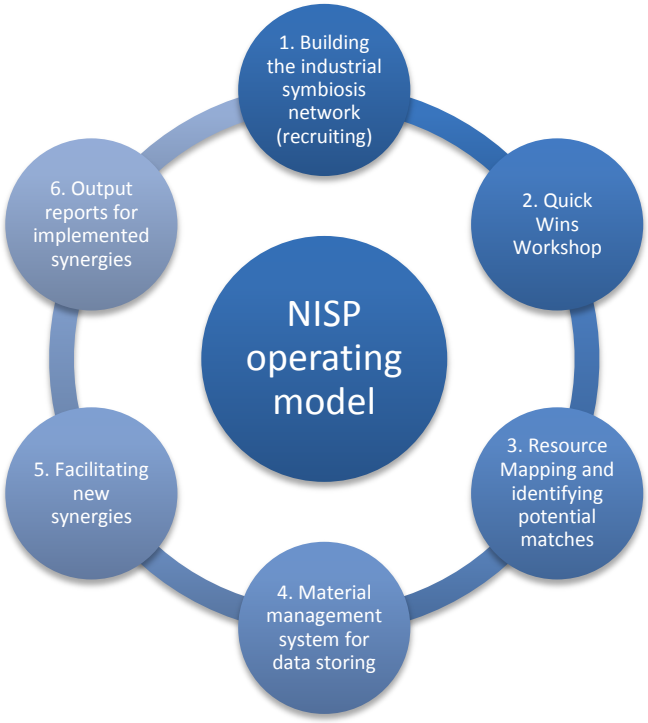


Figure 8. The operating model of NISP (modified Woodcock 2012, p. 7)

Paquin and Howard-Grenville (2012) found three main types of action as the industrial symbiosis network developed in the UK under NISP, which are *conversation*, *connection* and *co-creation*. At the first stage, a strategic view of region´s resources is created and interaction spaces are facilitated to build awareness of industrial symbiosis among potential participants and find potential exchange-partners through workshops and events. These "Quick Wins" workshops provide physical spaces for direct interaction including facilitated information exchange and networking activities around sharing individual companies´ resource needs and available waste and by-products. Organized and run with explicit goal of identifying potential future exchanges, these workshops often generate a large number of potential exchanges. (Paquin & Howard-Grenville 2012; Paquin & Howard-Grenville 2013)

The second stage of the development process includes goal-directed matching that directly connects promising industrial symbiosis partners. A notable distinction to first stage where everyone are invited to share ideas in a serendipitous fashion, the connection is directed explicitly toward bringing specific exchanges to fruition.

The co-creation actions enables further shift in the development of the facilitated industrial network supporting the development of infrastructures around important resource streams and replicating high-value resource exchanges. Because these network development projects are usually extremely work-intensive to facilitate, it has lead to more strategic relationships and deeper involvement with companies. The chosen projects are assessed carefully and often those which have the biggest opportunities and seemed "low hanging fruit" projects are selected at first hand. (Paquin & Howard-Grenville 2012; Paquin & Howard-Grenville 2013)

The success of NISP has accelerated its spreading across the world. Inside the Europe, for example programmes in Romania and Hungary, the European Commission has been financing these projects through its LIFE+ programme, which aims to support the implementation, updating and development of community environmental policy and legislation. (Laybourn & Morrissey 2009)

Whether the facilitated industrial symbiosis network is more feasible development path to network, is quite contradictory in literature. Costa et al. (2010) claim that emerge of industrial symbiosis depends on an enabling context which can be illustrated in terms of cognitive, structural, cultural, political, spatial and temporal embeddedness. They thus consider that self-organization is more feasible strategy for the development of industrial symbiosis. On the other hand, Mirata (2004) argues in his assessment of the NISP that coordinating bodies and governmental policies can foster the development of industrial symbiosis by influencing some of the factors that create the enabling context of industrial symbiosis. Likewise, Costa and Ferrão (2010, 985) propose that an overall context favorable to the development of industrial symbiosis "can be shaped through an interactive process wherein the government, industries and other institutions are guided towards aligning theirs strategies in support of collaborative business strategies in resource management". This process is seen as the middle-out approach. (Boons, Spekkink & Mouzakitis 2011)

Furthermore, according to Lombardi and Laybourn (2012) and their experience, facilitation certainly accelerates the identification and completion of business synergies. Chertow (2007) state that a coordinative function is required to support the management of inter-company information flows, play matchmaker for exchange opportunities and provide assistance and coordination in their application. Thus some facilitation activities seem to be feasible when aiming support and further adaption of industrial symbiosis. (Sakr et al. 2011; Lombardi & Laybourn 2012)

As mentioned, one of the main arguments in developing industrial symbiosis is that every participant of the business network gains benefits. In the next chapters, these benefits and possible challenges companies face in the development of industrial symbiosis are described more comprehensively from the companies´ perspective.

2.2.4 Benefits and new business opportunities in industrial symbiosis

A company´s decision to participate in industrial symbiosis is based on favorable combination of information availability, economic attractiveness, technical feasibility, regulatory facilitation and company´s individual motivations (Brand & de Bruijin 1999). Behera et al. (2012) emphasize that the key to the development of any industrial network is that each participant derives a benefit, economic and/or environmental. In addition, the decision to implement a network becomes more difficult when financial criteria is not met, but would rather produce other significant but less tangible benefits that are difficult to incorporate into the standard cost-benefit analysis. They also point out that the development of industrial symbiosis becomes more successful when the companies are motivated by policy instruments such as waste reduction targets and other similar environmental policies. Thus there are companies that practice more proactive environmental management, beyond mere compliance with regulations, in order to gain operational or strategic advantages by reducing operational costs or risks,

or by distinguishing their products and policies from their competitors. (Behera et al. 2012; Ashton 2010)

Mirata and Emtairah (2005) have studied industrial symbiosis networks from the innovation point of view. They argue that industrial symbiosis networks can contribute to nurturing environmental innovation at the local or regional level with stimulating collective problem formulation and definition, providing inter-sectoral interfaces and promoting inter-organizational collaboration and learning keeping the focus towards environmental challenges. Knowledge spillovers and innovation are thought to result from frequent inter-organizational communication and cooperation due to proximity (Ashton 2008). Innovation effects of the industrial symbiosis also seemed to be one of the elements contributing to companies´ willingness to commit to the network. The case-research executed by Mirata and Emtairah (2005) in Landskrona demonstrates that there are considerable potentials to be gained through the exchange of these intangible resources and through collaboration on areas such as environmental management, logistics and personnel exchange. (Mirata and Emtairah 2005; Boons et al. 2011)

Industrial symbiosis can be seen as a part of a business ecosystem, which is made from interrelated value chains, including the actual production companies but also their technology and service providers. Part of these value chains can be related to industrial symbiosis and used to produce more economic value added, while reducing resource consumption and the amount of waste (Figure 9). In addition, with symbiosis thinking, it can be possible to identify business opportunities even where traditional value chains are not able to achieve profitable business. Bansal and McKnight (2009) state that companies engaging in industrial symbiosis identify more comprehensively the materials and resources they process, thus aiming to extract as much value from inputs as possible. (Aho et al. 2012)

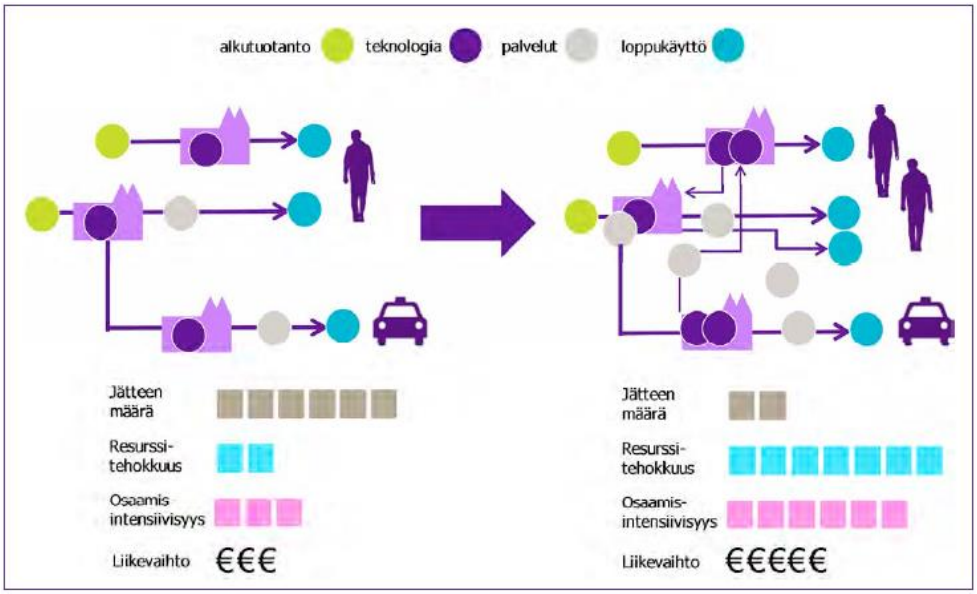


Figure 9. The difference result from industrial symbioses and new business ecosystems (Aho et al. 2012, p. 9)

Jacobsen (2006) suggest that in general, low-value by-product exchanges are often motivated by indirect economic benefits, whereas high-value exchanges are motivated more direct economic benefits that are related to the value of the by-products itself. These indirect economic benefits may be associated with long-term strategic planning and the desire for e.g. increased supply security, operational capability and economies of scale. (Chertow 2007; Jacobsen 2006)

A global market review by Aho et al. (2012) confirms the strength of megatrends and market drivers for industrial symbiosis. In many respects, while market-driven business is just emerging, profitability and market-driveness of industrial symbiosis are likely to increase substantially over the next few years. Resource efficiency solutions can be seen as a great provider of opportunities for market-driven businesses. (Aho et al. 2012, p. 6)

This development has also been noticed by companies. Spinverse, Sitra and Technology Academy Finland (2012) executed a survey on the latest R&D trends, where nearly half of the top 100 R&D investors and some other significant companies in Finland took part of. The survey shows that 68% of respondents

consider resource circulation in their company´s operations or estimate it to be important in the future and over 50% see high value potential in collaborating with other industries. In addition, resource intensive industries such as energy and chemical industries, consider resource allocation to be important to both strategy and operations. Business drivers were considered the most important drivers in the development of industrial symbiosis and over 50% of the respondents see significant value potential in collaborating with other industries. Table 2 concludes the main benefits gained from industrial symbiosis found in the literature review. (Tolvas et al. 2012)

Table 2. Gained benefits from industrial symbiosis according to literature

Gained benefits from industrial symbiosis according to literature			
1	Economic gains	**4**	Distinguishing from competitors
2	Regulatory facilitation	**5**	Innovation and learning
3	Reducing operational risks	**6**	New business opportunities

2.2.5 Challenges in developing industrial symbiosis

Because industrial symbiosis requires close inter-organizational cooperation, this can create also challenges and barriers beyond those of more traditional development projects. These challenges can be divided into four groups: technical, regulatory, business and social issues. (Chertow 2012)

As mentioned earlier, close proximity of symbiotic industrial facilities are one of the enabling factors to foster the development and to avoid large transportation costs and energy degradation during transit. Also, some of the materials need to be further processed to be eligible for one to use it as a raw material. For example the use of organic streams from fermentation process as feed or fertilizer requires assurance that all toxic components are absent and material is safe to use. In addition, some manufacturing processes require extremely specific material compositions, such as in car manufacturing, which makes the material recovery

very challenging. There can also be quality variations which brings its own risks for the manufacturing process. (Chertow 2012)

Costa et al. (2010) point out the waste definition of European Union as a barrier for the development of waste/by-product reuse as raw materials. They state that government contribution should take form of an integrated set of policy instruments that guide markets towards reuse and recycling, and foster the collaboration between companies. Related to governmental programmes, withdrawing of funding can bring the risk that companies will no longer participate when the service is no longer free for them. To prevent this, Costa et al (2010) suggest that these programmes should be implemented and managed in collaboration with companies, including the development of the funding strategy, and it should rely on strong social networking to stimulate trust and interaction. (Costa et al. 2010)

Salmi et al. (2012) state, the challenges in developing industrial symbiosis around the Gulf of Bothnia, arise from the current models of residue governance, which are limited to a market driven model and a public-administrative model. Public administration has not been able to promote enhanced waste reuse. Furthermore, changes in environmental permits aimed at turning wastes into by-products are often long and heavy processes which may turn too expensive for the company trying to sell a novel waste-based product. If a waste material needs to be processed prior to use, its status may prove hard to change from waste to by-product. Thus they state that "faster and better mechanisms determining waste-by-product divide would significantly facilitate the reuse of wastes in production" (Salmi et al. 2012, p. 123).

