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Exploring Private Facilitation Strategies for Industrial Symbiosis:

A Case Study from the Swedish Food Industry

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"There are no waste streams today. They all can become a resource!"

Bengt Fellbe, Bjuv municipality, Sweden

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Abstract

The concept of industrial symbiosis (IS) provides practical solutions for resource efficiency and low-carbon development. The IS represents a collective, multi-industrial approach for companies to improve their economic and environmental performance through the sharing of heat, electricity, water, by-products, information, and reuse of waste. The main challenges to IS emergence include a long duration and a complexity of the projects. Effective facilitation can accelerate the IS development process. Despite the recognition of diverse facilitation actors and roles, a contribution of private consulting firms to the emergence and development of IS remains unexplored. This study contributes to an understanding of IS facilitation by exploring possible roles and strategies of private facilitators. The research design included a grounded theory approach and a single case study from the Swedish food industry. In result, first, possible strategic steps for a private consulting firm to engage in an IS project were described. Second, the results demonstrate that private IS facilitators are valued for expert knowledge and experience in a specific innovation area, project management skills and a willingness to take a financial risk. Third, five main facilitation functions of private consulting firms were identified: project management, diagnostic function, direct transfer of expert knowledge, experience sharing, and providing contacts of service companies. Finally, facilitation actions of private firms were described and allocated to phases of IS systems emergence. A clear understanding of facilitation roles and cooperation options can foster the emergence and implementation of IS projects and enhance resource efficiency and low-carbon development, in Sweden and globally.

Keywords: industrial symbiosis, facilitation, barriers to innovation, innovation intermediary, food industry.

Executive Summary

Global resource use and carbon footprints are growing. Within the last 60 years, the annual global rate of resource extraction has increased from 5.0 to 10.3 tons per capita (Schanes et al., 2019). According to the International Energy Agency (2019), the direct industrial greenhouse gas (GHG) emissions reached 8.5 gigatonnes of carbon dioxide equivalent ($GtCO_2$) in 2017, which was 24% of global emissions. In Sweden, the GHG emissions produced by the manufacturing sector account for 25% of the total (Statistiska Centralbyrån, 2019). According to Steffen et al. (2015), the growing resource extraction, inefficient use, and carbon-intense practices have resulted in climate change, loss of biosphere integrity, land-system change, and altered biogeochemical cycles that are harmful to world's sustainable development. In particular, the food production systems contribute to climate change, biodiversity loss, freshwater use, interference with the global nitrogen and phosphorous cycles, and land-system change (Smith & Gregory, 2013; Willett et al., 2019).

The concept of industrial symbiosis (IS) provides practical solutions for resource efficiency and low-carbon development (Chertow, 2000; Deutz, 2014; Tälle et al., 2019). The concept is based on the notion of symbiotic relationships in nature whereby otherwise unrelated species exchange materials, energy, or information in a mutually beneficial manner (Chertow, 2000). Industrial symbiosis represents a collective, multi-industrial approach for companies to improve their environmental and economic performance through the sharing of heat, electricity, water, by-products, information, and reuse of waste (Chertow & Lombardi, 2005; Deutz, 2014). Despite its economic and environmental benefits and significant potential, the practice of IS has not yet gained broad acceptance – in Sweden, or globally.

Problem Definition

The main challenges to IS emergence include the long duration and the complexity of the projects (Chertow, 2000). As an inter-organisational innovation process, IS implies a significant change for the industrial companies that are involved. This change can be challenging for companies due to informational, organisational, technical, regulatory, and financial barriers (Aid et al., 2017; Siskos & Van Wassenhove, 2017). Effective facilitation by a third-party organisation engages the companies in cooperation, helps to overcome the barriers, and accelerates the IS development (Chertow, 2007; Chertow & Ehrenfeld, 2012; Hatefipour et al., 2012; Mortensen & Kørnøv, 2019; Paquin & Howard-Grenville, 2012; Patala et al., 2020; Zaoual & Lecocq, 2018). Studies suggest that collaboration between different facilitators of an IS project can identify new value potential (Klerkx & Leeuwis, 2009; Patala et al., 2020). The discovered categories of IS facilitators include public authorities, academic institutions, and private firms (Boons et al., 2017, 2017; Chertow, 2007; Paquin & Howard-Grenville, 2012; Patricio et al., 2018; Velenturf, 2017). Despite the recognition of diverse facilitation actors and roles, a contribution of private consulting firms to the emergence and development of IS remains unexplored.

Aim and Research Questions

This study aims to explore possible roles and strategies of private facilitators in industrial symbiosis projects. Following the aim of this study, research questions (RQs) are defined as:

RQ1: What strategies can be used by private firms to engage in IS projects as facilitators?

RQ2: Why are private facilitators relevant to IS emergence?

RQ3: How can private facilitators contribute to the development of an IS system?

Methodology

This study employed a grounded theory approach as a research strategy and a single case study from the Swedish food industry as a research design. An *analytical framework* for this study is presented in Figure I. The analytical process started with RQs. The RQs lead to a *conceptual framework* and purposive sampling for literature review and data collection. The collected data went through different stages of coding and constant comparison. In Figure I, an iterative process of constant comparison is shown by blue arrows. A substantive theory about possible roles and strategies for private IS facilitators was developed.

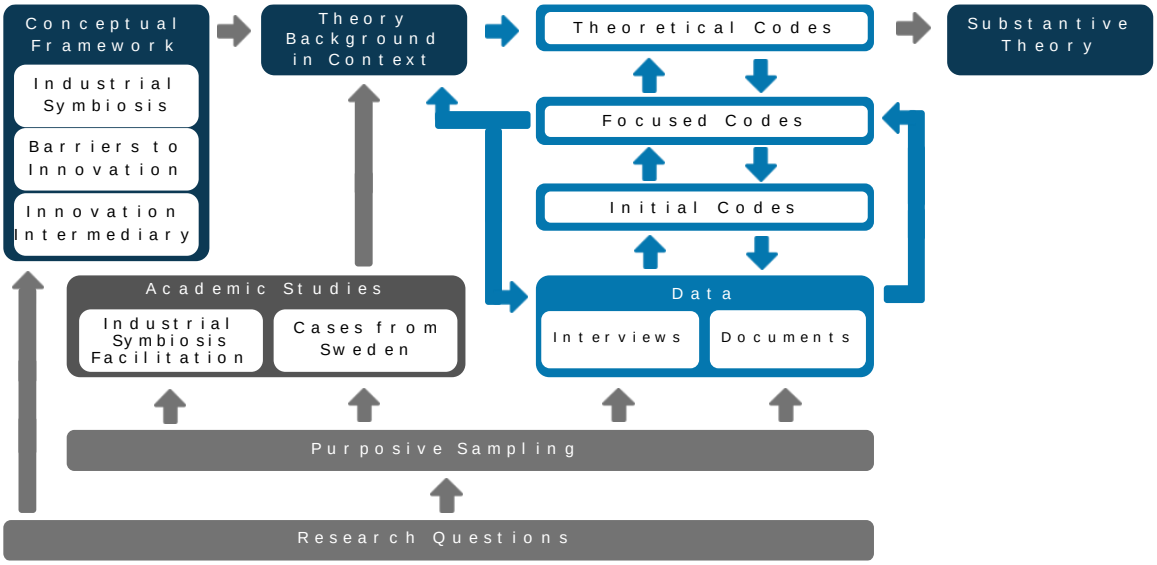

Figure I. Analytical framework
Source: developed by author based on Charmaz (2014) and Blaikie & Priest (2019).

Main Findings

Result #1: This study described strategic steps that can be taken by a private consulting firm to engage in an IS project (see Figure II). These steps include identifying the innovation idea based on firm's expert portfolio, finding a project through networking, involvement in the project, reflecting on the results of the project, and updating the strategy based on lessons learnt from the project. Strategic guidelines for a private IS facilitator included precise determination of goals, risk management, collaboration with other facilitators, and sustainability consideration. Thus, a private consulting company can become a valuable part of the IS facilitation process relying on its unique expertise and network.

Result #2: This study discovered the relevance of private facilitators to IS projects. First, IS project participants need an expert with experience in the practical implementation of synergy projects related to the same innovation area. Second, an opportunity assessment for the IS projects requires a company who can take a financial risk and complete a research project fast. Third, IS projects need institutional support for integration. Therefore, private facilitators are relevant to IS projects development, if they have expert knowledge and experience in a specific innovation area, project management skills and a willingness to take a financial risk.

Result #3: This study explored the contribution of private facilitators to the IS systems. The contribution was defined by functions performed by private facilitators to support the IS project development and scope of action associated with every function. The study identified five main facilitation functions that can be performed by a private facilitator: project management,

diagnostic function, direct transfer of expert knowledge, experience sharing, and providing contacts of specialised service companies. Within every function, the scope of action correlates with an IS project's phase. This study suggested a possible facilitation plan for an IS project (see Figure III) and a detailed description of every facilitation action. The detailed description of actions helps to allocate actions between various organisations, including private facilitators.