In Finland, company can apply for environmental permits through a process where the environmental authority and the general public evaluate the application. If there are no complaints against the permit application, the environmental authority can issue the permit without court decision. However, if there are any complaints during the evaluation phase, the permit process is transferred to an

administrative court. If further complaints occur after the court decision and after the applicant has revised the application, the process is transferred to the Supreme Administrative Court which often turns to the Court of Justice of the European Communities for further statements and recommendations. As can be seen, this whole permit process tends to be a time-consuming and expensive for all actors involved. Rautaruukki´s application to remove the waste status of slag and scrap metals is a good example of a massive permit process, which lasted from 2002 to 2008. The key issue in this case was the difference in interpretations of the environmental authority and the company on the Supreme Administrative Court´s criteria for waste. The environmental authority considered slag and scrap metal generated at the steel mill as waste because the need for further processing of these materials prior to reuse. On controversy, the company did not see these materials as waste because they are mart of a continuous production process and never been discarded. (Salmi et al. 2012)

As mentioned earlier, economic benefits illustrate the greatest enabling factor in the development of industrial symbiosis. Thus it is reasonable to assume that companies do what is in their economic interest and, if through incremental improvements or broader scale process design it is possible to eliminate waste in a cost-effective manner, rational companies will do so. Generally businesses address non-product problems at the lowest level cost and with the least use of company´s resources. Thus the time and desire to work with others, especially concerning low-value wastes is not included to company´s goals and strategy. Another interesting challenge Ashton (2008) points out is that subsidiaries of multinational companies can be restricted by corporate decisions to set contracts with particular vendors at a global or national level thus making it hard for developing new business relationships. Also the chance for a proposed partner to relocate brings a risk for company building trust and reliant cooperation. In addition, another problem may emerge in achieving the sufficient scale and supply of by-product streams. As the by-product flows are bound to main production and the demand, the availability of the by-product may vary. Also, the overall amount of by-product may be below the profitability to transport or decrease by the

adaption of new improvements in production processes that increases the resource efficiency and decreases the amount of waste generated. (Chertow 2012)

Furthermore, the trust and communication issues can be seen as social challenges in the development of industrial symbiosis. According to Heeres et al. (2004), establishing physical by-product exchanges is not the most important feature in industrial symbiosis development but issues of trust, good personal relationships and cooperation between companies become crucial factors for the initial state of the development. Most of the industrial estates are collections of companies in one location which are socially isolated from each other and this is far from the concept of community. Also connecting to regulatory barriers, liability issues may emerge due to the lack of mutual trust between business partners. Another key social barriers in the adoption of industrial can be seen motivational barriers. The industries and other participants involved must be willing to cooperate and to commit themselves to the development process. (Gibbs & Deutz 2007; Sakr et al. 2011; Chertow 2012; Brand & de Bruijin 1999)

Lastly, information barriers oppose challenges especially at the early stage in the adaption. The lack of theoretical knowledge about industrial symbiosis at a company and community level hinders the development (Romero & Ruiz 2013). As Sakr et al. (2011) state, it is essential to educate the community to disseminate basic principles and successful case studies of eco-industrial networks. Taddeo et al. (2012) highlight the dissemination of information and learning is crucial for both companies and the community in order to create an adequate cultural background for the development of industrial symbiosis. Table 3 exhibits the main challenges and threats in industrial symbiosis networks.

Table 3. Challenges and threats in developing industrial symbiosis according to literature

Challenges and threats industrial symbiosis according to literature			
1	Long distances	**6**	Incentives
2	Material characteristics	**7**	The rank of waste issues in

			companies
3	Regulatory barriers	**8**	Established company procedures
4	Business risks	**9**	Lack of knowledge
5	Lack of trust	**10**	Sufficient scale of by-product streams

In the next chapter, the concept of network orchestration is being introduced. In the end of the chapter, concepts of eco-industrial networks and network orchestration are being combined.

3 NETWORK ORCHESTRATION

Business networks have become more and more important for companies to survive in dynamic and ever tightening market conditions. Inter-organizational cooperation has recently demonstrated significant potential for maintaining and improving competitive advantages along supply chains, across lifecycle stages or via resource exchanges of energy and materials. They also bring access to knowledge, technologies, financial resources and enhanced learning. In the last decades, also the literature of business network has developed greatly and there are numerous studies and theories available about how business networks function. While many inter-organizational networks emerge through serendipitous process without any guidance from central network agent, some networks are intentionally orchestrated by an organizational actor who recruits network members and shapes their interactions. (Chertow 2008; Paquin & Howard-Grenville 2013)

Sakr et al. (2011) state that, cooperation between companies cannot be mandated through policy interventions and regulations but needs to generate over time with assistance of a motivated leader or a "champion". Thus development of eco-industrial networks requires an on-going process of building personal trust and buy-in. This champion can be an individual, company or some other external institution. In the case of successful Dutch eco-industrial parks, companies themselves were motivated to start new development projects with financial and advisory support from the local and regional government and university faculties. Furthermore, Romero and Ruiz (2013) state that this kind of champion or "park manager" could improve the adaptability of the system and speed up the formation of relationships between companies. (Sakr et al. 2011)

Network orchestration is a concept under the strategic network literature that tries to understand the process of assembling and developing an inter-organizational network via set of evolving management actions of a central hub firm (Paquin & Howard-Grenville 2013). Dhanaraj and Parkhe (2006, p. 659) suggest that

network orchestration is “the set of deliberate, purposeful actions undertaken by the hub firm as it seeks to create value (expand the pie) and extract value (gain a larger slice of the pie) from the network”. They also define hub firm “as one that possesses prominence and power gained through individual attributes and a central position in the network structure, and that uses its prominence and power to perform a leadership role in pulling together the dispersed resources and capabilities of network members”.

Actors involved in orchestrating activities have been referred in the literature as hub firms (Jarillo 1988; Dhanaraj & Parkhe 2006), lead organizations (Provan & Kenis 2008), champions or triggering entities (Doz et al. 2000; Sakr et al. 2011), anchor tenants (Agrawal & Cockburn 2003), strategic centers (Lorenzoni & Baden-Fuller 1995) and flagship firms (Rugman & D´Cruz 2000).

As traditionally the focus of core competencies has been at the firm level, since the rise of network organizations, this focus needs to take a broader view. It becomes more evident that the success is less based on the competencies an organization owns but on those it can connect to. Instead of owning a large diversity of capabilities and assets, companies can connect to these smoothly around the globe through connections with its network partners and suppliers. This way companies can create supply chains that stretch wider than ever before. This creates new opportunities to build more flexible internationally operated companies that can be reconfigured very quickly in today´s fast-changing world. (Kleindorfer, Wind & Gunther 2009, p. 12)

One example of this kind of supply chain is seen in the case of Li & Fung Trading. The company can be seen as the leading supplier without owning manufacturing competencies but has a competency in network orchestration that allows the company to draw together manufacturers and other partners into this flexible and highly adaptive supply chain. Let´s say that Li & Fung Trading receives today an order for 100,000 men´s dress shirts. The best place to source the yarn might be Korea, the buttons could come from China and it might be that

the weaving is best done in Taiwan in two different factories to speed the production of the order. In addition, Pakistan might be the best place for the cut, make and trim utilizing three factories to further speed up the production. If the same order came in a month later, this might result entirely different supply chain and production plan. Supposing that Pakistan is facing political unrest at that point, the entire supply chain would be able to shift into another country. In this case, the supply chain is evoked by the customer and the project moves along the best specific path inside a broad network of approximately 10,000 suppliers around the world. This can be done because Li & Fung is a networked organization. Although the fact that it supplies more than US$ 14 billion worth in clothing, toys and other products for the top brands in the US, it does not own a single factory but accomplishes all of this through network orchestration. (Kleindorfer et al. 2009, pp. 12-13)

Although the case example of Li & Fung is about large multinational company, network orchestration opportunities are not limited only to large global companies but can be applied equally to small ones. In Hong Kong alone, there are about 50,000 smaller trading companies that manage regional and global supply chains by doing some form of network orchestration activities, although not as extensively as Li & Fung. New technologies are one of the enabling factors that alleviate companies to participate in networks and engage in networks orchestration. (Kleindorfer et al. 2009, pp. 20-21)

In the next chapters, further examination on network orchestration framework and roles of the orchestrator are being made. In addition, as the importance of social emdeddedness were specifically emerged from the literature as one key factor of the orchestration process, also this was take under more specific examination.

3.1 Roles of the network orchestrator

Dhanaraj and Parkhe (2006) divide the orchestration into three processes that a hub firm must perform: managing knowledge mobility, managing innovation

appropriability and managing network stability. Managing knowledge mobility includes three sub-processes (Table 4) which are knowledge absorption, network identification and inter-organizational socialization. In addition, managing innovation appropriability includes the sub-processes of trust, procedural justice and joint asset ownership. Finally, the sub-processes of managing network stability are enhancing reputation by lengthening the shadow of future and by building multiplexity. (Dhanaraj & Parkhe 2006; Ryynänen & Patala 2013)

Table 4. Framework for orchestrating networks (Dhanaraj and Parke 2006)

Managing knowledge mobility	Managing innovation appropriability	Managing network stability
•Knowledge absorption •Network indentification •Inter-organizational socialization	•Trust •Procedural justice •Join asset ownership	•Enhancing reputation by lengthening the shadow of future and building multicomplexity

In addition Kleindorfer et al. (2009) describe three primary roles network orchestrator plays related to the focus, management and value creation of the company and the network. Each role is the expansion from the role of a manager within a traditional company as seen in the Figure 10. The shift form a manager of a traditional company towards the network orchestrator requires a transition in management from control to empowerment and value creation from specialization to integration. (Kleindorfer et al. 2009, pp. 22-24)

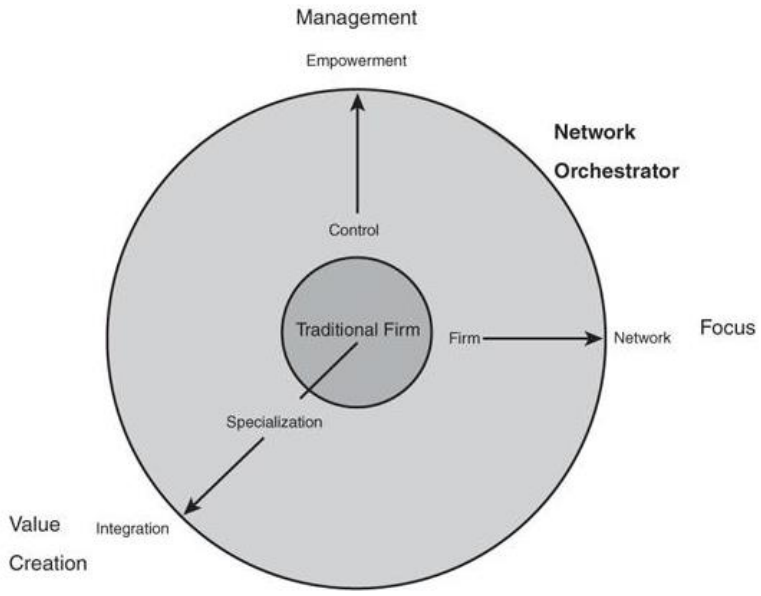


Figure 10. Three roles of network orchestration (Kleindorfer et al. pp. 22-24)

Design and manage networks

In network orchestration the orchestrator needs to shift the focus more from the company into the network. Thus today companies do not compete against other companies but networks are competing against networks. Although two companies can be seen as rivals, the roots are much deeper and these companies are just a part of wider networks. Thus it is no longer viable to compete by looking at a company in isolation from the network. (Kleindorfer et al. 2009, pp. 24-25)

Control through empowerment

The orchestrator needs to build a distinctive form of leadership and control while managing a dispersed network. Different from traditional rigid control systems used to managed factories, the network orchestrator needs to rely on a combination of empowerment and trust as well as training certification in addition to rewards when managing the network the company does not own. In addition the orchestrator empowers its managers and suppliers to act more entrepreneurially. (Kleindorfer et al. 2009, pp. 24-25)

Create value through integration

Lastly, network orchestrators have a different way of creating value. Traditionally the value came from specializations, honing skill in certain areas, protecting trade secrets and keeping the distance to rivals and even partners. Today in the world of open innovation and comprehensive information networks, value comes more and more from fighting for a market shares and protecting companies´ specialized core competencies. (Kleindorfer et al. 2009, pp. 24-25)

3.2 Social embeddedness in network orchestration

In the case of network orchestration as the orchestrator does not own the capabilities in the network, it brings challenges to the coordination activities and highlights the role of social embeddedness in the whole process. There are numerous studies available that emphasizes the role of social embeddedness of companies when developing business networks and relationships (Lambert & Boons 2002; Ashton 2008; Sakr et al. 2011; Paquin & Howard-Grenwille 2012). According to Paquin and Howard-Grenville (2012), embeddedness broadly describes the impacts of actors´ social interaction patterns and practices on their economic and organizational actions, and has been discussed in terms of structural, cultural, cognitive and political dimensions. Powell et al. (2005) claim that embeddedness enables actions between different participants by reducing social transaction costs through information flow and norms of reciprocity. From the point of view of eco-industrial networks, cultural embeddedness seems particularly important where trust and norms of reciprocity enable robust structural ties around resource exchanges to develop (Ashton 2008). (Paquin & Howard-Grenville 2012)

Uzzi (1997, p. 42) characterize embedded networks by three main features: (1) trust, (2) fine-grained information transfer and (3) joint problem-solving arrangements. These features allow companies to be more flexible and adapt complex and dynamic environment more quickly. As a result, companies gain

advantages in comparison to other forms of governance. (Domenech & Davis 2011, 283)

Domenech and Davis (2011, p. 295) state that "building trust requires time and frequency of contacts to develop, and, implicitly or explicitly, it is associated with a certain degree of general reciprocity and a heuristic approach of decision-making". Although trust is difficult to replicate in non-spontaneous networks, the coordinator might in some cases supplement long-term processes of trust building by providing common rules and implicit governance codes in order to coordinate negotiation and the realization of industrial symbiosis exchanges. In addition, coordination may also help generating learning from experiences and setting up forums for the participants to interact and facilitate join-problem solving. Policy making plays also a fundamental role in defining institutional framework in which companies operate. (Domenech & Davis 2011)

3.3 Orchestrating eco-industrial networks

Perspective of network orchestration has received little attention in the literature of industrial symbiosis which emphasizes self-organizing processes, excluding the view on facilitated industrial symbiosis where the external coordinating organization can be seen as an orchestrator (Paquin and Howard-Grenville 2012). However, Ryynänen and Patala (2013) state that emergent industrial symbiosis networks often include a large company with a central position and many ties to other members of the network as also in the case of Kalundborg where one of these companies, a power producer, has ties to five other members of the network, thus giving it a central position (Domenech and Davies 2011). (Ryynänen & Patala 2013)

Ryynänen and Patala (2013) introduces new framework for orchestration in industrial symbiosis based on their literature research. The framework suggest that the main orchestration processes of a hub firm are managing of 1) knowledge

mobility, 2) network stability, 3) eco-efficiency, 4) social embeddedness, 5) proximity, 6) variety of stakeholders and 7) relationship between core and non-core business (Figure 11).