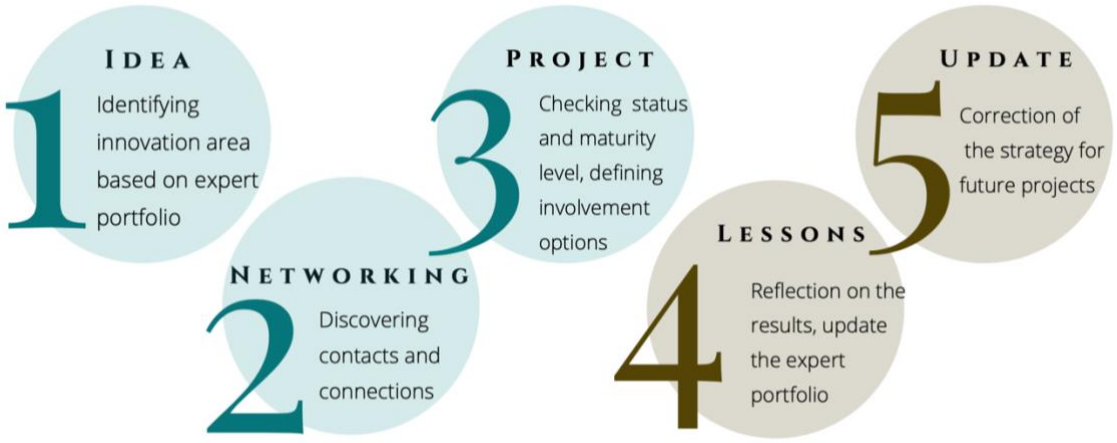

Figure II. Strategic steps for consulting firms to engage in industrial symbiosis
Source: author.

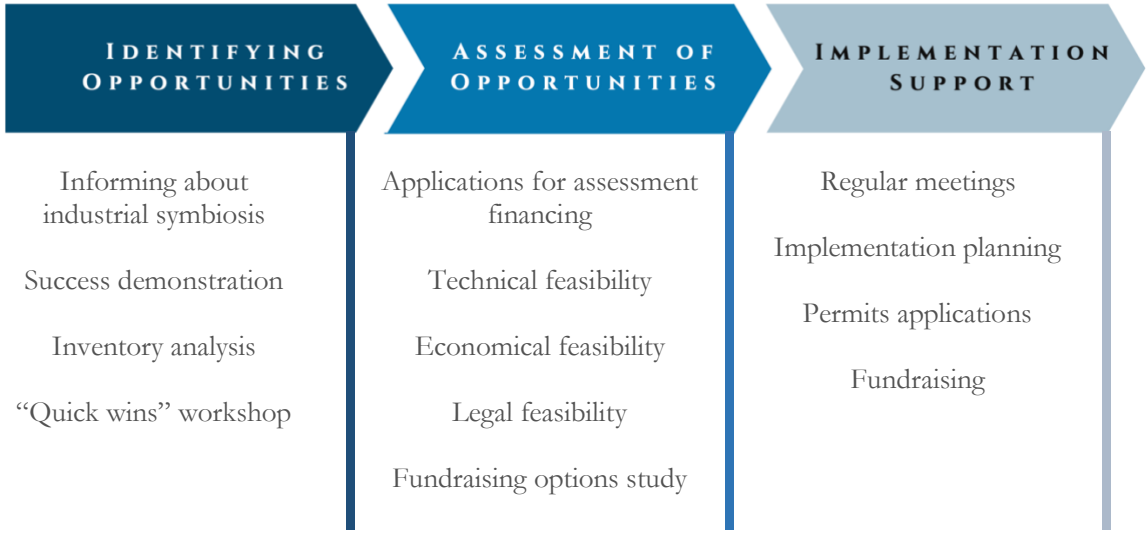

Figure III. Possible facilitation plan for consulting firms in industrial symbiosis
Source: Author.

This study contributes to an understanding of different roles of IS facilitators. It links the empirical results from the Swedish food industry with the *barriers to innovation* and the *innovation intermediary* concepts. The results emphasise the importance of collaboration between public, private and academic facilitators within an IS project. This study illustrates that sustainability consideration has to guide the actions of private consulting firms and increase the firm's reputation and trust from potential customers.

The conceptual and analytical frameworks (Figure I) can be used further in exploring collaboration opportunities in IS facilitation. A clear allocation of facilitation actions between public, private and academic actors can foster the emergence and implementation of symbiotic projects and enhance resource efficiency and low-carbon development, in Sweden and globally.

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Abbreviations

CBM	Circular business model
CE	Circular economy
FVoB	Food Valley of Bjuv
GHG	Greenhouse gas

$GtCO_2$	Gigatonnes of carbon dioxide equivalent
IE	Industrial ecology
IS	Industrial symbiosis
LCA	Life cycle assessment
LCI	Life cycle inventory
RQ	Research question
SLU	Sveriges lantbruksuniversitet [Swedish University of Agricultural Sciences]
SSEC	Swedish Surplus Energy Collaboration

1 Introduction

Global resource use and carbon footprints are growing. Within the last 60 years, the annual global rate of resource extraction has increased from 5.0 to 10.3 tons per capita (Schanes et al., 2019). According to the International Energy Agency (2019), the direct industrial greenhouse gas (GHG) emissions reached 8.5 gigatonnes of carbon dioxide equivalent ($GtCO_2$) in 2017, which was 24% of global emissions. In Sweden, the GHG emissions produced by the manufacturing sector account for 25% of the total (Statistiska Centralbyrån, 2019). According to Steffen et al. (2015), the growing resource extraction, inefficient use, and carbon-intense practices have resulted in climate change, loss of biosphere integrity, land-system change, and altered biogeochemical cycles that are harmful to world's sustainable development. In particular, the food production systems contribute to climate change, biodiversity loss, freshwater use, interference with the global nitrogen and phosphorous cycles, and land-system change (Smith & Gregory, 2013; Willett et al., 2019).

The concept of industrial symbiosis (IS) provides practical solutions for resource efficiency and low-carbon development (Chertow, 2000; Deutz, 2014; Tälle et al., 2019). The concept is based on the notion of symbiotic relationships in nature whereby otherwise unrelated species exchange materials, energy, or information in a mutually beneficial manner (Chertow, 2000). Industrial symbiosis represents a collective, multi-industrial approach for companies to improve their environmental and economic performance through the sharing of heat, electricity, water, by-products, information, and reuse of waste (Chertow & Lombardi, 2005; Deutz, 2014).

Multiple studies have discussed the environmental and economic benefits of IS initiatives. According to Jacobsen (2006), the success of IS exchanges depends on their context and the evaluation perspective. The most popular methods to evaluate IS exchanges include a triple bottom line approach, life cycle assessment (LCA) and material flow analysis (Berkel et al., 2009; Daddi et al., 2017; Eckelman & Chertow, 2013; Jacobsen, 2006; Park & Behera, 2014; Sokka et al., 2011). The key environmental benefits of IS include a reduction of raw material use and GHG emissions compared to stand-alone production (Berkel et al., 2009; Daddi et al., 2017; Sokka et al., 2011). Economically, firms benefit from avoiding waste disposal, substituting input materials at a lower cost, or long-term supply security (Berkel et al., 2009; Chertow & Park, 2019; Eckelman & Chertow, 2013; Jacobsen, 2006). According to Berkel et al. (2009), by-product exchanges in Kawasaki, Japan, compensate 513,000 tons of raw material use annually and provide economic opportunities by diverting the waste from incineration or landfill. A case study from Sotenäs in Sweden suggests that, in addition to environmental benefits, the IS development in the region can make a significant contribution to employment, revenues, skills, research, and innovation (Martin & Harris, 2018). The specific results of IS implementation are different in every case. Moreover, some studies pointed out on trade-offs between impact categories (Berkel et al., 2009; Chertow & Lombardi, 2005; Jacobsen, 2006). However, the implementation of industrial symbiosis can lead to environmental, economic, and social benefits.

In 2020, due to the pandemic situation triggered by the COVID-19 virus outbreak, communities in many countries, including Sweden, are discussing the issue of self-sufficiency in food production (Herin, 2020). The efficiency of the current croplands has to be increased, and the overall environmental footprint of production needs to be lowered (Tischner et al., 2017). According to the IS concept, the water, heat excess, and CO_2 from industrial processes can be effectively reused in the food industry (Nicolaidis, 2015; Parker & Svantemark, 2019). The industrial symbiosis can potentially address the issue of self-sufficiency in food production.

The importance of IS promotion and development was widely acknowledged. The New EU Action Plan on Circular Economy not only recognises IS as a solution for resource efficiency, but also suggests measures to enable broader IS development (European Commission, 2020). These measures include developing an industry-led reporting and certification system, supporting the IS implementation, and promoting the use of digital technologies for tracking, tracing and mapping of resources. In Sweden, a national strategy for a circular economy sets out the direction for a long-term and sustainable transition. This strategy suggests the IS as one of the essential circular economy business models (Government Offices of Sweden, 2020). Thus, from the political perspective, the IS is recognised as a part of the circular economy development.

The potential for IS development is significant. For instance, Aid et al. (2015) estimated the potential for regional material and energy flows in Sweden on a facility level. The results show about 6000 potential symbiosis connections in Stockholm, 3600 in Helsingborg and 3000 in Göteborg. Despite its economic and environmental benefits and significant potential, the practice of IS has not yet gained broad acceptance – in Sweden, or globally.