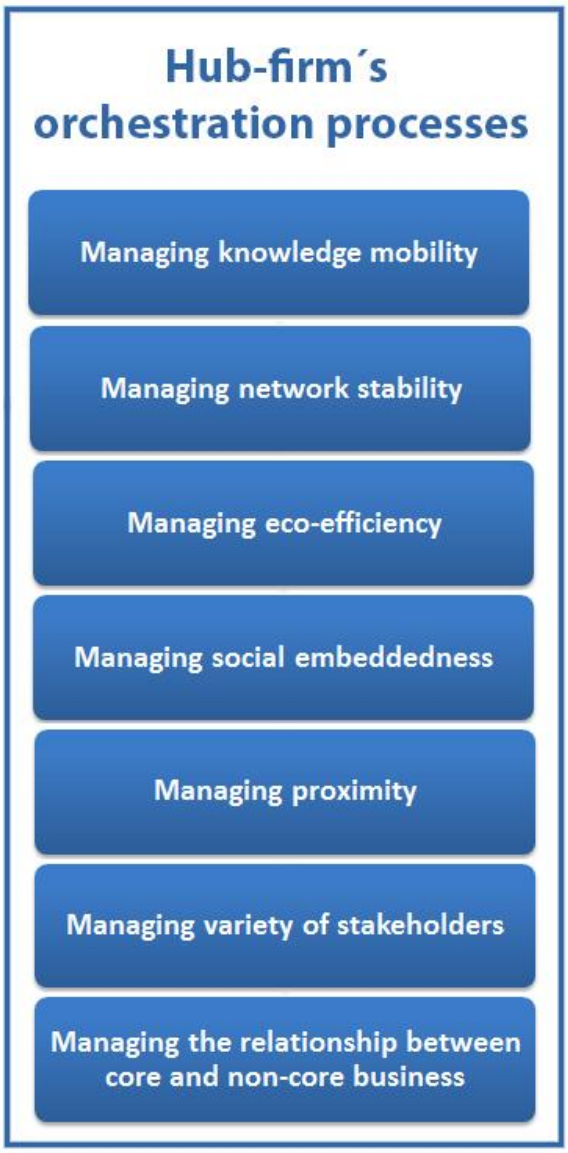


Figure 11. Hub-firm´s orchestration processes (modified Ryynänen & Patala 2013, p. 8)

Paquin & Howard-Grenville (2013) suggest that one dilemma network orchestrator faces is to build a broad-based interest in and support for the envisioned network´s activities. When assembling network to foster novel organizational activity, orchestrator must engage in sense making for external

audiences who have little or no prior understanding of the activity and its opportunities (Möller & Rajala 2007). Thus development of industrial symbiosis can be characterized as a social learning process where participants from different industries attempt to learn from each other´s business and found new business opportunities (Boons and Spekkink, 2012). In the case of industrial symbiosis, it often requires intensive knowledge sharing between participants thus the managing knowledge mobility is an important activity in the orchestration process. (Paquin & Howard-Grenville 2013; Ryynänen & Patala 2013)

Tudor, Adam and Bates (2006) state that industrial symbiosis and eco-industrial parks usually tends to be fragile on their nature. Because industrial symbiosis networks tend to be quite small business networks, leaving of one participant makes the whole network vulnerable. Thus the hub firm needs to manage the attractiveness of the industrial symbiosis in collaboration with other members and this way managing the stability of the network and develop it by bringing in new potential actors. (Ryynänen & Patala 2013)

Eco-efficiency is one of the main things in industrial symbiosis and in order to be collective approach to competitive advantage it needs to be managed as a whole. Industrial symbiosis has to be justified for the company management since it is not usually the core business for them. This requires careful measuring of the advantages and disadvantages of the development process. Thus managing eco-efficiency can be seen as a part of the orchestration activity. (Ryynänen & Patala 2013)

The literature of industrial symbiosis emphasizes especially the role of building trust, joint-problem solving, open communication and multiplexity (Baas 2011; Domenech & Davies 2011; Behera et al. 2012). This can be due to the differentiating business drivers of industrial symbiosis and the fact that usually contracts regarding by-product streams are not as formal as in the case of primary business (Baas 2011; Ashton & Bain 2012; Ryynänen & Patala 2013). The extensive social embeddedness can be however also a restricting factor for

identifying new business opportunities exploiting by-product streams (Paquin & Howard-Grenville 2012). Third parties such as government, industry associations and other coordinating bodies can help building the social embeddedness, but Ryynänen and Patala (2013) suggest it should be made centrally. Thus managing social embeddedness is one significant activity in orchestration process.

Geographic proximity helps to minimize costs and impacts of transport, improve trust and cooperation among companies and facilitate the material exchanges (Chertow 2000; Taddeo et al. 2012). One of the reasons why to favor proximate actors can be the reluctance to invest logistical expanses especially when it is not related to the core business but furthermore, the increased distance makes some resource exchanges infeasible due to increased distribution costs and decreased quality of some material flows, such as energy or steam (Romero & Ruiz 2013). Besides geographical distance, Ryynänen and Patala (2013) add narrow cognitive distance of actors and the proximity of the output (by-product of a manufacturer) and input (raw material of another manufacturer) into the consideration. At the system level the proximity should be managed by the hub firm. (Ryynänen & Patala 2013)

Sakr et al. (2011) claim that, the first step in developing industrial symbiosis is establishing the social network between companies and stakeholders and maintaining their continuous interest, mutual trust and involvement. In addition, a many studies have revealed the importance of collaboration and commitment among stakeholders (Gibbs and Deutz 2007; Heeres et al. 2004). For example in Wales, the Centre for Alternative Technology had the catalytic role in enabling relationships between businesses, leading to potential eco-industrial developments. Some companies may join into eco-industrial networks due to coercive actions such as stringent environmental regulations (Ashton 2008). However, strict regulation can also hinder possibilities for development for example in reprocessing opportunities of waste materials. Also the development of communities and associations that allow companies to interact can foster the development of new eco-industrial networks (Bansal & McKnight 2009). Thus

the variety of different actors involved can make it difficult to transfer knowledge and foster joint learning in the network and the orchestrator should be able to manage this. (Menenghetti & Nardi 2012; Ryynänen & Patala 2013)

The last orchestration activity is managing the relationship between core and non-core businesses. As mentioned earlier, by-product exchanges are not usually in the core business of company which can result in many threats for the customer. The availability of by-products is constricted by the demand for main products and thus cannot be optimized for the customer needs. In addition, the quality control for by-products is often not possible at the same level as for main products thus by-products often show more quality variance (Bansal and McKnight 2009). One interesting point of view is also the effect in waste reduction to the viability of by-product exchanges. When a company develops its process in order to reduce waste generation, this can result that the flow of by-product decreases under the viable level to transfer for customer.

4 RESEARCH METHODOLOGY

This part describes the research methodology and process used in the study. The present case study is qualitative of its nature. The main strength of qualitative research is the ability to study phenomena which are unavailable elsewhere. While quantitative researchers´ approach can tell a lot about inputs and outputs to some phenomenon, it settles with a purely operational definition and does not include the resources to describe how the phenomenon is locally constituted. Additionally, qualitative research is able to use naturally occurring data to find the sequences in which participants´ meanings are deployed and thus shape the character of some phenomenon. (Silverman 2006, pp. 43-44)

4.1 Case study

Yin (1989, p. 23) defines a case study as "an empirical inquiry that investigates a contemporary phenomenon within its real-life context when the boundaries between phenomenon and context are not clearly evident and in which multiple sources of evidence are used". Eisenhardt (1989, p. 534) highlights the potential of case studies to capture the dynamics of the phenomenon: "The case study is a research strategy which focuses on understanding the dynamics present within single settings". Case studies give a possibility to be close to the studied objects, providing inductive and rich description. It is useful especially when the situation is new and there is only little knowledge available about the phenomenon. Yin (2009, p. 2) suggest that case studies are the preferred method when three conditions are met. First, case study usually answers "how" and "why" questions. Second, the investigator has little control over the events under study and thirdly, the focus is on a contemporary phenomenon in a real-life context. Halinen and Törnroos (2003, 1286) add that case study is a strong method when studying change processes as it allows the study of contextual factors and process elements in the same real-life situation. In addition, case studies can be used also when

evaluating a case, a program or a network, or to help companies to change. (Halinen & Törnroos 2003, pp. 1286-1287; Yin 2009, p. 2)

Eisenhardt and Graebner (2007) state that case studies are one of the best bridges from rich qualitative evidence to mainstream deductive research. Case study is used in many different situations, to contribute our knowledge of individual, group, organizational, social, political and related phenomena. The need for case studies arises out of the desire to understand complex social phenomena. The method allows to retain a holistic and meaningful characteristics of real-life events, such as organizational and managerial processes, international relations and the maturation of industries. Yin (2009) describes case study as a linear but an iterative process (Figure 12). (Yin 2009, p. 4)

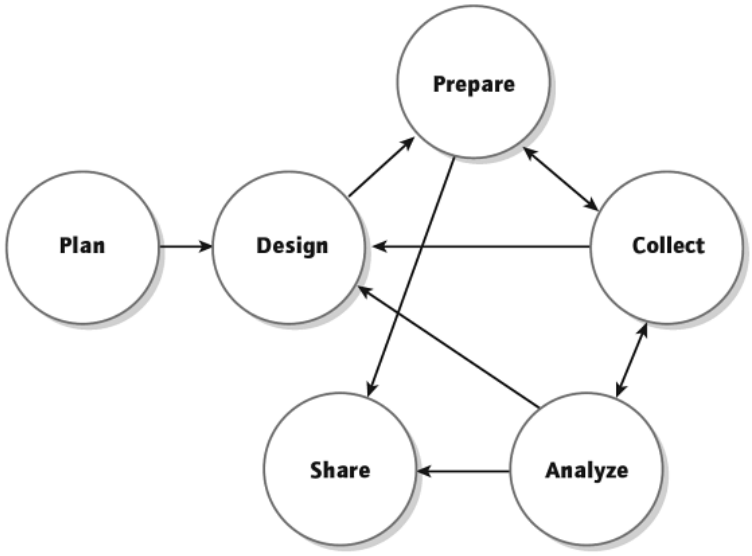


Figure 12. Case study research is linear but iterative process (Yin 2009, p. 1)

The present study followed largely the introduced model in the Figure 13. The planning phase of the research project started from defining the problem and research questions. After this, the overall planning of the project was done including research methodology, the key concepts for literature review and timeframe for the study. Preparing phase consisted of choosing the data sources on empirical part of the study and executing literature review on the concepts of eco-industrial networks and network orchestration. The literature review worked

as a basis when forming the questionnaires for experts and company representatives. The analyzing phase included content analysis from the collected data. As the process advanced, the overall design formed couple of times when new information was gained.

4.2 Interviews

One of the most important sources of information when conducting case studies are interviews (Yin 1994 p. 84). Interviews are very efficient way to gather rich empirical data, especially when the studied phenomenon that is highly episodic and infrequent. When talking about qualitative research, it can refer to the use of qualitative data in research strategies other than organizing the data into different cases and using replication logic to build theory. Silverman (2006, p. 20) claims that "authenticity rather than sample size is often the issue in qualitative research". The goal is to gather an authentic understanding of people´s experiences around the research area and it is believed that open-ended questions are the most effective and mostly used way to achieve this. (Eisenhardt & Graebner 2007; Silverman 2006, p. 20; Yin 1994 p. 84)

Interviews can be roughly divided into three categories based on the level of their structure. These categories are survey, semi-structured interview and in-depth interview. Survey or questionnaire is a data collection method most often used in quantitative studies. This data can be used to test hypotheses and it can be easily quantified because the structuring of the survey is very rigid and usually each question has pre-determined answer options. In opposition to survey, in-depth interview is completely unstructured and freer discussion-like situation. As the third approach, semi-structured interviews can be seen as the middle-ground of the two forms introduced above. Semi-structured interviews are based on a number of selected focal themes related to the framework of the research thus usually open-ended questions are being used and the discussion is directed with more specific questions. In semi-structured interviews, aspects and interpretations

of the interviewee are emphasized. (Tuomi & Sarajärvi 2009, p. 75; Metsämuuronen 2006, p. 114)

Because of the nature of the present study, the semi-structured interview was chosen to the method for interviews. This way interviews can be directed better while still focusing on open-ended questions and bringing interviewees´ opinions and aspects freely to the table. Open questions were constructed based on the objectives and the knowledge gained from the literature review. These questions were merely guidelines and some focal points for discussions and the overall structure of interviews varied between every interview. The chosen interviewees were experienced in the field under study. It was also aspiration to gain interviewees from wide range of industries to get comprehensive picture from the situation. In the next section, further information about interviews and content analysis made are being presented.

4.3 Content analysis

The general analyzing method in qualitative research is content analysis. It can be utilized to analyze data systematically and objectively in many different situations. Data can include variety of written information from books, letters and articles but also from interviews and dialogues etc. Thus content analysis is well-suited for analyzing unstructured material. The aim is to increase the information value of fragmented data shaping it into a meaningful, clear and coherent material that offers condensed and general description of the phenomenon under the study. The content analysis can be divided into five phases: selecting material, reduction, data grouping, interpretation of the data and assessing the reliability of the analysis. (Hirsijärvi & Hurme 2008, p. 143; Tuomi & Sarajärvi 2009, pp. 91, 103, 108)

The empirical data for this study was obtained from a total of 15 semi-structured interviews. These interviews were conducted at 12 different companies, consisting

of consulting, research and manufacturing companies both from the public and private industries. Table 5 shows the titles of the respondents, what kind of company they are working and the duration of the interviews.

Table 5. List of interviews conducted in the study

Interviewee	Title	Company	Interview type	Duration
A	Consultant	Public development organization	Face-to-face	40min
B	Consultant	Public development organization	Face-to-face	1h
C	Senior Lead	Public fund	Face-to-face	1h
D	Senior Lead	Public fund	Face-to-face	1h
E	Senior Consultant	Consulting company	Skype call	30min
F	Project Manager	University of Applied Sciences	Face-to-face	45min
G	Research and Development Manager	Bio-energy sector and food production related business	Face-to-face	1h
H	Head of Industry, Energy and the Environment	Region development center	Face-to-face	1h 6min
I	President	Management consultancy in food industry	Skype call	50min
J	Business Development Manager	Bioenergy solutions provider	Phone call	30min
K	President	Chemical products producer	Phone call	45min
L	Development Manager	Waste disposal and treatment	Skype call	45min

M	President	Biofuel process technology provider	Phone call	45min
N	Project Manager	Energy and material efficiency consulting	Phone call	44min
O	Research Professor	Technical research organization	Face-to-face	1h

The interviewees were chosen due to their experience with the concepts of industrial symbiosis and green supply chain management. Experts from consulting and research base were previously worked closely with different companies helping them to develop symbioses between other companies and increase the awareness of these matters. Manufacturing companies that were selected to this study were already utilizing concepts of industrial symbiosis and green supply chains in practice.