1.1 Problem Definition

The main challenges to IS emergence include the long duration and the complexity of the projects (Chertow, 2000). The complexity refers to inter-organisational nature of IS. As an inter-organisational innovation process, IS implies a significant change for the industrial companies that are involved. This change can be challenging for companies due to informational, organisational, technical, regulatory, and financial barriers (Aid et al., 2017; Siskos & Van Wassenhove, 2017). Effective facilitation by a third-party organisation engages the companies in cooperation, helps to overcome the barriers, and accelerates the IS development (Chertow, 2007; Chertow & Ehrenfeld, 2012; Hatefipour et al., 2012; Mortensen & Kørnøv, 2019; Paquin & Howard-Grenville, 2012; Patala et al., 2020; Zaoual & Lecocq, 2018).

Academic studies emphasised the importance of understanding facilitation roles in the IS (Paquin & Howard-Grenville, 2012; Patricio et al., 2018; Zaoual & Lecocq, 2018). Typically, an effective IS facilitation process requires actions performed by different organisations (Aid et al., 2017; Boons et al., 2017; Patala et al., 2020). Moreover, studies suggest that collaboration between different facilitators of an IS project can identify new value potential (Klerkx & Leeuwis, 2009; Patala et al., 2020). To understand how different facilitators can collaborate most effectively, the researchers could focus on possible scopes of action for specific categories of facilitators. The discovered categories of IS facilitators include public institutions (local government, public networks), academic institutions, and private firms (Boons et al., 2017, 2017; Chertow, 2007; Paquin & Howard-Grenville, 2012; Patricio et al., 2018; Velenturf, 2017). However, the specific contribution of different categories of IS facilitators to the emergence and development of IS systems is unexplored.

The significance of private firms in environmental innovation process was recognised in academic studies (Bessant & Rush, 1995; Kanda et al., 2018; Kivimaa et al., 2019; Mignon & Kanda, 2018; Pinto, 2019). These firms specialise in supporting participants with the implementation of technologies or bridging between demand and supply of knowledge (Mignon, 2017). Pinto (2019) stated that private consulting firms help to manage innovation processes and to solve emerging problems. From an IS perspective, several studies indicated that private firms could take part in the IS development process (Johnsen et al., 2015; Siskos & Van Wassenhove, 2017; Velenturf, 2017). According to Siskos & Van Wassenhove (2017), private firms can manage an IS system development during construction and operation phases. Nordregio report (Johnsen et al., 2015) described that the Danish approach to IS emergence

implies a close interaction between the Danish Business Authority and regional authorities with private consulting firms. However, a possible scope of actions of the private firms within the emergence of IS systems remains unexplored. Despite the recognition of diverse facilitation actors and roles, the IS literature does not discover how private firms can contribute to the emergence of IS and how these organisations can share roles with other facilitators.

1.2 Aim and Research Questions

This study aims to explore possible roles and strategies of private facilitators in industrial symbiosis projects. Following the aim of this study, research questions (RQs) are defined as:

RQ1: What strategies can be used by private firms to engage in IS projects as facilitators?

RQ2: Why are private facilitators relevant to IS emergence?

RQ3: How can private facilitators contribute to the development of an IS system?

1.3 Scope and Delimitations

The private IS facilitators are in the scope of this study. However, the organisations mentioned in the IS literature as private facilitators are very diverse. Differences between these organisations should not be overlooked, and the research results from one private facilitator may not be generalised to all private facilitators (Mignon & Kanda, 2018). The examples of private firms involved in IS facilitation include process and technical consultants (Johnsen et al., 2015), private waste management companies (Aid et al., 2017), synergy management services companies (Siskos & Van Wassenhove, 2017). Moreover, IS facilitation represents a case of innovation intermediation (Patala et al., 2020). Thus, a typology of innovation intermediaries can be applied to IS facilitators. According to Mignon & Kanda (2018), examples of private intermediaries include consultants, incubators, and industry associations. This category consists of organisations that are funded by charging fees for provided services, or by collecting membership fees. A private consultant is a type of intermediary that assist companies during innovation implementation processes and bridge between demand and supply of knowledge (Bessant & Rush, 1995; Klerkx & Leeuwis, 2009; Mignon, 2017; Mignon & Kanda, 2018; Pinto, 2019). According to Klerkx & Leeuwis (2009), private consultants perform functions of demand articulation, network composition, and innovation process management in the Dutch agriculture sector. However, the contribution of these firms to the development of IS systems is unexplored. The scope of this study is limited to exploring possible roles and strategies of private consultants in industrial symbiosis projects.

A single case study from the Swedish food industry is investigated as part of this thesis. The chosen case is an emerging IS system in Bjuv industrial park located in Scania, Sweden. The system is called "Food Valley of Bjuv" (FVoB) and aims for exchange of heat, water and waste between different industrial facilities. This case explains the possible development of a new circular business area in Swedish food production. Once successfully implemented, the same pattern is planned to be applied to many other locations in Sweden (Regional Council of Scania, 2018). The initial project started around 2013 and still in progress. Over the years, the participant's composition for the FVoB changed. Many private consulting firms contributed to the project's development. In a search for the most relevant focal company within the FVoB case, this study followed the example of the Green Symbiosis programme in Denmark (Johnsen et al., 2015). In the programme, the public funds for IS development are allocated to technical consultants that carry out resource checks (i.e. assess companies' wastes and identify synergies) and facilitate matches between companies. As a result, the private consulting company WA3RM AB was identified. In 2015-2017, WA3RM facilitated a feasibility study for a project called

"Recirculation based production and processing of vegetables and fish" (WA3RM, 2017). This feasibility study was financed by Sweden's Innovation Agency Vinnova and provided a basis for the FVoB. Thus, this thesis focused on the contribution of the private consulting company WA3RM to the "Food Valley of Bjuv" project.

1.4 Ethical Considerations

The general ethical principles of research were applied to this study (Blaikie & Priest, 2019). First, the study is designed to make a worthwhile contribution to the understanding of IS facilitation practice. This contribution should support the broader acceptance and development of IS with its environmental and economic benefits. Second, the research is designed in accordance with sound practice. A case study research design and a grounded theory approach used in this study are accepted among academic researchers (Bryman, 2016; Charmaz, 2014; Creswell, 2007). Semi-structured interviewing as the primary data collection method is appropriate for the research design and approach (Brinkmann & Kvale, 2015). Third, this study was conducted in accordance with the principle of academic freedom. The initial idea for this study appeared as a thesis project for environmental consulting company Ensucon (Lund, Sweden). However, the support from Ensucon was advisory; and the company benefited only as part of the study's audience (see section 1.5). Thus, this study followed such ethical principles as worthiness, high methodological standards, and academic freedom.

The specific ethical principles for research interviewing were applied in this study (Brinkmann & Kvale, 2015). First, all interview participants were informed about the aim of this study and that the Food Valley of Bjuv project was investigated. The information was in the text of every interview request sent via e-mail. Participation was voluntary. In one of the interviews, the participant pointed out that the information about the research was too general, and he could be prepared better if he knew all the questions in advance. However, the contribution of this interview was valuable for generating results. Second, all interview participants' personal information is not mentioned in the study. Participants permitted the disclose of companies' names and job titles. Third, the risk of harm to participants is negligible. The benefit from participation was an opportunity to better understand the issue of IS facilitation (by reflecting on their own answers, or from the study's results). Fourth, the role of the researcher during the interviews was conducted in an ethical and independent manner. The participants were provided with a fully supportive and positive environment to answer the questions. Thus, the interviewing as primary data collection for this study was guided by the principles of informed consent, confidentiality, beneficence, and morally responsible research behaviour.

1.5 Audience

The audience for this study is represented by four groups. The first group comprises the academic researchers specialising in innovation intermediation or IS facilitation issues. The second group is the IS practitioners both from public and private sectors looking for an in-depth understanding of theoretical and practical steps of IS planning and successful implementation. The third group is private consulting firms looking for business opportunities in IS projects in Sweden, specifically in the agricultural and food industry or other sectors. In Sweden, there is a growing interest among state-owned consultancies (RISE, 2020), joined governmental and industrial networks with consulting functions (IVL, 2020), and private consultancies (The Loop Factory, 2020) to provide services associated with IS development. The engagement of private consulting firms to IS project development offers a business opportunity for these companies. This opportunity can be uncovered by exploring the strategies for engagement and possible actions that can be performed by these firms in IS projects. The fourth group is government-funded institutions and network platforms in Sweden and other countries looking for an understanding of measures to stimulate IS development.

1.6 Disposition

Following this introduction, the study comprises five chapters. Chapter 2 starts with creating a conceptual framework for this study. Section 2.1 summarises the concepts that are used in this study and explains how those concepts are applied. This section compiles the conceptual framework that defines the selection of studies for the literature review and further research. Section 2.2. describes the theoretical background for this study.

Chapter 3 covers the methodological approach used in this thesis. This study used a grounded theory approach as a research strategy (3.1.1) and a single case study as a research design (3.1.2). The chapter describes the rationale behind different choices, explaining why and how certain features contribute to the general research aim of this thesis. Section 3.2 describes the data collected in this study, including semi-structured interviews and documentary data. Section 3.3. explains how coding and constant comparison were used in this study for data analysis.

Chapter 4 presents the results of the case study. Section 4.1 describes the case of the Food Valley of Bjuv (FVoB) including the context characteristics, the IS idea behind the project (4.1.1), and perspectives of different stakeholders within the project (4.1.2.). Section 4.2 focuses on RQ1 and explores possible strategies that can be used by private consulting firms to get involved in the IS facilitation by describing the steps of a company WA3RM to engage in FVoB project (4.2.1) and strategic considerations that were derived from this experience (4.2.2). These strategic considerations can be seen as guidelines for other private consulting firms willing to facilitate IS projects. Section 4.3 focuses on RQ2 and RQ3. It explores the role of private facilitators in IS emergence by describing the relevance of these actors to IS projects (4.3.1) and their action-by-action contribution to IS projects' development (4.3.2).

Chapter 5 presents the reflections on findings from the case study; compares the results to the previous knowledge about IS facilitation strategies and roles (5.1); and discusses the use of methods in this study. Chapter 6 summarises conclusions of the study, including practical implications and future research opportunities. The research aim of this study was to discover possible roles and strategies of private facilitators in industrial symbiosis projects in Sweden.

2 Literature Review

This chapter starts with creating a conceptual framework for this study. Section 2.1 goes over the concepts that are used in this study and explain how those concepts are applied. The section summarises with the conceptual framework that defines the selection of studies for the literature review and further research. Section 2.2. describes the theoretical background for this study.

2.1 Conceptual Framework

The RQs (section 1.2) and inductive logic of inquiry have determined the use of concepts in this study. First, to explore the relevance and contribution of private facilitators in IS projects, basic features of IS facilitation and relationships between them have to be discovered. Ontological tradition suggests that concepts identify the basic features of a social phenomenon and relationships between these features (Blaikie & Priest, 2019). Second, the existing knowledge on IS facilitation and roles of different actors can provide initial ideas of what to look for in an empirical study. According to Blaikie & Priest (2019), this opportunity is offered by sensitizing tradition. Therefore, both ontological and sensitizing traditions of using the concepts were applied.

The purpose of using concepts in this study is to create a *conceptual framework* (Figure 2-1). Based on the ontological tradition, this framework identifies the main features of IS facilitation process relevant to RQs: the process of IS development, conditions and actions, barriers, and facilitators supporting the development process. Based on the sensitizing tradition, this framework provides the initial ideas of what should be found in an empirical study. On the last stage of analysis, the empirical findings were compared with this conceptual framework to construct a theory about the roles and strategies of private facilitators in IS projects. The concepts used in this study include *industrial symbiosis*, *barriers to innovation*, and *innovation intermediary*.

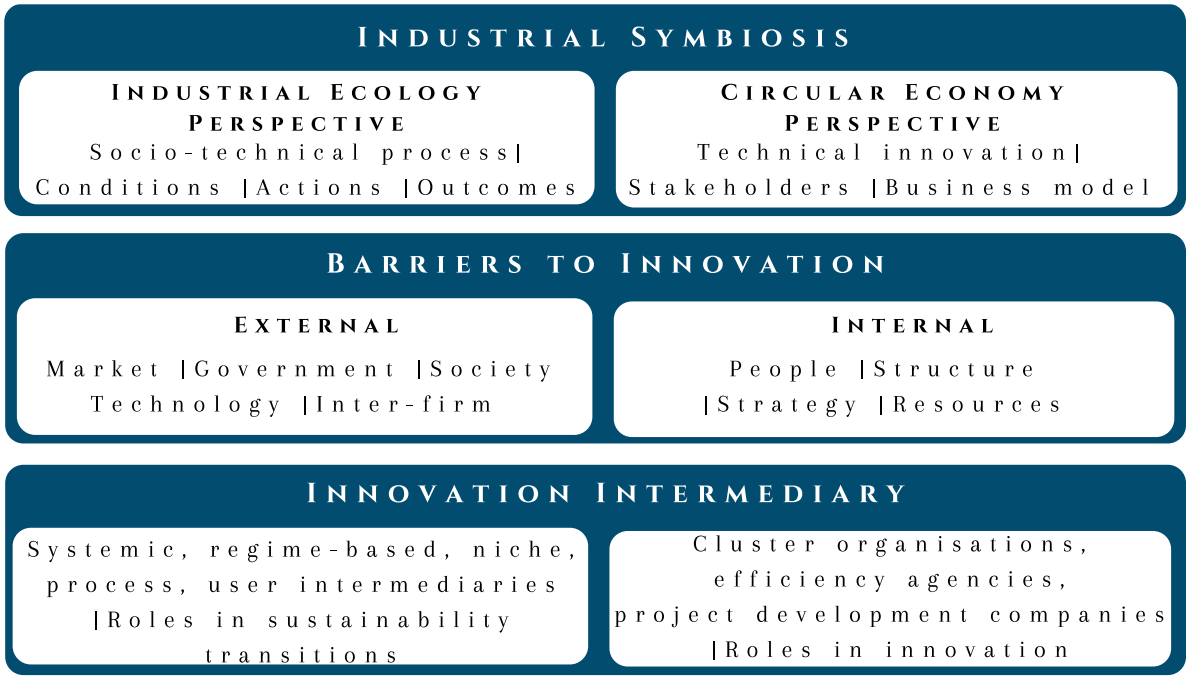

Figure 2-1. Conceptual framework

Source: Author

2.1.1 "Industrial Symbiosis" Concept

A key concept of this study is *industrial symbiosis*. The concept emerged from the idea that wastes from one industrial activity can become raw materials for another, reducing the environmental impact (Frosch & Gallopoulos, 1989). As a concept IS has many definitions. The most cited definition of IS was formulated by Chertow (2000: 313) describing it as a phenomenon that "engages traditionally separate entities in a collective approach to competitive advantage involving a physical exchange of materials, energy, water, and by-products". Deutz (2014: 5) has defined the IS as "a flow of underutilised resource(s), from an entity which would otherwise discard them, to another entity which uses them as a substitute for new resources". According to the concept, the underutilised resources can be in solid, liquid, and gaseous form, or the form of energy, including heat or electricity. From the business perspective, the IS development can be seen as an approach to achieve a more sustainable and integrated industrial system, which identifies business opportunities that leverage underutilised resources (Lombardi & Laybourn, 2012). Thus, the concept of IS suggests a cooperative business-oriented solution for resource efficiency and reducing the environmental impact of the industrial processes (Boons et al., 2017; Chertow, 2000, 2007; Chertow & Lombardi, 2005; Deutz, 2014).

Figure 2-2 schematically presents the idea of IS. The IS system aims to utilise energy and/or material flows that would be disposed of otherwise. It can be created by connecting the flows between existing production systems and by setting up a new production system using the flows from the existing system (Mirata, 2005). As a result, this system decreases the volume of primary resources needed and the volume of discharged energy and/or materials.

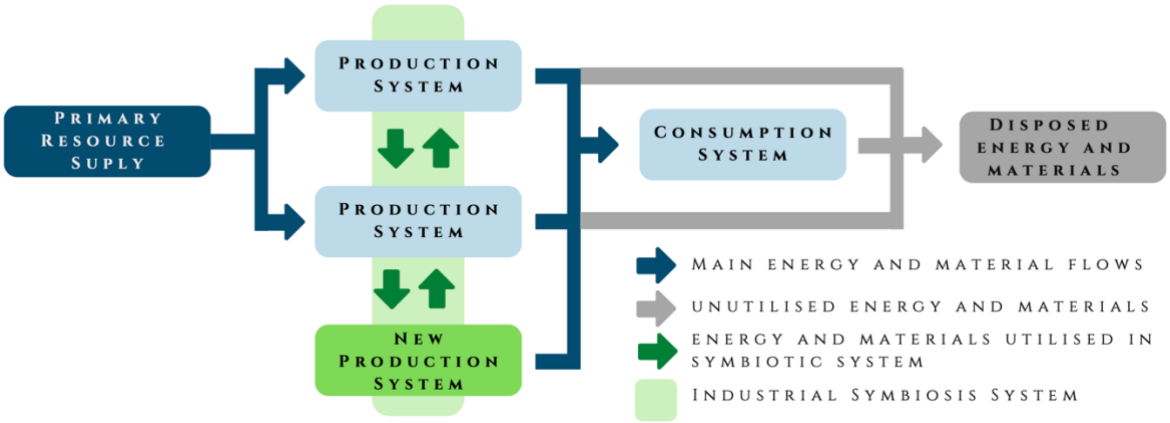

Figure 2-2. Industrial symbiosis system

Source: author based on Chertow (2000), Mirata (2005), and Deutz (2014)

Two different perspectives on IS are commonly recognised in literature: the *industrial ecology* (IE) and the *circular economy* (CE) perspectives. There were not many attempts to develop an integrated perspective on the IS concept (Baldassarre et al., 2019). Both perspectives provide a valuable contribution to the understanding of the role of private facilitators in IS.

Industrial Ecology Perspective

IE as a discipline aims to reduce the environmental impact of industrial systems by closing energy and resource loops on analogy with the ecosystem (Ehrenfeld & Gertler, 1997). The above definitions of IS by Chertow (2000) and Deutz (2014) are from the IE perspective. IE addresses the process of design and implementation of industrial clusters (Baldassarre et al., 2019). Initially, the industrial park of Kalundborg in Danmark was used as an example of the IS

concept in practice (Chertow, 2007). This focus on industrial cluster emphasizes the importance of geographical proximity. According to Baas (2011), the proximity of industrial companies is needed to ensure the connections between entities and the exchange of energy, wastes, and by-products. Moreover, IE perspective addresses the IS as a dynamic, collaborative process. Boons et al. (2017: 941) has formulated IS as "a process of connecting flows among industrial actors through the use of secondary material, water, and energy resources and/or utility and service sharing, such as collective use of infrastructure or environmentally related services across a network". This definition suggests that IS is a process of change. This change has to be made by the developing and mobilising of resources, including intellectual capital and social capital by public and/or private actors (Boons et al., 2017). IE perspective provides an understanding of the design and implementation of IS as a socio-technical process. This process includes starting conditions, implementation actions, and outcomes (Baldassarre et al., 2019). Thus, IE perspective on IS can be used to analyse the implementation actions of different actors.