The main themes in the interviews were divided by the three research questions. The main themes were:

1. Drivers for eco-industrial networking
2. Development process of eco-industrial network
3. Promoting factors in Finland
4. Features of possible facilitation programme in Finland

Interviews were recorded and transcribed for further analysis. The content analysis was conducted with the help of NVivo 10 software which is software platform for analyzing all sorts of unstructured data in qualitative studies.

After the transcription of the data from interviews, it was read one more time to get an overall picture before the coding phase. Next, the first coding phase was conducted to find main themes emerging from the data. At first, some basic main themes were selected but during the first coding round, more themes emerged. After the first coding phase, the coded data was read, themes were organized and

renamed and also some more themes were added before the second round of coding.

The second coding round was conducted for more comprehensive analysis and to ensure that every significant reference points were taken for further inspection. After the second round, the data was once more read and the themes were further processed and categorized. Some of the themes were combined or linked as sub-categories. At this point, over 150 themes were identified due to the two coding phases. Also the number of appearances of each theme was checked to highlight the most significant ones in the analysis and consider those of few appearances, to ignore from further inspection. These findings from the content analysis are being presented in the next two chapters. The findings are divided into five categories following a logical order according to the objectives of the research: 1) the main drivers to develop eco-industrial networks, 2) success factors in the development process, 3) the most significant challenges in the development process, 4) eligible promoting actions for further development and 5) facilitation the development in Finland.

5 PROMOTIONAL ACTIONS FOR ECO-INDUSTRIAL NETWORKS

This chapter focuses on identifying main drivers for companies to develop eco-industrial networks and also the most significant success factors and challenges that these development projects often include.

5.1 Identified main drivers for companies to develop eco-industrial networks

To further understand the logic and enabling factors in the development process of eco-industrial business networks, it is essential to understand the main motives for companies to start implementation processes. There were seen a significant consistency in the results when analyzing the data from different interviews. The main drivers include seven themes (Table 6) that are being introduced in this chapter.

Table 6. Themes for drivers in developing eco-industrial networks

Theme	Number of items coded	Illustrative example from the data
Economy	15	"The money is the driver in here more or less, either as profits or as savings. That is quite an absolute value for these being able to work."
Environmental resources	12	"Of course there is the economic aspect on the background that you are aware that there might be the sort of metals which price has gone up for example, or that it is considered that there will shortages in the future"
Active player	9	"Of course, it is clear that there has to be this kind of enthusiast and maybe even idealistic actor"
New business possibilities	7	"Then of course this generates new business and this is also seen as one important motive"
Innovation and learning	9	"And also the fact that they come to us asking if we could do this kind of new stuff because operating in this field. And there, I think come the best side of this synergy that it leads

		always into new things."
Legislation	6	"In order to get the society to work as a whole and more rational in the environmental point of view, of course the legislation have meaning because in companies alternative costs are always analyzed"
Company image and customers	6	"When you understand the meaning of environmental management and that the image from companies forms from different things and how they take care of their backyard is always becoming more important "
Area development and employment	4	"And then of course the employment, as we see companies´ needs we can shape our education and laboratory services towards that."

Economy was by far the most dominating theme when identifying the drivers for developing eco-industrial networks. This seems very logical after all profitability is the main thing in order to develop sustainable business model. Interviewees saw that there are significant possibilities for companies to enhance their cost-effectiveness due to better resource efficiency.

1. "When talking about business, there cannot be other drivers. For a moment it can be sustainable operation according to all the other indicators but if it does not reach profitability within the timeframe the owners and the board of the company have set, then such a business does not have conditions to continue" Person M

Environmental resources was often mentioned along the economy as the resource prices are climbing and becoming scarcer and scarcer. This enforces companies to find new ways to enhance the use of materials and utilize waste streams produced in their productions.

2. "Resources prices are climbing and different conflicts are emerging, so although you have not thought these things before, they are becoming more important." Person D

Although the economic side of the environmental resources seems to be dominant, there are also some companies that truly take environmental issues into

consideration and regard them as one important driver. In addition, one interesting fact was mentioned that in most cases environmental issues are in the core of companies´ strategy but they are unable to measure the effects thus they are kept only as expense items.

3. ”Of course, one big aspect is also the environmental impacts, you cannot deny that. And like many it is already evenly powerful driving force but in reality, the most of the companies still focus on cost effectiveness” Person E

Active player was also seen as one of the most significant drivers for companies to develop eco-industrial networks. In most of cases there were seen some active and motivated orchestrator taking control in the network development process. The orchestrator could have been a single person of a focal company or some external organization. By the proactive work and motivation, these active players worked as a driving force drawing other companies into the network and steering the development.

4. ”Maybe at the beginning everyone did not quite understand where we are going but I just am good to talk and to justify things so I always got them with me to see the cards a bit further” Person I

New business possibilities was also common driver for the development of eco-industrial network. In most cases the waste material is not eligible for further usage at its current state but requires for some form of processing. If these material streams are large enough it can generate a need for a whole new service provider which has the potential for profitable long-term operation.

5. ”Then I decided that I will start building a business model for this kind of company that is able to utilize side-streams of other companies. And it was the year 2005 and basically for a half a year I just did some research, investigated a bit what kind of waste streams was generated in Finland and also in other Nordic countries.” Person K

Innovation and learning were also seen significant for companies to develop business networks and can be seen closely related to the theme of new business possibilities. As these new business possibilities may require some certain knowledge that the company does not currently possess and would become expensive to be gained through internal R&D, networking becomes an attractive option. Business networks can enable greater organizational learning between participants without remarkable monetary investments. This cooperation can also result in new technological innovations which in some cases can be seen as one driving force in developing eco-industrial networks.

6. ”Our partner has aluminum sulphate factory that was established in Harjavala 40 years ago and there these guys have done industrial chemistry a lot longer than me. So you can guess how easy it is to go talk with them when you face a problem. And also the fact that they come to us asking if we could do this kind of new stuff because operating in this field. And there I think comes the best side of this synergy that it leads always into new things. This is the main point for my opinion.” Person K

Legislation was also mentioned as a common driving force. Although this was seen as having the greatest impact on the large audience and so-called laggards whereas innovative firms were seen years ahead in the development. Especially landfill fees were brought up several times to have affected in industrial symbiosis development which is also related to economic drivers.

7. ”Well, you cannot really control the peak and innovative companies with legislation. There are the ones that already anticipate and live 10-15 years ahead. But then there is this that in order to get the society to work as a whole and more rational in the environmental point of view, of course the legislation have meaning because in companies alternative costs are always analyzed” Person I

Company image and customers were seen as a moderate driver in developing of eco-industrial networks. Especially among large companies the significance of the company image becomes more important and this trend is rising little by little also

among smaller companies. Some frontline companies have being able to achieve competitive advantage due to better environmental management. In the case of SMEs one possible way to differentiate from the competitors could be more environmental aspect along with the quality and utilizing that in marketing activities to activate consumers and other customers.

8. ”Actually the first drivers that back in the day put forest industry to clean up their waste water in the 70s´, quite soon these companies realized that if you proactively improve these things in the frontline you can achieve competitive advantage.. if we think about these kinds of companies that have the product itself as very environmental and earthy, for example these kinds of mold products or seedbeds that are being produced from waste through composting or bio gasification processes, then surely it is very visible in the marketing how the product is manufactured. And this is seen to grow all along especially in the food production.” Person H

Although it was seen in the interviews that many industries till today do not see customers as very significant driving force in implementing eco-industrial networks. An exception was pointed out in the case of green supply chain management where customer organization assess available suppliers there environmental point of view is usually one criteria. Thus also different environmental certifications come into bigger role as concrete evidence that certain aspects have been taken into account in the business. In the case of misuse by a supplier, the customer company may face wide disapproval and deterioration of company image.

9. ”There are not yet this preparedness to pay more and start to develop operations and physically calculate some image benefits but in a way it still is being seen as a positive matter. I think the biggest problem is the current worldwide economic situation why it is very hard to justify these actions.” Person L

Summarizing the chapter. The most significant drivers for companies to start implementing eco-industrial networks are economic. Companies are being very

enthusiast about the possibilities of industrial symbiosis and see the potential in their businesses. Besides economical drivers, also the scarcity of resources came up as companies are starting to realize the fact that some materials are running out at accelerating pace. Also the pressure of legislation forces companies to develop new and more efficient ways of material processing. This opens up new innovations and business possibilities as companies are working together.

Another important driver was seen the use of an orchestrator. In every case there were seen some active and motivated player that led the network development process. This has also been noticed by many other studies as shown in the literature review of this study. As quite interesting insight, customers were not seen yet as a significant driver in the eco-industrial development process. Although among large companies the brand and customer insights and satisfaction are known to be important and the trend is increasing. Also the characteristics of the product and the distance of the end-customer affects how the customer is taken into account. As the seventh minor driver was mentioned area development and employment that came from the representatives of public organizations.

5.2 The main success factors in the development process

In this chapter, the main factors for a successful eco-industrial network development project are being presented. There were seen some dispersion between the interviews, but eight main success factors were identified according to their appearance in the transcribed data. Table 7 shows the main themes and their importance according to number of coded items from the interviews.

Table 7. Themes of success factors in the development process of eco-industrial network

Theme	Number of items coded	Illustrative example from the data
Location	9	”Generally when talking about materials or these logistical symbioses, usually the fact is that in order that symbiosis to be profitable, the distances have to be reasonable”
Motivating leader	8	”These industrial uses for those recycled nutrients have been the kinds of crazy ideas of out CEO that many have laughed at, but when you believe on something enough you may succeed”
Facilitation	6	”It requires the kind of a band master, an external party which is inside enough and softens these different parties and drivers through decisions. So it is very challenging task of course and there have to be these participants who everybody trust”
Social networks and trust	13	“They have very significant meaning. Things start to go a lot smoother when people know each other”
Mutual benefit	4	”It does not erase other companies´ financial criteria, that is, if and when they do cooperation they expect that their financial situation will not decrease, rather to improve. And then their delivery or kind of operational reliability will remain at least at the current level.”
Information and awareness	9	”For company to participate it is needed to see the benefits. Whether it is a cost savings, sustainable use of resource and image issue or whatever but there has to be a clear goal in order to participate”

Location was seen as one of the most significant factor in the development process. As mentioned in the literature review of this study, also the interviews suggest that close locations support the development of symbiotic business relations. This is the case especially in industrial symbiosis as from the supply chain perspective they are usually covering wider areas. For example in the case of excess heat and steam, it is not possible or profitable to transport them for long distances.

10. ”In the case of heat transfer this low-temperature energy is not profitable to transfer, it is not wise to transfer that 30-degree water from Loviisa to Helsinki as the heat dissipates. But that 30-degree water is viable to transfer behind the wall” Person I

Motivating leader was mentioned also one of the most important success factors closely related to active player mentioned earlier as a driving force. Cases where two motivated companies connect in symbiotic fashion, there may not be one dominating “champion” who takes control of the development process but the process is seen as a normal cooperation between these companies. Although, if one of these two companies have the specific need to find counterparty, then this one will act as a more of driver in the process. Also in more complex networks it is often essential to have some sort of an orchestrator who is motivated to bring project to the finish line. The orchestrator also motivates others, increases the general awareness and builds trust among the participants.

11. ”Well of course you have to have the desire and enthusiasm for it in some way because someone needs to be the sort of driver in that development process” Person A

Facilitation, closely related to the theme of active player, was also raised as a success factor in many network development projects. It seemed that most companies needed special guidance in the process as they had not been familiar with these possibilities and did not know how to implement this kinds of projects. Although, there were some companies that had been in these NISP workshops organized by Sitra, Motiva and GAIA Consulting, that had later on wanted to continue the development process on their own after they had found new possible synergies. Thus they did not want to include external actors in the development process.

12. ”Then of course the facilitation is mostly quite important. In a way it was a bit like kicking it forwards while companies took care of practical tasks.. So yes, I think the facilitation is extremely important.” Person A

Social networks and trust became also very important factors when developing eco-industrial networks. Although, this specific aspect was asked about in the interviews which may have had an effect on the number of items coded, they still considered it to be extremely important. After all, business among companies is done by people thus it is justified to assume that informal social networks play a significant role when developing business relations. The empirical data suggests that this is especially important in the early phase of the development process. When participants know each other, the phase of planning and preliminary study can be significantly faster than in the case that counterparties are unknown to each other. Although, social networks do not build a profitable business by themselves, but promote the emergence of it. Thus it is essential that the business model is viable from the beginning.

13. ”Well yes, these informal social networks are extremely important because entrepreneurs are quite alone when they start thinking about new lines of businesses or new investments. And if there is yet a confidential group that is able to give their own complementary views from ten different point of views, there needs to be a quite a group of consultants to get the same kind of comprehensive picture from this network that a single sauna evening can generate.” Person I

In addition to social networks, trust between participants of the network was also highlighted, when building symbiotic relations. Network orchestrator, whether being a focal company or an external facilitator, needs to build trust among the participants in order to motivate them to share internal information about side-streams etc. The trust were also seen essential when building robust and long-lasting business relations.

14. “Let´s say, now when I have been in here almost 15 years, they dare to trust me but at the beginning it was quite cautious.. ..there has to be entrepreneurs that understand not to measure in every place who benefits and how much but have mutual trust and in the long run everybody wins.” Person I

Mutual benefit emerged also as one success factor in the development process of eco-industrial networks. In order to company to make decision to develop in industrial symbiosis, it is needed to see the benefits that can be gained from this cooperation. As mentioned in the driving forces, economic benefits were the most dominant but companies can seek also other benefits such as organizational learning and innovations. The mutual benefit can be seen one significant factor in building a robust and long-lasting symbiotic relationship between companies. If some parties do not benefit from the cooperation they may withdraw thus in some cases setting the whole network under risk.