The IE literature suggests several ways of how IS emerges. The most cited ways include self-organisation (Chertow, 2007; Ehrenfeld & Gertler, 1997), public planning (Chertow, 2007; Gibbs & Deutz, 2007), and facilitation (Boons et al., 2017; Paquin & Howard-Grenville, 2012; Patala et al., 2020). These three ways are illustrated in Figure 2-3. In self-organised IS, the symbiotic connections are developed by industrial companies participating in the network. In planned IS, the entire symbiotic system is set by a public organisation (municipality, industrial development agency, regional planning commission, etc.). This public organisation aims to provide public benefits and does not participate in the exchanges (Chertow & Ehrenfeld, 2012). The studies suggest that self-organised IS systems have a higher success probability than the planned ones, but longer development periods (Paquin & Howard-Grenville, 2012). In facilitated IS, the symbiotic connections are set by a third-party organisation that becomes a part of the symbiotic system in terms of sharing the economic benefits and knowledge (Boons et al., 2017; Paquin & Howard-Grenville, 2012). In comparison with self-organised and planned systems, the facilitated IS can have both a high success probability and shorter development periods (Paquin & Howard-Grenville, 2012). Thus, the facilitation can be seen as a way to increase the IS system's success probability and speed up its development.

In practice, the emergence of IS can have characteristics from all three models. For instance, Boons et al. (2017) suggest seven different types of dynamics based on initial actors, their motivation, overall storyline, and typical outcomes. Moreover, several studies argue that IS systems develop and change over time (Boons et al., 2017; Doménech & Davies, 2011; Paquin & Howard-Grenville, 2012). In general, the IE perspective describes the IS system development as a process and sets emphasis on how does this system appears step-by-step.

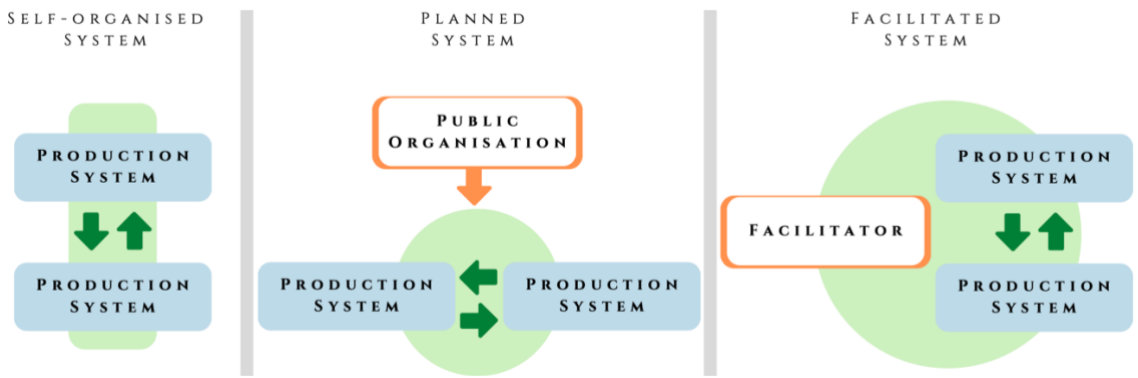

Figure 2-3. Three ways of industrial symbiosis emergence
Source: author based on Chertow (2007) & Paquin & Howard-Grenville (2012).

Circular Economy Perspective

IS is also discovered from CE perspective. IS represents an example of a circular economy business model (Baldassarre et al., 2019; Bocken et al., 2014; Short et al., 2014). CE can be defined as "a regenerative system in which resource input and waste, emission, and energy leakage are minimised by slowing, closing, and narrowing material and energy loops" (Geissdoerfer et al., 2017: 759). This regenerative system can be achieved through different strategies, including design, maintenance, repair, reuse, remanufacturing, refurbishing, and recycling (Ellen MacArthur Foundation, 2013). These strategies can be driven by implementing circular business models (CBMs). A spectrum of possible CBM can be structured into eight different archetypes: maximise material and energy efficiency, create value from waste, substitute with renewables and natural processes, deliver functionality rather than ownership, adopt a stewardship role, encourage sufficiency, re-purpose the business for society/ environment, and develop scale-up solutions (Bocken et al., 2014). An archetype to create value from waste includes the IS as a CBM. According to Baldassarre et al. (2019), CE perspective investigates three main aspects: technical innovation, collaboration, and sustainable business model innovation. First, technical innovation in IS is based on the exchange of otherwise unutilised energy and materials across production systems (Fraccascia et al., 2016; Short et al., 2014). Second, the collaboration aspect identifies the stakeholders that interact to implement and operate the IS system (Short et al., 2014). Third, sustainable business model innovation aspect covers business model elements that aim in creating value from waste. These elements include a value proposition, value creation/delivery activities, and value capture mechanisms (Bocken et al., 2014). CE perspective on IS focuses on different stakeholders and their roles in IS. Thus, this perspective can be used to analyse different roles in IS implementation, including the possible roles of private facilitators.

Both IE and CE perspectives on IS provide an understanding of different aspects of IS. The IE process perspective sets emphasis on how does the IS system appears step-by-step. The CE perspective discovers the economic logic behind the system implementation and different stakeholders' roles. This study considers both perspectives as equally important to generate an in-depth understanding of private facilitator's role and strategies for IS.

2.1.2 "Barriers to Innovation" Concept

The IS implementation process can be understood as environmental innovation. Environmental innovation occurs when new or modified processes, techniques, production systems or products are developed to improve the environmental performance of production and consumption activities from a lifecycle perspective with or without prior intention (Horbach, 2008; Kanda et al., 2018; Kemp & Arundel, 1998). Since IS represents a modified process or even a new production system (see Figure 2-1) that can potentially improve environmental performance, it can be considered as environmental innovation (Chertow, 2007; Harris, 2004; Mirata & Emtairah, 2005; Short et al., 2014). As inter-organisational innovation, IS implies a change for industrial companies that are involved. This change can be challenging for companies because of different barriers. The IS implementation process should start with identifying barriers and systematic look into their reasons. According to Harris (2004), in IE, the barrier categories are, in most cases, the same as enabling factors. Elimination of barriers can be achieved only with a detailed plan of action (Hadjimanolis, 2003). This plan of actions requires an outside independent perspective which is represented by facilitation. Hence, IS facilitation is needed to identify and overcome the barriers.

Barriers to innovation concept is an approach to discover factors preventing innovation in organisations (Hadjimanolis, 2003; Kemp & Arundel, 1998). The plan of actions based on identified barriers represents a facilitation strategy that supports the IS implementation plan.

Thus, barriers to innovation concept is a starting point for understanding IS facilitation strategies.

The identification of barriers requires a classification methodology. The literature on IS covers a wide range of barriers. However, as noted by Golev et al. (2015), this literature lacks methodology for the analysis of IS barriers and real cases that describe the process of investigation and overcoming these barriers. The development of this methodology and the exploring of possible strategies to overcome IS barriers can potentially help to the practical implementation of IS projects. The most cited classification for barriers to innovation includes external and internal factors (Hadjimanolis, 2003). External barriers originate from the outside environment (society, government, market, competitors, etc.); internal barriers exist inside the organisation.

First, external barriers include market-related, government-related, technical, societal and inter-organisational barriers (Hadjimanolis, 2003). Market-related barriers can be represented by market failures, "short-terminism", and financial barriers. The "short-terminism" issue occurs when potential investors need short-term results to invest in a project. This barrier is essential to IS development since IS projects are long-term and do not offer economic benefits within the first years. The financial barriers can occur when the investors are not willing to share the risks associated with innovation projects. Different regulations and policies represent government-related barriers. The barriers to innovation occur due to unintended results of policies and side effects of regulations. For instance, obtaining environmental permits for IS project can take long and cause a barrier to the project's implementation. Technical barriers are also relevant to IS projects since creating value out of waste and connecting the flows between industries require advanced technology.

Second, internal barriers can also be called organisational barriers. Internal barriers refer to specifics of the company experiencing the barrier. These barriers include people-related, structural, strategy,- and resource-related factors (Hadjimanolis, 2003). People-related barriers occur on an individual level due to perceptions, lack of motivation, lack of commitment, deficits in skills, lack of knowledge, even personal goals and interests that can differ from organisational ones. The top management's lack of commitment can be indicated when the risk-taking is not supported in the company, or there is a lack of toleration of failure (Hauschildt, 2003). At the same time, the lack of knowledge about the idea of IS can become a barrier on different levels of the company. Structural barriers hinder the innovation process by decreasing the problem-solving capacity of the company. They occur in communication flows, incentive systems, and obstacles created by different departments (Hauschildt, 2003). Strategy barriers can appear when the innovation does not match the strategic goals of the company, or the opposite when technical personnel is not aware of innovative strategy and objectives (Lee, 2000). This barrier is relevant, because IS project is typically different from the company's core business. Resource-related barriers include lack of internal funds and lack of equipment.