15. ”The fact that the demand and supply face and at some point there come reasonable increase in value for all the parties.” Person J

Information and awareness were also brought up during the interviews as success factors in the development process. This can also be seen as a challenge, because most companies or public administration does not see the benefits to be gained through symbiotic business relations across different industries. This is especially hard in SMEs where there are usually shortages of resources to investigate these possibilities or make investments to implement those. In successful development cases participants are informed and aware of possible benefits to be gained through networking thus being motivated to participate in the development process.

16. “If it relatively small company which has a certain core business it is of course harder to start building that kind of a comprehensive picture and to perceive different various industries that could possibly be exploited.” Person E

In several cases, the role of area development organization such as ELY, has had a significant role of information source especially for SMEs and new entrepreneurs.

17. ”ELY Centre has been a tremendous aid in here as a source of information that I think many basic entrepreneur does not always even realize how much they could gain from.” Person G

Summarizing the chapter. The most significant success factors the empirical study brought up were the location, awareness and active player. As mentioned, different characteristics of resources restricts possibilities of transportation. Thus especially in the case of industrial symbiosis it is quite essential that parties of the network are located as close as possible to ensure both operational possibility and profitability. Also, participants need have knowledge about these possibilities to work together across different industries and think their own processes in a wider perspective. They also need to have mutual goals for the development project to be successful.

In addition to active player, the facilitation was mentioned as one of the significant success factors. The both can be seen quite close factors whereas facilitation was meant to be done more by external operator. One important role for both active player and facilitator is building the general awareness and trust among participants of the network. In addition, facilitator should keep in mind to ensure that every party of network will gain benefit in order to build a robust network.

5.3 The main challenges in the development process

In this chapter the main challenges that emerge in the development process of eco-industrial network are being introduced. In order to plan promotional actions for this development, it is needed to understand also the biggest challenges that companies face when start developing eco-industrial networks. Although some general threats were being presented in the literature review, it is needed to investigate challenges that occur in the context of the study i.e. in Finland. After all, business environments vary significantly between different countries. There were found six different themes (Table 8) that emerged through the empirical study that are being presented in the following.

Table 8. Themes of main challenges in development project of eco-industrial network

Theme	Number of items coded	Illustrative example from the data
Regulative barriers	11	”Well, if we think you have some pile of waste and then the permitting process lasts a year and a half. So relatively few smaller entrepreneur have the desire and possibilities to start that kind of process, thus these are the kind of big challenges.”
Lack of resources	13	”Companies have a great desire to get into these workshops but it is challenging especially among SME sector when there is no time or resources to get one person free for a day or a half for these occasions. So it is not easy.”
Lack of awareness	7	”But in away when you go from normal, I mean across the normal practices into new areas, it generates these kinds of new challenges nobody has come even to think about.”
Location and long distances	7	”Logistics kills quite a many good ideas if you have to transport resources from Lapland to southern Finland.”
Resource characteristics	8	”We are forgetting here that you cannot just supply these (materials) into another place but in many cases that specific company needs to be established and this requires for some kind of financial instruments.”
Lack of mutual trust	9	“If I will start processing your by-product stream will I trust that you are able to supply my needs and on time.”

Regulative barriers was the most dominant challenge that companies face when developing eco-industrial networks. Especially different permitting processes emerged as a mutual challenge in nearly every interview. Example cases were such as environmental permits and changing the waste status of some material. It was said that these permitting procedures lasted very long time which in turn complicated significantly the beginning of the development project. Also the predictability was seen as one of the challenging factor when talking about legislation.

18. ”There is one example that I have heard and I got the permit to use it. In one mill of Stora Enso, they have a process that generates X amount of ash, I do not

remember the exact amounts but anyway, the landfill costs are two million Euros annual. At the same time the mill needs to reduce operating costs in order to achieve total 200 million Euros annual. This ash has been analyzed so that it has the possibility to be utilized and they already have the demand for it to utilize for example in construction. But there are some decrees that prohibit this utilization thus this two million Euros need to be taken from someplace else. And in that point I think it comes into a social issue, like in a way which is better, you retain employment or that this kind of norm prohibits the utilization although it has been proven to be safe and able for reuse." Person D

Especially in the case of SMEs and a new company, the whole permitting process may become too expensive to go through thus restricting the utilization of the identified potential business opportunity. In addition, it can restrict the access to finance which may build a threat for the whole operation of the company.

19. "Permitting process, bureaucracy in general, control, detailed regulation, well if it does not prevent the development it at very least makes it difficult, sometimes very significantly or slow the process dramatically. And in the worst case, in the case of a company which do not have enough capital and is trying to get this kind of long permitting or administrative procedure through, the project may fall before it ever gets even started. So yes, it is quite significant barrier or at least a delay which raises the threshold significantly." Person M

Lack of resources is another main challenge in the development process of eco-industrial networks. It was mentioned several times in the interviews that it is challenging to find time for these new development projects because of limited human resources of companies and busy schedules.

20. "They do not necessary have the time to develop their networks when there are only two persons working and both are busy. They may be interested in this issue and they have identified existing possibilities, they have already made some small tests but it stops there because of limitation of resources." Person F

In addition, financing were considered second the most important challenge in the development process according to appearance in the data. Especially representatives from companies considered financing the biggest challenge when adopting new operating models such as industrial symbiosis. It can be hard for new companies to get finance before successful permitting procedure thus this early phase of developing new business is strongly dependent on entrepreneur´s own capital.

21. "Getting the finance and different permits is challenging, well usually it is hard to get finance if you do not have the permits. And overall, throughout all of this costs will emerge from necessary planning and if there are no financial sources you better have to have a lot of money to even start planning the business and to apply permits." Person G

Lack of awareness is also considered as one of the challenges when adopting eco-industrial networks. Although the basic principles of close interaction between companies are well-known and used for a long time, seeing the bigger picture is still being obscured. For ages many industries such as the forest industry have formed clusters of companies that share resources and services but traditionally the focus has been restricted inside one industry. Thus often these new business possibilities outside the own industry are not seen. This also creates challenges in the legislation as mentioned above, because of the lack of awareness that in turn strengthen some of the barriers for the development.

22. "And then one challenge is the lack of knowledge, also among authorities. The topic is also quite new for many authorities. It is new even for researchers, I mean in a way that things are being investigated but there is not enough profound knowledge." Person D

Location and long distances were also mentioned both as success and challenging factors when building eco-industrial networks. The location is especially important when implementing industrial symbiosis because usually as the distance of transport increases, the profitability gained from the shared resource decreases.

In addition, some resources such as surplus heat are not suitable for transporting long distances.

23. ”That is one especially in sparsely populated area when having biogas plant, often the heat remains unexploited because of long distances which make it unprofitable.” Person L

Another interesting challenge categorized as a sub-theme for the location can be mentioned area planning or zoning. It is quite usual especially in bigger localities that same kinds of industries settle in same locations. Thus this partially restricts building of close symbiotic relations across industries especially in cases of industrial symbiosis when the characteristics of the shared resource do not enable longer transportation, as mentioned earlier. This can also reduce the amount of new business possibilities identified in the area after being so to speak isolated from different kind of companies.

24. “Officials of both nationally in provincial and municipality area planning they want one kind of companies on one side of the town and another kind to another side of the town when these should be located next to each other. Their products may not have anything common with each other but those by-products or surplus heat, they could be concatenated but the area planning does not allow these coming close enough.” Person I

Resource characteristics came also as one of the main challenges in the development process. The characteristics of the resource can bring many different challenges when developing close business network such as industrial symbiosis. As pointed out in the theme of legislation, the current status of the by-product can slow significantly or restrict the development process. Also the characteristics may prevent the possibility to transport the resource at least for long distances. In addition, it may be required that the by-product is processed before it is able for further utilization by another manufacturing process. Another problem can emerge from the absence of suitable company or technology to process the material.

25. ”Of course in the case of some wood product as it is, there is problem but when it is processed and there have been used some chemicals it can bring challenges.” Person N

In addition, the volumes of the by-product streams may be insufficient to be profitable to transport and process.

26. ”The streams itself may be quite large but from the aspect of this one user comparing to its main stream, they may be a bit too small, and this is the point in here.” Person K

Lack of mutual trust including business threats emerged from the data also as one challenging area when building close business networks. If the participants of the networks do not have same goals and mutual trust the structure of the network cannot become robust. Companies may face serious business threats if some participant of their network withdraws.

27. ”In Kokkola there has always been industrial symbioses and there zinc sulphide are taken in to process sulfur oxide. This sulfur oxide can be used as a dissolver or it can be processed to sulfur acid. Again, this sulfur acid can be processed to potassium sulphate in other words fertilizer. When adding potassium chloride sulfur and hydrochloric acid are being generated and from hydrochloric acid can be processed calcium chloride in other words road salt or such. And all of these processes are operating together; there are Boliden, Yara and Tetrachemicals. And if one of these withdraws they all are in trouble.” Person K

Summarizing the chapter. The main challenges to come up from the interviews were legislation and companies´ resources. In legislation there were seen many obstacles when implementing new business possibilities, mainly concerning to permitting procedure. These were seen very long which in turn affected in getting finance and threatened the whole operation especially in the case of SMEs or new entrepreneurs as they have very limited resources. Also the problems in waste-status change came up several times.

The second biggest challenge was seen in getting finance as these kinds of development projects usually need for different investments and extensive preliminary studies in the beginning. Also human resources were mentioned several times which is especially the challenge in SMEs to get people available for workshops and such occasions to identify new business possibilities and also to be able to implement them. Besides these two biggest themes, the awareness, location, mutual trust and resource characteristics were came up as main challenges in the development process.

5.4 Identified actions for promoting eco-industrial networks

In order to promote further spread of eco-industrial networks it is essential to build more supportive context that stimulates companies to see these new possibilities and encourages them to start the implementation. This chapter represents the most viable promoting actions based on the empirical study where four main themes emerged quite heavily: building the awareness, active facilitation, incentives and dismantling the legislative barriers. Table 9 shows the importance of these four main promotional activities based on the appearance in the data.

Table 9. The themes of promotional activities for the development of eco-industrial networks

Theme	Number of items coded	Illustrative example from the data
Building awareness	15	”Mainly the government or the authorities should be these kinds of enablers and the key principle could possibly be this kind of knowledge sharing, promoting the flow of information and dismantling the administrative barriers.”
Incentives	11	”But now the question is if we want to raise this completely into another sphere. And then for my opinion we need new financial instruments that enable the implementation in wider scale than what we as SMEs have possible.”
Active	14	”The primary mean would be supporting this facilitation and

facilitation		possibly building uniform database. I think this would be the most efficient way.”
Dismantling the legislative barriers	13	”And of course it should be discussed and plan these permitting procedures a bit and in general to carve these unnecessary obstacles out. At least that they would not last very long because money has a bad quality not being able to wait at all.”

Building awareness, as mentioned both in success and challenging factors, seems to be one of the most promising way supporting the development of eco-industrial networks. The networking and industrial symbiosis themselves are not new concepts but have been utilized for ages. However the problem usually lies in the point of view that is restricted too much into own industry and one cannot see the bigger picture. Thus the education about these new possibilities should be spread among wider audience especially for SMEs where the resources are often very limited to do research about these concepts and their possibilities.

28. ”Maybe the first step in this kind of network development process is raising the interest among companies and also spreading the kind of awareness that companies start to think their resource politics and the use of resources more widely; where do we take and what kind of materials, where do they go, how do we link with other companies around us with our streams.” Person O

There are different ways available for building general awareness about the possibilities of industrial symbiosis and green supply chain management. One effective possibility would be bringing these successful cases into awareness. As mentioned in the data, companies need concrete examples of these possibilities and models to realize the possible benefits to be gained and thus justifying to themselves to go for it. To get a wider penetration, a bigger change in ways companies think their operations and processes are in order.

29. ”It might be a bit because of the fact that this industrial symbiosis is quite new concept and companies need those good examples to get confirmation for their believes that this is worthwhile to go through in many companies.” Person N

Another way to increase the awareness and implementation would be piloting of different concepts and trying to find the best practices for these network development processes to be able to replicate these on wider scope. However this brings many challenges because as mentioned in interviews the network development procedure is always case-specific. Thus the outcome cannot be too generalized process that may not fit well into real context or does not bring genuine benefits to the case under development. Thus multiple piloting of different kinds of cases should be in order to find the best practices that suit into the specific industry structure and need.

30. ”We need those pilot parks and I do not think that through tax reductions or such (will work), I think it is the healthy profitability and that you can see the model working and you get your own vision from that.” Person I

Active facilitation was considered as one of the key promoting actions along with building the general awareness of eco-industrial networks. The majority of the interviewees considered the active player of so-called orchestrator as one of the most significant drivers and success factors in the network development process. The motivated orchestrator drew new companies into the network by building the awareness and trust among the participants. Here also the significance of social networks emerged as an important factor especially at the beginning of the development process. Thus it seems very eligible that establishing some sort of active public facilitator would support the further implementation of eco-industrial networks.

31. ”When we are thinking about what Sitra and the government are now trying to drive here, that could these existent models of industrial symbiosis be utilized and build more of those in Finland, then the answer is this kind of facilitating organization. Not an organization that sells business premises or commodities but also actively builds these symbioses” Person K

Incentives was in turn mentioned as a viable promotional activity in supporting the development of eco-industrial networks. Although there were also a few

controversial statements about interfering free market conditions too much. Unsuccessful case of subsidies was seen in wind power tariffs where the subsidies are seen as prerequisites in order to business being profitable. Thus in the case of eco-industrial networks, subsidies and other financial aids should not be permanent. There were also mentioned that current electricity subsidies could be transferred more into resource efficiency with less focus to the energy source thus being more technology neutral.

32. ”It is a bit like that wind power tariff. It is hard to compete without the support but these kinds of supporting actions tend to guide operations too much towards certain direction.. ..So there should be some transition period and not the way that now we start to support some operation and there is no end in sight but just to the point that companies get on their feet.” Person O

It was mentioned several times that every development project should be at first hand based on a profitable business plan that has a real potential to succeed thus enabling efficient use of public funds. As mentioned earlier, companies face huge economic challenges in the early phases of the development project, especially in the case of new company. It can be difficult to acquire the needed capital before comprehensive preliminary studies and permitting processes. To help companies to take this first step and lower the threshold, some new financial mechanisms should be formed that focus especially on these early phases of the development process. In addition, normal investment support was mentioned although added that there already are some forms of investment support available. Especially company representative brought up that the state should take a bigger role in financing new businesses where banks are being seen as very careful to grant loans these.

33. ”But now the question is if we want to raise this completely into another sphere. And then for my opinion we need new financial instruments that enable the implementation in wider scale than what we as SMEs have possible. And I think that large companies will not build these new industrial symbioses.” Person K

34. “Should there be some sort of planning support for these kinds of promising businesses so it would not necessary be for investments but if seen as interesting enough the company could get planning money for it” Person G

Different kinds of European Union financial mechanisms were also mentioned as one source of capital to fund public promotional activities and building up “the big picture”. Thus building the awareness about the possibilities and obstacles is important also in the EU level as well

35. ”Now there are coming significant financial inputs from European Union also for resource efficiency through different financial channels LIFE+, Horizon, and in Finland EAKR financing regionally.” Person C

Dismantling the legislative barriers emerged as the fourth promotional activity in supporting the development of eco-industrial networks in Finland. Legislation was seen in two different ways, as a challenging factor but also as a driver. For innovative companies that are ahead of development, it was seen sometimes as a huge bureaucratic barrier which hindered their implementation actions. On the other way, legislation can boost the implementation of new operating models among the big audience and the laggards that are not motivated to change their operations proactively. It can also support new innovations by pressuring companies to make changes in their processes, for example by raising the landfill fees in order to decrease the amount of waste produced. These cost sanctions force companies to think alternative ways to streamline their operations thus sometimes generating radical innovations that will become as new standards inside industries. In addition, it can also create new businesses when new innovations and technologies emerge or one finds a possibility for additional services.

As a side of guiding actions it is extremely essential to bring down some of the barriers in legislation that companies faces in order to create a more supportive context for developing eco-industrial networks. The primary action would be bringing these barriers into the light so that government could identify these more efficiently. The government would have the responsibility to make these

necessary changes but also become more adaptive for the changes in the social environment. It was mentioned that legislation often lack behind thus slowing down innovative companies.

36. ”Pressuring. By that I mean this kind of lobbying by opening cases that show how these permitting processes hinder or slow down the business. So in a way collecting this kind of argumentation bank for it and then use it in order to fasten changes.. ..So in a way, till to today the regulation has always done by the one standard and then there are these industrial symbioses that in a sense go across those industries and problems occur” Person D

The biggest obstacles in legislation were seen in permitting procedures. Usually these took very long time but it were also significantly dependent on the location and what ELY centre they where applying from. It was said that the general permitting procedure should be unified and speed up to build more supporting context for companies, especially for startups and SMEs who have usually very limited resources. I was also said that this issue has been notified and under work as being a part of national efficiency programme.

37. ”That permitting issue has been tried to ease little by little but still there are quite a lot of problems thus one development activity in this national material efficiency programme is simplifying this permitting procedure.” Person A

Summarizing the chapter. The main promoting actions found in the study were building awareness, using incentives, active facilitation and dismantling the legislative barriers. As mentioned, the general awareness was pointed out also as a success and challenging factor thus is selected for an essential promoting action. Another big challenge emerged was limited resources in companies thus forming of new financial instruments for supporting companies would also be one key promoting factors. At the current general financial situation, investments like these are quite difficult to justify in companies, especially in a case if the outcomes and benefits cannot be accurately shown. It was mentioned that especially in the beginning of the development project during preliminary studies

and planning would be essential because usually getting finance before permitting procedure was seen very challenging. Thus these kinds of financial aids for planning phase would lower the threshold for companies to start the implementation of networks and new businesses.

Closely related to this issue was seen the third main promotional action, dismantling the legislative barriers. As it was mentioned, overall bureaucracy and especially permitting procedure was seen very significant problem in the eco-industrial network development process. These procedures took usually very long time although there were no complaints occurred during the process.

As the fourth main promotional activity was mentioned active facilitation. Often companies need that active player or orchestrator from outside to show the possibilities available and help in planning the implementation. Thus this kind of a national facilitation programme could be in order as one very concrete promotional activity. The facilitation process and possible framework for national facilitation programme are being presented in the following chapters.

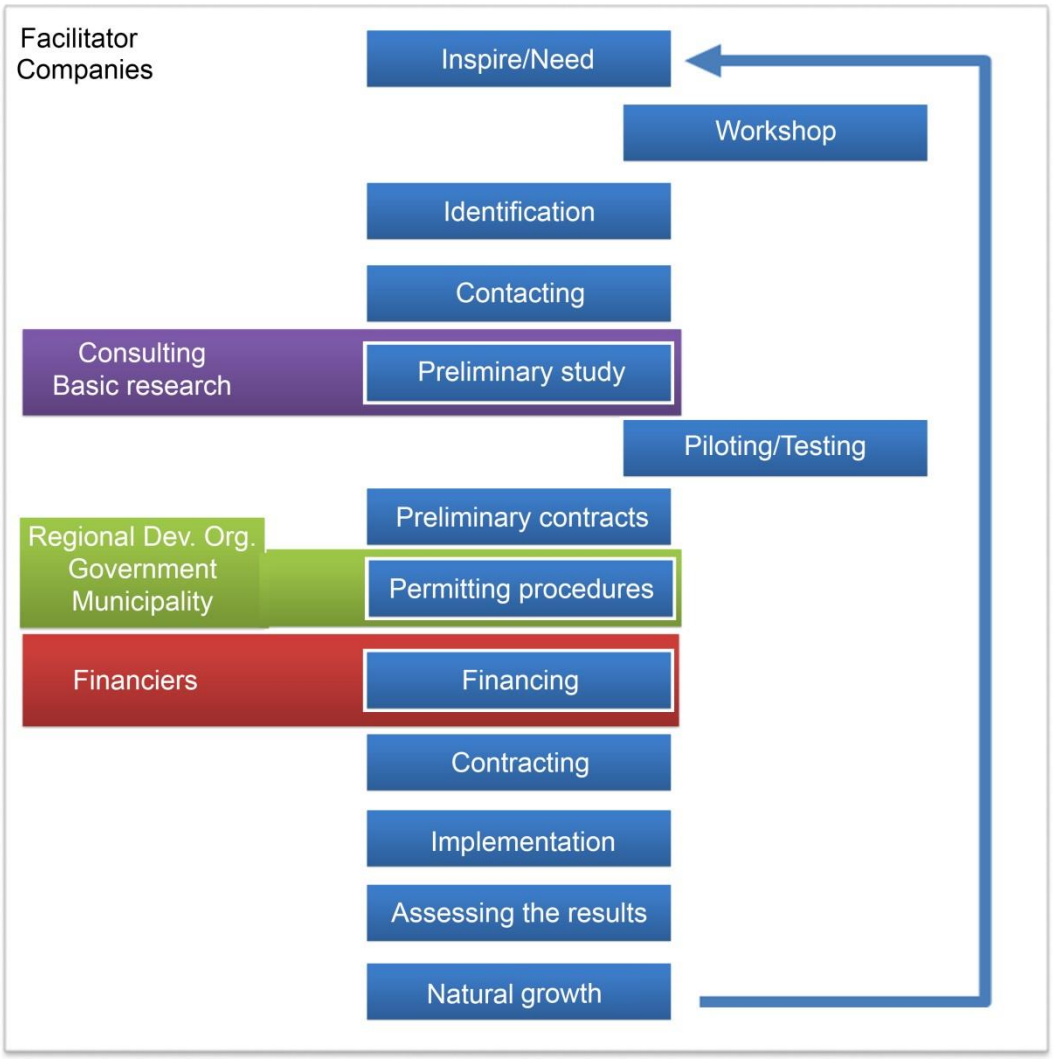
6 FACILITATION OF ECO-INDUSTRIAL NETWORKS IN FINLAND

In this chapter, further investigation about facilitation activities in Finnish context is made and a framework for this process is built. In addition, the main characteristics of nationwide facilitation programme are identified.

6.1 Facilitation process in the Finnish context

One goal of this study was to open up the concept of the facilitation process, what steps or milestones are there and who are the participants in most cases. As mentioned, development processes vary a lot case-by-case but when analyzing the data, certain similarities could be found thus the framework was built. The majority of the interviewees had been a part of a facilitation process but also the ones that had been developed networks on their own, could gave some insights about the development processes and certain aspects that are needed to take into account.

The framework was built based on the data gained from the interviews. In some of the cases the development process was a lot smoother and faster, depending for example on the research characteristics etc. whereas some were more complex processes including comprehensive preliminary studies and several sources of finance. Thus the framework was chosen to be more comprehensive describing the usual steps that may occur but also the stakeholders affecting in them. The framework of the facilitation process is presented in the Picture 13.



Picture 13. Facilitation process of eco-industrial network

As seen in the picture, the facilitation process can start from raising the companies´ enthusiasm. In practice this happens through building the general awareness among companies and presenting new business possibilities that can be gained through the development process. It was said that this phase was very important due to the lack of awareness especially among SMEs. Another route to start the process is discovering a need for symbiotic relation, for example noticing significant amount of excess heat produced inside a process thus some other company could be able to utilize this. The process can start due to the discovery done by the facilitator or a company producing this excess heat and wants to find a utilizer for this resource stream.

The second phase goes through this kind of workshop where systematically resource information is gathered from different company representatives. In these, regional resource needs and availability are identified thus it enables the identification of suitable counterparties, for example the producer of this excess heat and nearby located greenhouse which could utilize it effectively. Another option besides workshops is direct identification of counterparties made by the facilitator or the active company representative. In most cases companies already have wide networks that can bring new possibilities to the identified problem. But when assessing the facilitation process, one facilitator´s task is to use his/her own expertise and networks to identify suitable counterparties and find suitable matches whether they have been in different workshops or identified through another route.

The third phase includes contacting of these suitable counterparties. After the identification of possible synergy, the facilitator brings these operators together. The goal is to discuss about these synergistic possibilities and try to assess if these were worth to further study. It is also the place to decide about mutual goals and responsibilities for preliminary studies. Another important matter in this phase of the process is to start building trust between these companies and the facilitator, after it was identified as one of the main success factors.

In the fourth phase of our framework, preliminary studies are executed to ensure the profitability and benefits of the development project but also to assess different challenges related to this matter and plan further the possible business model. Thus this is very essential phase where often different consulting is being utilized. This consulting is helping to assess for example the possibilities for the utilization of the material stream or to build a business model around it. If there are found an existing solution or operating model to the problem, after successful analysis, companies can move to the next phases. In a case when some new technologies, practices or bigger investments are needed, further investigation is required. In addition to consulting services, data suggests that also basic research that happens in universities and research and development organizations are

needed to take along into the network. In a case where this resource link is very simple, for example a bio waste being utilized in bio gasification plant, the process can directly move into contracting phase after it is being assured that the material does not consists any harmful substances.

The fifth phase is signing preliminary contracts. In a case for example of building new facilities around available by-product streams, according to the interviews preliminary contracts are quite often signed to ensure the involvement of the parties after the construction phase.

The sixth and seventh phases include required permitting procedures and getting finance for the development project. As mentioned, these resource allocations often require some sort of permits before the operation is allowed to begin. The usual participants in this phase can be seen regional development organizations, governmental authorities and the local municipality. For example in the case of a new facility, it can be required for different environmental permits, area planning, construction permits etc. Also, according to the interviews, successful permitting procedure is often required before getting finance for the implementation phase. Obviously this phase includes different financiers including public financing organizations and private financiers.

The eighth and ninth phases would be planning and signing the actual contracts and start the implementation of the development project. During and after the implementation would also be important to assess the development project and the results of it. By doing this, companies can enhance organizational learning and identify things to fix in the next development project. This is also important for the facilitator to be able to document the achieved benefits and in order to develop the whole facilitation process in the future.

The final phase of the development project would be the natural growing of network. As stated in the interviews, often after the first successful synergies, the network started to grow naturally as the participants have changed their way of

thinking about their processes finding new possibilities and starting to promote it in their own networks. Thus the whole facilitation process can be seen as iterative as the process starts all over again from the new identified need or possibility.

6.2 The main characteristics of nationwide facilitation programme in Finland

In this chapter the active facilitation as a promotional activity is further discussed by taking nationwide facilitation programme under the scope. The goal is to further understand the facilitation process and what kind of unique characteristics the programme possibly implemented in Finland should have comparing to existing ones in other European countries such as NISP in Great Britain. In this case, the facilitation activities were planned especially from the industrial symbiosis point of view as it being the core concept of the study. The chapter is divided into four sections, coordination, contacting, information system and financing.

6.2.1 Coordination of the programme

When analyzing the data from the interviews there were noticeable similar characteristics between the potential Finnish facilitation programme and NISP in Great Britain. Especially the coordination aspects seemed quite similar when trying to thinks about possible model for Finnish context. It was mentioned in most of the interviews that some sort of a service organization is needed coordinating the facilitation activities. According to the persons interviewed that had already done facilitation practices, explained that close and active facilitation was often needed because of limited resources and the lack of awareness in companies. In other words, there had to be some active player to drive the implementation process and motivate companies that it was worth of doing.

Most of the interviewees thought that the coordination of nationwide eco-industrial or industrial symbiosis development programme should have both national and regional levels. In this model, regional level of coordination was seen extremely important as an operational level for executing projects and bringing more companies into the programme. This regional facilitator would have the best knowledge of local companies and capability to detect new possibilities for synergies. Current regional development companies such as ELY was pointed out as one potential operator for the regional level. They already have existing organizational structure and the local knowledge but also the social network with companies´ representatives. Although it was called into question if the current ELY regional division was appropriate in this case or should the amount of divisions be reduced.