The barriers can vary in different contexts. These contexts include the type of innovation, the type and size of the company, the sector, the location, and the phase of the project's development. Moreover, Hadjimanolis (2003) states that different stages of the innovation process have different barriers that need to be eliminated. As mentioned above, IE perspective considers IS implementation as a process with different phases. According to Siskos & Van Wassenhove (2017), IS project has phases as a project idea, feasibility study, construction, and operation. Thus, the plan of actions to reduce barriers has to be specific not only to the context but also to every phase of the IS implementation process.

As the inter-organisational innovation process, IS implementation requires to be coordinated by a third-party. The complexity of barriers increases when it comes to multi-actor innovation. Additional transaction and coordination barriers occur because companies have to open their institutional borders (Petersen et al., 2014). The third-party can focus on reduction of these barriers. This third party acts as an intermediary in the innovation process, helping to overcome the barriers and foster the innovation. The concept of innovation intermediary is essential for this study to understand the role of private facilitators in the IS development process.

2.1.3 "Innovation Intermediary" Concept

The role of private facilitators in IS can be explored through a concept of innovation intermediary. *Innovation intermediary* is defined by Howells (2006: 720) as "an organisation or body that acts as an agent or broker in any aspect of the innovation process between two or more parties". Typically, this organisation provides information on potential partners for innovation, negotiates transactions between parties, mediates any existing collaborations, and helps to find specific knowledge, funding and support for the innovation outcomes. Other terms for intermediary include a *third-party*, *broker*, and *facilitator* (Gliedt et al., 2018; Howells, 2006; Kanda et al., 2018; Kivimaa et al., 2019). IS facilitators are also identified as innovation intermediaries (Patala et al., 2020). Thus, the concept of innovation intermediary is appropriate to explore the role and strategies of private facilitators of IS.

On a general level, the innovation intermediaries play a role in the sustainability transition. Howells (2006) suggests that intermediaries can initiate change within science networks and local communities. Kivimaa et al. (2019) indicate that transition intermediation occurs between local projects and the global innovation niche. The intermediaries can retranslate the world's best practices for a local experimental project. Bessant & Rush (1995) state that consultants specifically are an integral part of policies aiming at stimulating the diffusion of industrial best practice. Besides, intermediaries can create connections between governments and businesses within society. According to Gliedt et al. (2018), the links between innovation intermediaries, green champions, and policy entrepreneurs can contribute to a green economic development strategy. The study suggests that sustainability-oriented innovation intermediaries link business, municipal, and state actions to accelerate sustainable development in a politically feasible way. Kanda et al. (Kanda et al., 2018) recommend to policymakers a complementary use of environmental innovation intermediaries to support sustainability transition. Thus, further exploration of a role and operational strategies of private consultants in IS facilitation can contribute to understanding the pathways for the sustainability transition.

On an operational level, the role of an innovation intermediary depends on its type. Among different classification, Kivimaa et al. (Kivimaa et al., 2019) provide the most explicit typology of innovation intermediaries based on their emergence, neutrality, goals, context, and level of activity. The typology has five categories: systemic intermediary, regime-based transition intermediary, niche intermediary, process intermediary, and user intermediary. An IS facilitator can be classified as a *process intermediary* that "facilitates a change process or a niche project rather than broader niche level; in support of context-specific (project-based or spatially located) and/or external (niche, regime) priorities set by other actors" (Kivimaa et al., 2019, p. 1070). The functions of process intermediaries include facilitation and support in projects and processes that contribute to sustainability transitions. Typically, these intermediaries are established or employed to facilitate the implementation of a project. This project can be part of a niche or transition processes (as networks or information platforms).

The roles of innovation intermediaries can be seen as *functions* and *actions*. *Functions* are general categories that refer to "what" can be done to support the innovation process (Bessant & Rush, 1995; Howells, 2006; Kanda et al., 2018; Kivimaa et al., 2019). *Functions* can be divided into

actions. Actions are specific categories that refer to "how" the function is performed (Hakkarainen & Hyysalo, 2016; Howells, 2006; Patala et al., 2020). According to Kanda et al. (2018), the functions of innovation intermediaries include eight categories: forecasting and road mapping, information gathering and dissemination, fostering networking and partnerships, prototyping and piloting, technical consulting, resource mobilisation, commercialisation, and branding and legitimation. These functions consist of specific actions. For instance, forecasting and road mapping function includes such action as generating a portfolio of cutting-edge environmental innovations for a particular industry. Information gathering and dissemination function includes such action as providing a platform for meetings and information sharing, gathering and distributing information among key stakeholders. This typology development included case studies of environmental intermediaries from Scania, Sweden. It provides a valuable context-specific classification of functions for this thesis. However, in all the cases investigated by Kanda et al. (2018), the intermediaries were state-owned or state-funded. Since the focus of this thesis is on IS facilitators from the private sector, the question is, can the same functions be applied to the private intermediaries.

Some studies analysed the variety of organisations that can intermediate innovation. According to Mignon & Kanda (2018), there are three main types of intermediaries: cluster organisations, efficiency agencies, and project development companies. The cluster organisations play a role of networking platforms. The efficiency agencies are government-funded organisations supporting the innovation development at the regional level (e.g. the Swedish Energy Agency). The project developing companies include private consulting firms that support the innovation development of their clients. Mignon & Kanda (2018) describe the functions of the private consulting firms in innovation which is relevant to this thesis. The discovered functions are presented in Table 2-1 below. In theory, there is a clear separation between possible functions of different intermediaries. The functions of private consulting firms are limited to coordination during all the project phases (planning, construction, and operation). This typology relies on data from the renewable energy sector. Mignon & Kanda (2018) do not state if it can be applied to IS projects. However, the proposed spectrum of functions is relevant to this study.

Studies related to private consultants' role in innovation process suggest that most of the functions are similar for any innovation. According to Bessant & Rush (1995), there are four functions of a private consultant in the innovation process. Those include the direct transfer of expert knowledge of consultant; experience sharing, when a consultant transfers experiences and ideas from one context into another (company, industry, location); "marriage brokering", providing a company with specialised service contacts; and diagnostic function, helping a company to articulate, define its needs in innovation, create a strategic framework for change, and identify potential barriers. Exploring motivations of companies to engage with consultants, Pinto (2019) agreed that consultants provide expert knowledge and access to other innovation players. According to the study, the most valuable features of consultants are training services from consultants, expert skills, and strategic partnerships with knowledge centres. Pinto (2019) stated that companies look for a consultant's assistance in the search for a way to manage innovation processes and solve emerging problems in the later phase of the process. That is why the diagnostic function suggested by Bessant & Rush (1995) is essential in an initial phase of innovation.

In general, the concept of *innovation intermediary* provides a theoretical understanding of different actors supporting the innovation process and their functions. The discovered intermediaries include private consulting companies and their functions. However, there is a lack of empirical studies that explore the context-specific aspects of how these functions are performed.

Table 2-1. Intermediary organisations and their functions in innovation

Organisation Type	Functions
Cluster organisations	• Fostering networking and partnerships (e.g. provide platforms such as breakfast meetings, conferences, seminars to discuss innovation opportunities); • Increasing awareness by gathering and dissemination of sector specific information among their members and clients; • Providing environmental innovation forecasts and roadmaps for members.
Efficiency agencies	• Connecting companies to local business development organisations, energy consultants, banks and industry associations; • Assistance to companies with writing applications for funds and bridging them to banks, writing tenders, evaluating bids, commenting on prices and offers.
Project developing companies	• Coordination between stakeholders (industrial companies, property owner, neighbors, building permit authority, technology suppliers) during a planning phase; • Coordination between financing companies; • Coordination of the construction (road builders, foundation builders, installers, grid owners, etc.) and ensuring the requirements that all actors deliver what is required; • Coordination of the maintenance contracts on behalf of all stakeholders during the operation phase.

Source: Mignon & Kanda (2018)

2.2 Theoretical Background on Industrial Symbiosis Facilitation

The theoretical background on IS facilitation was collected based on the conceptual framework developed for this study (section 2.1). The selection of studies for this literature review is described in section 3.2.1. The selected studies cover both general literature on IS facilitation and case studies from Sweden. Thematically, this review covers the actions addressing barriers to IS development (2.2.1) and facilitation functions of different organisations in IS (2.2.2).

2.2.1 Addressing Barriers to Industrial Symbiosis

The emergence of IS is connected with different factors that can hinder or enable the process (Harris, 2004). Some studies discover critical conditions for IS emergence (Boons et al., 2017; Doménech & Davies, 2011; Mortensen & Kørnøv, 2019). However, some authors adopted the *barriers to innovation* concept explained in section 2.1.2 (Graham Aid et al., 2017; Bacudio et al., 2016; Golev et al., 2015; Harris, 2004; Siskos & Van Wassenhove, 2017). From this concept's perspective, the hindering factors are barriers, enabling factors are actions addressing the barriers. This approach suggests that the critical conditions can be addressed by facilitation.

The IS studies discovered a wide range of barriers that can hinder the process of emergence or implementation. The facilitation actions can be classified according to the barriers these actions address. The literature indicates informational, organisational, inter-organisational, technical, regulatory, economical, and financial categories as the main barrier categories to IS development that can be addressed by facilitation (Graham Aid et al., 2017; Bacudio et al., 2016; Golev et al., 2015; Harris, 2004; Siskos & Van Wassenhove, 2017).