38. "But then those hands-on activities should be, for my opinion, taken place on those areas. And there could be someone like ELY centre or some else regional operator or there can also be other options available, but that there would be some kind of regional division. I am not sure if the current ELY centre division is viable or is there in a way too much ELY centers for this use and should those areas be wider." Person A

39. "In the case of industrial symbiosis it should be promoted through national level by utilizing different information systems and in a way by supporting the political environment but also this kind of regional development actions are required to bring those operators together." Person H

On the other hand, also the national level was seen very important in order to form a coherent system that is led by the same principles but that also utilizes mutual database of resource streams and best practices. This can be seen as one of the main characteristics to prevent internal competition between different areas. There were also few interviewees that thought national level could be the only level of coordination thus reducing all the mid-steps and forming as simple structure as possible. However the majority considered the two-level approach to be the best solution for the coordination structure.

40. “So in away practicalities should be managed regionally but national level could guide who does what.” Person K

41. “That national level is extremely important in order to achieve coherence and mutual goals.” Person F

In most of the industrial symbiosis development projects external expertise is needed assessing the possibilities of resource processing. Thus in addition to strategic management, the national level would also contain some sort of a pool of experts that are specialized in different materials and their processing opportunities. In this way, the whole system could utilize the expertise and best practices for different cases but it would also be more realistic to implement comparing to situation where every region would have their own group of material experts from every field. This approach is quite similar to NISP where the expertise also flows between different regional divisions.

42. “But in a fashion that the knowledge could flow from one region to another and controlling this could be one of the roles of national operator, so that these best practices could be for the use of every Finnish companies. So that could be the role for the national level operator but the regional operator would be closer in enabling to bring companies together because the local knowledge is better on the regional level.” Person N

43. “For my opinion some kind of expert pool or such should be linked into this model, so we would not expect that these regional operators or facilitators need to be expert in every field but in a way they could utilize some sort of expert network. I think it would be wise. That these experts would not necessary be attached to any specific region.” Person A

6.2.2 Applications for the contacting phase

When assessing the three NISP workshops held in Helsinki, Rauma and Jyväskylä, all the interviewees that had participated in at least one of those, thought they were a great place for networking and learning about industrial symbiosis. The procedure itself seemed logical, as long as the participants had the knowledge about their needs and available by-products before coming to the workshop. In this kind of workshop, basically everyone declare their needs for resources but also the available by-products or waste streams they produce and are willing to find utilizer for. After the workshop, company representatives get a report about the workshop held and facilitators start identifying possible synergies and getting different parties together. Another main idea in these workshops besides gathering of resource information is social networking. After spending a day or a half together at one group, these company representatives start building social networks that could help them in the development project led by the facilitator or even starting by their own.

44. "What is good about organizing some public workshop is that you may get companies from different industries. And when targeting to these industry-border industrial symbioses for example between food and forest industries or else, then this kind of workshop executed with a wider rake, could be a good idea." Person N

45. "It could be more functional if those local companies were gathered together a bit more selective so it would not be such a public auction." Person L

According to the interviews, it was also mentioned that in workshop held in Jyväskylä, as the majority of the group were from local companies, the whole procedure went significantly smoother and participants started networking easier than in Helsinki, where there were companies from all over Finland. Thus more selective and regional workshops could be in order to achieve better results when building the facilitation model in Finland.

Although, when assessing this contacting phase as long-term practice it was mentioned that the number of participants would most likely reduce significantly after companies eventually losing their enthusiasm for consecutive workshops of same content. Thus the next step could be more focused regional groups but also other ways to get resource information, build awareness and enthusiasm among companies. Several interviewees thought that leaving the contacting only for the companies, would not work. Thus other approach could be executing interviews among local companies by the regional facilitator.

46. "We need these kinds of workshops but everyone is not able to come to these, thus we need also interviews and other social contacting." Person F

47. "For my opinion it should be sort of a combination. Sometimes the workshop could be the best solution but eventually it can turn that the workshop cannot offer enough counterparties for your organization or resources.. .. This workshop could be thought more of a way that they are in a way customized and thought beforehand what kind of companies to invite who might have synergistic possibilities between them.. .. On the side of workshops there could also be other ways to identify suitable partners and I think that the facilitator´s job would also be to identify suitable partners outside these workshops." Person A

An interesting aspect to this workshop model was mentioned by couple of company representatives that these workshops and information system seemed like auctions where the best offer could get the most of material streams. This makes the role of waste processing companies quite problematic and it was said this would affect in contract policies in the future to raise transaction costs thus making it harder for other companies to "steal" material streams.

48. "Our CEO has been in those workshops and he has given quite harsh critique about them to be nothing else but a clearance sale. Basically operators will put raw materials or wastes to the table and then put us to compete for them which basically means who takes them the cheapest will win.. ..But maybe it would be more functional if those local companies were gathered a bit more selectively together not to be such a public auction." Person L

6.2.3 Financing of the programme

About financing the programme, the majority of interviews thought it should be free for companies at least in the beginning of the programme in order to ensure wider penetration rate. It seemed that at this stage companies needed more concrete examples of the potential benefits before they would be willing to pay for these facilitation services. It was also mentioned that at the current worldwide economic situation, these kind of new investments that has little unknown outcomes, are very difficult to justify in companies.

49. ”It is pretty obvious that the group is a lot smaller if it is not free because companies think a lot about their costs and although if it is not any large number but you cannot see the financial benefit right away it does not necessary inspire” Person A

50. “In the early phase companies hardly will go financing and the reason is that in the beginning there are no experiences. There are no experiences and companies have numerous highly topical and strategic issues to think about that need money. And if this kind of, if it needs some access fee from company to get in, the decision gets easily undone or they decide not to get in. Thus is see it working in a way that at first it would be free for companies when you enable big penetration and if the concept works, at later point it is easier to bring this kind of payment element into play.” Person M

Some of the interviewees thought that after the adaption phase of the programme, it could become self-contained by membership fees or commissions from material streams from these achieved synergies. Although, also in this scenario the number of members will reduce but if the programme can show companies and society concrete benefits, it could establish some level of a sufficient membership base and attract new companies as well.

51. ”Surely the role of the state is important in the beginning but as it develops I would see that there could be a chance for some commissions or membership fees.” Person C

52. “If some commercial operator brings these kinds of organizations together where the other produces some waste and the other could utilize it, then what is the revenue model here and why these two organizations would continue to pay for this third party for their mutual cooperation.” Person N

According to interviews, some portion for finance could become from EAKR for these regional level operators. In addition TEKES could have bigger role in the research and piloting financier. Although more detailed financial structure could not be achieved from the data analyzed thus this needs for more specific investigation in the future. In addition, the possibility of European Union financial streams should be further investigated. As mentioned in the interviews, EU is bringing significant investments for resource efficiency through LIFE+ and Horizon. Also the European Industrial Symbiosis Association (EUR-ISA) was established aiming to enhance resource-intelligent business co-operation. Basically the organization promotes the use of the best practices of industrial symbioses and also tries to affect on European Union to take corrective actions to build more supportive context in this matter.

6.2.4 Basic principles of the required information system

As in NISP model, the information system seems to be the most viable solution as a starting point for the nationwide facilitation programme in Finland. The role of a mutual information system would be storing the resource information from different areas i.e. the available resource streams and needs. Thus these regional facilitators are able identify potential resource linkages and start building symbioses between companies. In addition, these regional facilitators are responsible for updating new information to the system after obtaining this data through workshops or other means. As this information system would be nationwide it would also enable identification of synergies outside regional divisions. Thus this would help to find counterparties wider but also in Greenfield planning where certain new businesses should be placed, for example new bio gas

facilitation would not be profitable to place next to the existing one but to area where raw material sources are near and plenty. This would also support more national development aspect to this case if the coordination is done right and regional divisions are not competing against each other.

53. ”Well, all may be needed that we can know if someone has something excess, what is the quality of it and what are the freight costs. I mean, sure it is good to know these kinds of locations that meet the conditions and then find if there are someone who could utilize these resources.” Person I

54. ”..Especially that visualization (is great) that we get those resources on the map and that is also good business development tool if we can see that in some area there is some certain resource then we could make are plan that this kind of mill or company should come to here in order to utilize these excess heat and waste materials.” Person C

The challenge lies in areas´ company bases and available by-products. As mentioned in the previous chapters, quite often by-products are not suitable for further utilization at their current state but are needed for some processing. However there may not be suitable company available inside the distance where it would still be profitable to transport and process the material. On the other hand, this obstacle is also what brings new business opportunities into the area. If the amounts of these by-product streams are significant, the regional coordinator could inform these possibilities both inside the region and nationally in order to find new entrepreneurs into the area.

When analyzing whether the information system should be open for audience or encrypted, at first answers varied between the interviewees but after further thinking, the result was almost anonymous for the encrypted option. In the open version, certain problems could occur. One challenge that emerged in the case of open information system was the confidentiality issue. It was mentioned several times that the most companies are not willing to publish their material stream information. Although some of the waste generation information is already public

knowledge by law, some parts could give out confidential information about substances used in the production, the amounts of them or they could even give bad image about their production due to the amount of waste they generate. One approach was that some of the information could be open and those that company feel confidential, are only permitted for the use of facilitators. When a facilitator identifies a possible synergy, he/she needs to get an approval from the donor company to hand over the resource information for the second party. Also there were seen problems in building trust in this kind of "distant" approach. Thus one of the main tasks of the regional facilitator would be building social networks and trust between different parties.

55. "In this model, the company should stay classified and then if someone becomes interested, for example ELY centre asks for permission to hand this information for another party." Person G

56. "It does not generate the trust in that way comparing if being here closely with each other where you cannot trick others because at the same time you trick yourself too when being a part of this ensemble." Person I

It would also be viable that the new information system would be compatible with the existing similar systems such as VAHTI where companies have to publish some of their waste information. VAHTI is a reporting system where every company owning environmental permit are obligated to enter information about their waste production and emissions to air and water. Information about the environmental load has been saved since the 1970s but their scope and reliability varies. Usually the information is expressed in annual amounts. (Ymparisto.fi)

Although due to previous tests made with VAHTI system, the information at its current form is not eligible for the case of industrial symbiosis. In order to get the information from VAHTI suitable for this purpose, the current material classification should be changed.

57. “VAHTI has the problem that it is based on the EU waste classification which does not support this kind of material-based categorizing at all. First it is categorized by industries, for example there is some chemical industry and under that is say wood or plastic waste or other. And in addition there are combined with different materials, for example wood and plastic and paper can be in the same. So as you see the classification you cannot know for sure what material it contains.” Person A

Another existing system is M-Pankki which is a web-based resource marketplace where companies can publish their available products or needs. Unfortunately the system has not become popular and at the time of writing the present report at April, there were only twelve different notices open.

After having these problems with the existing systems, one additional option comes occur. One yet very potential option would be utilizing the existing software SYNERGie used in NISP in Great Britain. This would speed up the implementation phase of the programme after reducing the need for developing a completely new information system from scratch. Also the system has already founded to be functional and many bugs have been fixed from the original version. Although certain problems may occur after it being developed originally for the specific needs in Great Britain. Thus this software should be further tested before making the final decisions.

7 CONCLUSIONS

The purpose of this thesis was to increase the understanding about eco-industrial networks and search viable ways to support the development of these in Finland. Further investigation was conducted about the facilitation processes and the characteristics of a possible nationwide facilitation programme in Finnish context. The research started from literature review that focused on concepts of network orchestration and eco-industrial networks where concepts of industrial symbiosis and green supply chain management were included. The goal of the literature review was to gain understanding about business network development processes and unique characteristics of different types of eco-industrial networks.

Thus the literature review worked as a basis for the empirical part of the study, where the phenomenon was investigated as a case study fashion. A total of 15 semi-structured interviews were conducted in order to acquire the desired insights on the research themes. The interviewees were selected due to their former experience in the field under the study. Content analysis of the transcript interviews were conducted utilizing NVivo 10 –software developed for qualitative analyses. Further information about the content analysis process is presented in the chapter 4.

Table 10 presents all of the research questions and short conclusions. The later part of the chapter details the conclusions for each research questions.

Table 10. Summary of the main conclusions of the study

	Research question	Conclusion
1	How business networking aiming to sustainable use of resources and reducing environmental load i.e. eco-industrial networks can be supported in Finland?	There are four main promotional activities to support this development: 1) Building awareness 2) Active facilitation 3) Dismantling the legislative barriers 4) Incentives

2	What phases and actors does active facilitation of eco-industrial networks include?	According to the empirical data, a 13-step framework for the facilitation process was being built, found in the Figure 13. One essential point is to understand this as an iterative process.
3	What are the main characteristics of a national facilitation programme suitable for Finnish context?	The main characteristics of the programme: 1) Coordination in two levels; regional (operational) level and national (administrative) level 2) Contacting; in the early phase, workshops were seemed as viable way to start the development process but later on other ways need to be formed. Active facilitators are in significant role. Previously built facilitation process could be utilized in this. 3) Financing model; in order to achieve greater penetration, the programme should be free for companies. Later when results can be seen, there is a possibility to move towards commercial model. 4) Information system; due to the compatibility problems with existing systems, utilizing SYNERGie from NISP seems a viable option.

The first part draws together the main promotional activities that support the further development of eco-industrial networks in Finland. The second part focuses on the facilitation process and the final section represents the main characteristics of a potential nationwide facilitation programme in Finland. In the final part, the results of the study are being assessed and implications for future research are made.

7.1 Implications of the research findings

This part of the study represents the conclusions that can be made based on the research findings found in the chapters 5 and 6. This chapter is divided into three sections according to three main research questions.

7.1.1 Propositions for promotional activities

The focus was to find viable promotional activities in order to create a more supportive context for companies to identify new synergistic opportunities and be able to implement those better. The detailed analysis of the empirical findings can be found in the chapter 5.4.

The main promotional activities discovered from the empirical data were divided into four themes; 1) building awareness, 2) incentives, 3) active facilitation and 4) dismantling the legislative barriers. These activities are also well-balanced with the discovered success and challenge factors of the development process. All of the interviewees considered that building awareness was one of the most significant promoting activities. In the case of industrial symbiosis, although the concept itself is quite old and companies have utilized others´ resource streams for ages, somehow there can be seen a mindset lockdown into own industry thus new possibilities across industries are not seen in most of the companies. However this promotional activity does not only address companies but also governmental authorities. The research suggests there are many obstacles in legislation that hinder the wider adoption of these concepts in practice, thus dismantling the legislative barriers is another suggested promotional activity. Bureaucracy and especially permitting procedures were considered significant challenges in the development processes. There are cases were some synergy has been identified and assessed to be very lucrative for both parties and also for the society due the employment, but the legislation prohibits the implementation.

Third promotional activity founded in the study was active facilitation. In most of the cases there were mentioned to be some motivated and active player who took control of the development process and drew new companies into the network. This player was either from the focal company of the network or from an external development organization. It was mentioned that companies often need someone to kick-start the process and in a way be in charge, thus active facilitation is suggested to be one of the main promotional activities. This relates also closely to

the first promotional activity of building awareness, where these facilitators educate companies about these new possibilities but also governmental authorities when identifying certain challenges found in development projects.

The fourth promotional activity emerged from the research was the use of different incentives. At the current world wide economic situation companies are struggling with profitability and ever tightening competition, thus new environmental investment decisions are hard to justify especially when the outcomes are not clear for companies. Especially in the case of SMEs limited resources were suggested to be one of the main challenges, thus it is very hard to investigate these new possibilities not to speak of leading the implementation process of network development. Although it was also mentioned that incentives should not become the precondition for profitability, but new developments should always based on potential business plans.

7.1.2 Facilitation process

As the active facilitation was identified as one of the main promotional activities, further investigation about the whole facilitation process was justified. Although few existing frameworks can be found in the literature, our aim was to open the concept of facilitation and look different steps of the process closer from the Finnish context. Thus the framework seen in the Figure 13 was being built showing different steps and usual stakeholders affecting in these. The detailed analysis of the illustrated framework is presented in the chapter 6.1.

This framework can be used in building awareness about the whole facilitation process and to give some guidance for the planning of national facilitation programme and its procedures. It is important to understand eco-industrial network development as an iterative process where the result is not necessary a stable network but adapts to its environment and grows as new business

possibilities are identified. Thus the end goals of the development projects must not be too restricted but enable changes as new possibilities emerge.

The research confirms the importance of social networks and mutual trust in the development process of eco-industrial networks as mentioned in the literature review. Although, the biggest driver for companies to start developing eco-industrial networks are economic ones, existing social networks were seen as significant supportive factor especially in the early phases of the process. However companies need new channels in order to build synergies across industries. Workshops seem to be viable option especially in this early stage of the development to increase the awareness and to bring different companies together. In addition, facilitator´s own networks and active search for counterparties should not be forgotten.

7.1.3 Characteristics of a nationwide facilitation programme

When assessing facilitation as a promotional activity, it came occur several times that some sort of a nationwide facilitation programme could be in order. Thus research included also investigating certain main characteristics of a programme suitable for the Finnish context. The goal of this was to give information for decision-makers and to form a potential structure for the programme in order to support the preliminary studies. More detailed research findings can be found in the chapter 6.2.

The research suggests the Finnish model to have quite many similar characteristics comparing to NISP in Great Britain. First of all, the research suggests that the structure of the coordination activities should be divided into two different levels; nationwide and regional levels. The regional level was considered to be essential for operational actions to take place in. This regional operator would coordinate the facilitation activities in practice, having the best knowledge and networks of local company base. Regional development organizations such as

ELY centers were mentioned as a potential candidate to take control over these operations as they already posses the local knowledge and have gained the credibility among companies. However the national level coordination was also seen important to guide and control the big picture. One possible challenge was seen rivalry between different regions thus the role of the national coordinator would be developing the cooperation between different regional operators and to ensure efficient information flow between them. In addition, as these synergistic possibilities often require new technologies and material expertise, some kind of expert pool was mentioned as one option to ensure better success rate and the use of best practices across different regional divisions. This pool of experts would consist of different material experts but also universities and other research and development organizations.

In addition for better information flow, the research suggests mutual information system to be required such in the case of NISP. This system would contain the information about available resource streams but also the resource needs in order the facilitators to be able to identify potential resource linkages more efficiently also across different regions. In addition this system would help in Greenfield planning if it was able to identify certain resource concentrations. Unfortunately it was mentioned that existing systems such as VAHTI containing waste information could not be utilized in the new system at their current states because of classification problems. As these are set by the EU waste classification standards they are considered challenging to change. Thus options would be whether to develop own information system from scratch or to go for the system used in NISP. The self-developed system could be fitted exactly for the Finnish context and needs but would also contain threats. The development process could become long and expensive but also possible bugs and other weaknesses in the system under testing phase could repel participants. Thus the SYNERGie system used in NISP would be a primary suggestion after all it has been tested and proven functionality in practice. In addition, if the programme does not become popular among companies and become suspended, these big development costs are being saved.

When assessing the financial structure of the programme, clear junction was the programme to be free for companies in order for greater penetration. It was suggested that especially in the early phase where companies do not understand the concept and possible outcomes it is hard to justify the investments if there was being some commissions or membership fees in order to participate the programme. After the introduction phase and concrete results of the programme, it was mentioned that it could be possible to develop revenue model around the programme but still the turnout would reduce significantly. Thus new financial mechanisms are required in order introduce the programme successfully. Certain finance sources were mentioned such as EAKR for these regional divisions, but also TEKES and different finance sources from European Union such as LIFE+ and Horizon.

7.2 Assessment of the results

Assessing the reliability of interview research is quite challenging. When assessing the findings, it is essential to notice, that these are based on opinions of a certain group of experts in a certain time. Thus it is usual that answers of the interviewees for the same question pattern vary in time. In addition, if research is conducted by two different persons, according to Hirsijärvi and Hurme (2008, p. 186), it is quite implausible these two persons to make the exact interpretations based on an interview of a third party. They also suggest that this is not necessary a weakness but a consequence of the changed situation.

7.3 Theoretical implications and future research

The findings of the present research also contribute to existent literature on eco-industrial networks. The research increases the understanding about the network development process in Finnish context. It brings together the main forces including drivers for companies but also the main success factors and challenges

that are included in the process. The framework for facilitation process identifies also the different stakeholders process usually includes in different steps. Thus the findings can help both facilitators and companies in understanding the overall development process.

Implication for future research area could be further investigation of social science in the eco-industrial development process as these were identified important success factor. Also combining institutional entrepreneurship into the eco-industrial network research would be an interesting area, as active player was seen another significant success factor. These active players initiate organizational changes in many different ways despite pressures towards stasis.

Another implication for future study emerged during the DemaNET project was the assessment of possibilities to utilize different Decision Support Systems in workshops of the facilitation process. It would be very interesting area to investigate how these kinds of remote workshop models work as social networks and building mutual trust were seen significant in the development process. However these could be one option to address the issue of limited resources when these workshops would not be location and time-dependent. Thus the participation among SMEs into workshops and promotional events could be improved.

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APPENDICES

Appendix 1: Questionnaire form for consultants and experts

Appendix 2: Questionnaire form for company representatives

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DEMATERIALIZATION THROUGH NEW MODELS FOR INDUSTRIAL NETWORKING

Teollisen symbioosin edistäminen Suomessa

Tutkimushaastattelu
Haastattelu käsitellään anonyymisti ja luottamuksellisesti.

Tämä tutkimus kuuluu osana VTT:n johtamaa DemaNET – projektia, jonka tavoitteena on arvioida ja edistää innovatiivisia konsepteja sekä verkostopohjaisia toimintamalleja, joilla pystytään tukemaan suomalaisen teollisuuden tuotantoon käytettävän materiaalin ja energian vähentämistä, eli dematerialisaatiota. Tarkasteltavina konsepteina ja toimintamalleina kokonaisprojektissa ovat uudelleenvalmistus, strategiset ekoteolliset verkostot sekä arvopohjaiset liiketoimintamallit.

Tutkimuksemme sekä haastattelu kohdistuvat ekoteollisiin verkostoihin, joilla viitataan resurssien kestävään käyttöön ja ympäristökuormitusten vähentämiseen tähtäävää yritysten välistä verkostoitumista. Läheisenä käsitteenä toimii myös teollinen symbioosi, jonka tavoitteena on muodostaa syklimäinen ja osittain suljettu resurssienkierto yritysverkoston sisälle hyödyntämällä yritysten prosesseissa syntyviä sivuvirtoja/jätteitä sekä yhdistämällä erilaisia palveluja kuten logistiikkaa. Tavoitteena on, että verkoston kaikki osapuolet hyötyvät ja samalla tehostetaan resurssien käyttöä sekä kestävää kehitystä.

Taustatiedot

1. Toimenkuvanne ja historia yrityksessä?
2. Kerrotko hieman yrityksenne taustoista?
3. Millaista toimintaa yrityksenne tekee ekoteollisten verkostojen edistämiseksi Suomessa?

Ajurit

4. Mitkä ovat yritysten motiivit osallistua/kehittää tätä toimintaa yrityksissään?
5. Milloin toiminta on aloitettu?
6. Kuinka monta yritystä (karkeasti) toiminnassa on ollut mukana?

7. Millainen vastaanotto yrityksissä on ollut tälle toiminnalle?

Ekoteollisen verkoston kehitysprosessi

8. Millaisten resurssien vaihtoa toteutetut teollisen symbioosin kehitysprojektit yleisimmin ovat sisältäneet?
9. Ketä toimijoita verkoston kehitysprojektiin yleisimmin kuuluu ja mitkä olivat heidän roolinsa?
10. Kerrotko tarkemmin prosessista ja sen eri vaiheista? (Esim. miten toimijat saatiin yhteen, tarvittiinko projektin läpiviemiseksi uutta teknologiaa tai muita investointeja ja miten ne hoidettiin)
11. Mitkä tekijät näkisit tärkeimpinä onnistuneelle teollisen symbioosin kehitysprojektille?
12. Mitkä ovat keskeisimmät haasteet?
13. Miten luonnehtisit sosiaalisten verkostojen merkitystä ekoteollisten verkostojen kehittämisessä?
14. Tuoko verkostoon liittyminen mukanaan myös organisaation sisäisiä muutoksia? Millaisia?
15. Ovatko yritykset alkaneet aktiivisesti edistää teollista symbioosia omissa verkostoissaan?

Ekoteollisen verkostotoiminnan edistäminen Suomessa

16. Millä konkreettisilla toimintatavoilla resurssien kestävään käyttöön ja ympäristökuormitusten vähentämiseen pyrkivää verkostotoimintaa voidaan edistää?
17. Millaiset kannustimet yrityksille ovat sopivin vaihtoehto? (Esim. verovähennykset kustannuksista, lainat ja lahjoitukset Tekesiltä, vapaat markkinat ilman julkista sekaantumista, julkiset investoinnit PK-yrityksille, lainat ja lahjoitukset EU:lta?)
18. Millä tavoin näet toiminnan kehittyvän tulevaisuudessa?

Yleisen toimintamallin kehittäminen Suomessa

19. Näetkö järjestelmällisen ekoteollisten verkostojen kehittämisen/fasilitoinnin tehokkaana tapana edistää kyseistä toimintaa Suomessa?
20. Kuinka toimintaa kannattaisi koordinoida?
21. Mikä on mielestäsi tehokkain tapa uuden yritysverkoston osapuolten yhteensaattamisessa? Miten yritykset saadaan paremmin osallistumaan?
22. Mitä kanavaa pitkin tiedonjako saatavilla olevista resursseista olisi mielestäsi sopivin? (esim. online-tietokannat, markkinatutkimukset,

erilliset palveluorganisaatiot, julkiset kansalliset organisaatiot, julkiset alueelliset organisaatiot)

23. Miten yhteydet tarvittavaan tietotaitoon/uusiin innovaatioihin ja teknologioihin järjestetään? (Esim. tiettyjen symbioosien implementointi voi vaatia erityisosaamista fasilitoijalta sekä uutta teknologiaa resurssien prosessoinnissa)
24. Mikäli tietojärjestelmän kehittäminen tulee tarpeelliseksi, millainen tämä olisi ja miten se olisi yhteydessä jo olemassa oleviin järjestelmiin?
25. Kuinka tällaista ekoteollisten verkostojen kehittämistoimintaa tulisi mielestäsi rahoittaa?

26. Tuleeko mieleen jotain muuta asiaan liittyvää, mitä ei ole käsitelty?
27. Ketä muita voisi haastatella aiheeseen liittyen?

Appendix 2: Questionnaire form for company representatives

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Teollisen symbioosin edistäminen Suomessa

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Tutkimuksemme sekä haastattelu kohdistuvat ekoteollisiin verkostoihin, joilla viitataan resurssien kestävään käyttöön ja ympäristökuormitusten vähentämiseen tähtäävää yritysten välistä verkostoitumista. Läheisenä käsitteenä toimii myös teollinen symbioosi, jonka tavoitteena on muodostaa syklimäinen ja osittain suljettu resurssienkierto yritysverkoston sisälle hyödyntämällä yritysten prosesseissa syntyviä sivuvirtoja/jätteitä sekä yhdistämällä erilaisia palveluja kuten logistiikkaa. Tavoitteena on, että verkoston kaikki osapuolet hyötyvät ja samalla tehostetaan resurssien käyttöä sekä kestävää kehitystä.

Taustatiedot

1. Toimenkuvanne ja historia yrityksessä?
2. Kerrotko hieman yrityksenne taustoista?
3. Ovatko käsitteet ekoteollinen verkosto ja teollinen symbioosi tuttuja?
4. Millaista toimintaa yrityksenne tekee ekoteollisten verkostojen edistämiseksi Suomessa?

Ajurit

5. Mitkä olivat yrityksenne motiivit osallistua teollisen symbioosin kehitystoimintaan?
6. Milloin toiminta on aloitettu?

7. Kuinka monta yritystä tähän kaiken kaikkiaan osallistui? (Kuinka monen yrityksen kanssa teillä on resurssienvaihtoa)
8. Millainen vastaanotto yrityksessänne/verkostossanne on ollut tälle toiminnalle?

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9. Millaisten resurssien vaihtoa toteutetut teollisen symbioosin kehitysprojektit ovat sisältäneet?
10. Ketä toimijoita verkoston kehittämisprosessiin teidän tapauksessanne kuului ja mitkä olivat heidän roolinsa?
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