Overcoming Informational Barriers

Before industrial companies realise the potential for IS and start working on a project idea, they have to overcome informational barriers (Chertow, 2007; Golev et al., 2015; Siskos & Van Wassenhove, 2017). Informational barriers refer to a lack of knowledge. In the agriculture and food industry, the lack of information about cooperation opportunities and competence in project's procedures are two main barriers for inter-organisational innovation activities (Petersen et al., 2014). The informational barriers can occur on different organisational levels and during different phases of IS project implementation. First, it would not be possible to understand the potential for IS if there is a lack of awareness about IS concept (Bacudio et al., 2016; Golev et al., 2015; Siskos & Van Wassenhove, 2017). This barrier causes an insufficient understanding of IS terminology and its benefits for the environment and the company. It can be addressed by informational seminars among top managers and other potential stakeholders (Bacudio et al., 2016; Bocken & Geradts, 2019). Second, the personnel can lack practical knowledge of IS implementation. This barrier can be addressed by recruiting staff expertise in IS and series of training related to implementation steps in IS projects (Bocken & Geradts, 2019). Third, a lack of information sharing among industrial companies can hinder the emergence of an IS project. This barrier refers to a situation when the industrial companies do not exchange information and publically available data on processes and waste streams is insufficient to identify matches (Bacudio et al., 2016; Golev et al., 2015; Siskos & Van Wassenhove, 2017). The facilitation actions addressing this barrier include creating an *inventory* and organising "quick wins" workshops between potential partners.

The *inventory* is an essential step in facilitating an IS project. It is a collection of life cycle inventory (LCI) data, waste data, and industry attribute data related to local companies to identify suitable matches (Aid et al., 2015; Siskos & Van Wassenhove, 2017). LCI data is a material flow information on industrial processes or products. In some European countries, national or international initiatives have created LCI databases of material flows and waste streams from participating companies. The examples include the European Platform on Life Cycle Assessment (EPLCA, 2020), the UK National Industrial Symbiosis Program (NISP, 2020). In Sweden, the Swedish Live Cycle Centre (SLCC, 2020) represents the LCI database. These databases hold gate-gate and/or cradle-to-cradle information of resource streams from and to the environment that is related to a particular industrial process or product (Aid et al., 2015). Waste data can be obtained from corporate environmental reports, local waste management company databases, national or international statistics. Industry attribute data includes location, economic information, production, industry classification code related to individual industrial companies and facilities. This data can be obtained from national statistical bureaus or other agencies. The inventory is essential for identification of potential IS exchanges and conducting a feasibility study on the later phase of IS development.

The inventory can be later used during the "quick wins" workshops, where all the potential partners are brought together (NISP, 2020; Paquin & Howard-Grenville, 2012). The engaging companies should start with using preexisting individual and organisational contacts and expand afterwards. The idea is to create interactive spaces for presenting the related case studies, discussing the inventory information, and sharing individual company's wastes, energy and material excesses and resource needs. These networking activities can result in an opportunity identification that refers to input-output matching and new process discovery (Grant et al., 2010; Paquin & Howard-Grenville, 2012). These workshops have to be part of a strategic plan. Otherwise, the realisation of the identified opportunities can be blocked by other barriers (Grant et al., 2010).

Overcoming Technical Barriers

The technical barriers represent different technical obstacles that prevent the IS project from development. These barriers can include uncertainty in the technical feasibility of the identified opportunities (Golev et al., 2015) and lack of technological expertise (Bacudio et al., 2016; Golev et al., 2015). The technical feasibility can be investigated internally. The researchers suggest that companies should be active in the search for technical solutions from the latest scientific achievements (Park & Won, 2007). The new personnel with specialised knowledge can also be recruited (Bocken & Geradts, 2019). However, internal expertise can be supported by a consulting company or research organisation (Golev et al., 2015; Park & Won, 2007; Siskos & Van Wassenhove, 2017). The external organisation can provide direct expertise, the knowledge from experience in other projects, specialised service contacts. These features correlate with mentioned in section 2.1.3 functions of private consultants in the innovation process (Bessant & Rush, 1995; Pinto, 2019).

Overcoming Organisational Barriers

The organisational barriers to IS development projects occur when the organisation's strategy, goals, and performance measures do not motivate managers to develop and participate in the IS projects (Golev et al., 2015). Here, the most influential barriers include a lack of support from the top management (Bacudio et al., 2016), incompatibility of IS project with a current management practice, and incentive scheme focused on short-term financial targets (Bocken & Geradts, 2019). For example, sometimes due to the existing management practice, operational managers do not have enough time in their schedule for coordinating the IS implementation process (Bacudio et al., 2016). The possible facilitation actions for organisational barriers include communicating the benefits of the IS project (related to overcoming the information barrier, but more specific), senior management supervision, creating structurally separated unit, tailored implementation plan, incentive scheme for the IS project implementation, and including the project into the corporate targets and policy (Bocken & Geradts, 2019; Fichtner et al., 2005; Golev et al., 2015; Grant et al., 2010).

Overcoming Cooperation Barriers

The category of cooperation barriers relates to difficulties of inter-organisational collaboration within IS project. This category includes a lack of willingness to collaborate, a lack of trust among industrial companies, and a lack of institutional support for integration, coordination and communication (Bacudio et al., 2016; Chertow, 2007; Fichtner et al., 2005; Golev et al., 2015; Siskos & Van Wassenhove, 2017). The willingness to cooperate can be increased through informational campaigns and training about the benefits of sustainability and cooperation between companies (Fichtner et al., 2005). According to Golev et al. (2015), the trust between key companies is one of the critical elements for a new IS project. The trust is considered as a prerequisite of successful cooperation since most companies lack any collaborative mechanism (Bacudio et al., 2016). The coordination barriers can be addressed by arranging regular meetings between managers of companies (Fichtner et al., 2005). However, Golev et al. (2015) suggest that a coordinating body can significantly increase the trust, willingness to cooperate, and cooperation in general. Moreover, creating a synergy operator can help to overcome the economic and financial barriers associated with IS projects (Siskos & Van Wassenhove, 2017).

Overcoming Regulatory Barriers

Regulatory barriers refer to difficulties of regulations related to IS projects. First, in some cases, the regulation of transportation and reuse of waste did not recognise recent technological advances (Golev et al., 2015; Siskos & Van Wassenhove, 2017). Some companies might need external legal advice to make sure the project meets the requirements. From regulation authority's perspective, a regular and timely update of environmental legislation is necessary.

Second, the construction of new infrastructure or facilities for the project needs specific permits from authorities. Obtaining these permits can be hard and might benefit from external support (Golev et al., 2015). Third, a lack of policy incentives for IS initiatives is also a barrier (Bacudio et al., 2016). For instance, the regulation can promote an IS emergence by prohibiting to landfill reusable waste, providing tax relief, or promoting best-known practices in waste reuse (Bacudio et al., 2016; Chertow, 2007; Donovan, 2019; Golev et al., 2015; Milios, 2018). The IS projects can have specific regulatory barriers related to the industry or technology. For instance, in Sweden, specific regulations support municipalities as local decision-makers in protecting agricultural land (Öhlund et al., 2020; Swedish Board of Agriculture, 2013).

Table 2-2. Actions addressing barriers to industrial symbiosis

Category	Barrier	Addressing Action
Informational	Lack of awareness	Seminars on IS concept Study similar cases
	Lack of practical knowledge	Training on IS practice Recruiting with IS knowledge
	Lack of information sharing	Inventory analysis "Quick wins" workshops
Technical	Technical uncertainty	Technical feasibility study
	Lack of technical expertise	Recruiting with specific expertise Connect with knowledge centres
Regulatory	Difficult regulation	Legal feasibility study Timely update of environmental legislation
	Obtaining permits	Permits application support
	Lack of policy incentives	Prohibit to landfill a reusable waste Promote best practices Providing tax relief
Financial	Long payback periods	Economic feasibility study Finding a contractor/creating a synergy operator
	Limited access to financial instruments	Applying for business innovation and research grants, green bonds, or business loans Eligibility check for subsidies
Organisational	Lack of support from the top management	Communicating the benefits of the IS project
	Incompatibility with a current management practice	Tailored implementation plan Creating a separated unit Senior management supervision
	Incentive scheme focused on short-term	Incentive scheme for implementation Including the project into corporate targets and policy
Cooperation	Lack of willingness to collaborate	Seminars on the project's benefits Informational campaigns
	Lack of institutional support for integration	Regular meetings Finding a contractor/creating a synergy operator
	Lack of trust among industrial companies	

Source: synthesised by author based on Siskos & Van Wassenhov (Siskos & Van Wassenhove, 2017), Bocken & Geradts (2019), Bacudio et al., Golev et al. (2015), Donovan (2019), and Paquin & Howard-Grenville (2012).

Overcoming Financial Barriers

The category of financial barriers refers to difficulties for IS project implementation related to the monetary support of the project. The main financial barriers include long payback periods and limited access to financial instruments (Bacudio et al., 2016; Fichtner et al., 2005; Golev et al., 2015; Grant et al., 2010; Polzin et al., 2016; Siskos & Van Wassenhove, 2017). Grant et al. (2010) state that the challenges of financing or looking for investment capital for IS projects are similar to any projects in innovation. According to Fichtner et al. (2005), the inter-organisational projects aiming to connect energy and material flows are typically capital-intensive. Moreover, the payback periods for these projects are long. This is a significant challenge for IS projects. Especially when short-term profits are emphasized in a company's corporate practice. To address this challenge, an economic feasibility study can be conducted. The economic feasibility might support the investment decision with a potential for increased revenue, lower operational costs, lower input or waste disposal costs, diversified and/or secured water, energy, and material supplies (Golev et al., 2015). Another financial barrier is the limited access to financial instruments. This barrier can be addressed by applying for support through economic development and venture centres, business innovation and research grants, green bonds, and business loans. Moreover, since the environmental outcomes of IS projects include public benefits, these projects may be eligible for subsidies through governmental agencies (Grant et al., 2010).

All identified in literature actions are collected into Table 2-2. First, some of the actions can address two or more barriers. Second, actions from the same category can be performed on the different phases of IS project implementation. Third, actions can be performed by different actors. Some of the actions are meant to be performed only by the company itself (recruiting, creating separated unit, senior management supervision, etc.). However, most of the identified actions aim to coordinate united efforts between organisations and thus have to be performed by external facilitators (seminars, workshops, feasibility studies, etc.). Some studies separate the actions that can be executed by an external facilitator and classify those actions chronologically (Grant et al., 2010; Paquin & Howard-Grenville, 2012; Zaoual & Lecocq, 2018). This approach identifies several phases in the facilitation process. Moreover, this approach demonstrates that the emergence of IS system can rely on a facilitation plan. A theoretical version of the facilitation plan is illustrated in Figure 2-4.

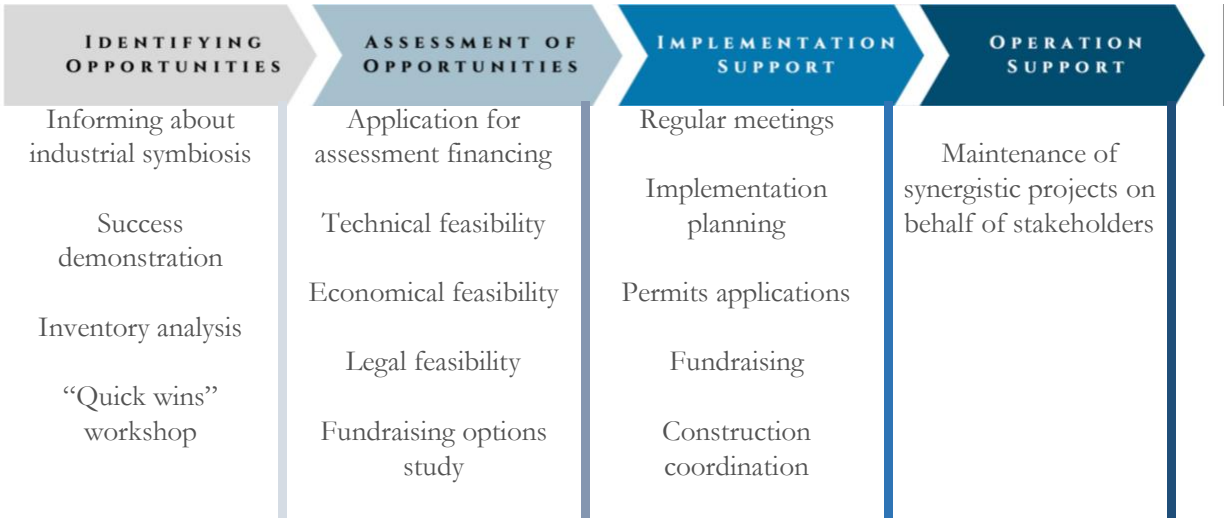

Figure 2-4. Phases of facilitation plan for industrial symbiosis
Source: author based on Grant et al. (2010), Paquin & Howard-Grenville (2012), Zaoual & Lecocq (2018), and Siskos & Van Wassenhov (2017).

Based on the *innovation intermediary* concept described in section 2.1.3, the IS implementation process can be facilitated. Many studies on IS stated that facilitation is crucial for accelerating development towards IS (Chertow, 2007; Chertow & Ehrenfeld, 2012; Hatefipour et al., 2012; Mortensen & Kørnøv, 2019; Paquin & Howard-Grenville, 2012; Patala et al., 2020; Zaoual & Lecocq, 2018). Facilitation actions are essential to address the barriers experienced by industrial companies involved in synergy cooperation. A facilitation plan can be used by a potential facilitating organisation to support an IS project emergence and development.

2.2.2 Facilitation Functions in Industrial Symbiosis

IS literature shows the importance of facilitation to IS project development. This contribution can be seen as different functions that are needed to overcome barriers. This approach correlates with actions addressing the barriers (see section 2.2.1). One function can include several actions and be performed by several facilitators. Table 2-3 presents an example of IS facilitation functions typology. IS facilitators can create trust between industrial companies that have never worked together before, raise awareness and reveal value based on industrial ecology principles, institutionalise the synergy cooperation through collective norms and governance mechanisms (Chertow & Ehrenfeld, 2012; Doménech & Davies, 2011; Grant et al., 2010; Patala et al., 2020; Zaoual & Lecocq, 2018). These functions are typically performed by government agencies or governmentally-owned organisations (Costa & Ferrão, 2010; Zaoual & Lecocq, 2018). However, the recent studies indicate that these functions can also be performed by associations, NGOs, and private businesses (Paquin & Howard-Grenville, 2012; Patala et al., 2020; Walls & Paquin, 2015).

Table 2-3. Facilitation functions in industrial symbiosis

Category	Associated Actions
Revealing value	• Raising environmental awareness within companies; • Promoting the use of residual materials as valuable resources; • Highlighting the potential economic and environmental benefits
Generating trust	• Activating communication and reducing the mental distance between the companies by providing a platform; • Creating common policies, codes of conduct, confidentiality charters, and partnership agreements
Activating industrial symbiosis	• Identifying potential exchanges; • Absorbing and reducing the associated transaction costs
Institutionalizing industrial symbiosis	• Sharing feedback and success stories; • Building indicators for the assessment of the economic and environmental benefits

Source: Zaoual & Lecocq (2018)

In some studies, waste management companies are recognised as potential IS facilitators. These companies contribute to IS development by finding ways to move waste up the waste hierarchy (European Commission, 2018). In Sweden, the waste management companies (both public and private) tend to expand their functions towards synergy creating and addressing the barriers to IS development (Aid et al., 2017). However, these companies focus more on material resources, rather than the energy, water and heat reuse opportunities.

Some studies discuss the functions of different networks in IS facilitation. These networks can build a level of trust between the potential partners for IS exchanges (Paquin & Howard-

Grenville, 2012). The trust between the potential partners is an important issue in the Swedish context. For example, Baas (2010) argues that in all the IS cases in Sweden, the level of trust is very high. The trust leads to many links between municipalities, industrial companies and knowledge centres to develop common solutions. The function of building trust includes different actions from organising facility site visits and one-on-one meetings with the company's personnel and network's personnel (Paquin & Howard-Grenville, 2012). In several Swedish regions, specific organisations for cooperation between different actors are designed (Baas, 2010). In Sotenäs, Sweden, the IS system has been facilitated by the Sotenäs Symbioscentrum. The Symbioscentrum aims to create "green", local jobs and contribute to a better environment and sustainable future for the local community (Martin & Harris, 2018). As a result, several synergies between industrial companies have been realised. The network supported the permits application process. The potential business opportunities for industrial companies include innovative products upcycling waste heat, renewable energy, food production, aquaculture, algae production, fish industry waste, and other wastes from the neighbouring sea. Thus, the networks perform a specific function of connecting different companies and building trust.

Despite the recognition of diverse facilitation functions, the literature does not specify how private consulting firms can contribute to the development of IS projects and how these firms can share facilitation functions with other organisations.

3 Methodology

3.1 Research Approach

This section covers the methodological approach used in this study, the rationale behind different choices, explaining why and how certain features contribute to answering the RQs and achieving the research aim. The research design includes a grounded theory approach (3.1.1) and a single case study from the Swedish food industry (3.1.2).

3.1.1 Grounded Theory Approach

A grounded theory approach was chosen as the research strategy for the thesis. Creswell (2007: 83) defines grounded theory as "a qualitative research design in which the inquirer generates a general explanation (a theory) of a process, an action, or an interaction shaped by the views of a large number of participants". Typically, the IS project includes a network of different participants, namely industrial companies, public facilitators, academia, private facilitators being in "interaction" with each other (Chertow, 2000). Thus, an IS facilitation strategy can be seen as an action or a set of actions leading towards an "interaction". According to Creswell (2007: 85), this "process" or "action" in focus has phases that occur over time. An IS project develops over time and has different phases: project idea, feasibility study, construction, and operation (Boons et al., 2017; Chertow, 2007; Golev et al., 2015; Siskos & Van Wassenhove, 2017).

A grounded theory contrasts with the most qualitative approaches by providing "both a way of analysing situated action and of moving beyond it" (Charmaz, 2014: 228). The *situated action* refers to the "why" questions. A grounded theory approach can provide an explanation by answering "why" question in addition to "what" and "how". In this thesis, it is important to understand why private facilitators are relevant for IS projects (RQ2). The research has to explore a *situated action*. Therefore, a grounded theory approach appears to be applicable to explore roles and strategies for private facilitators in IS projects.

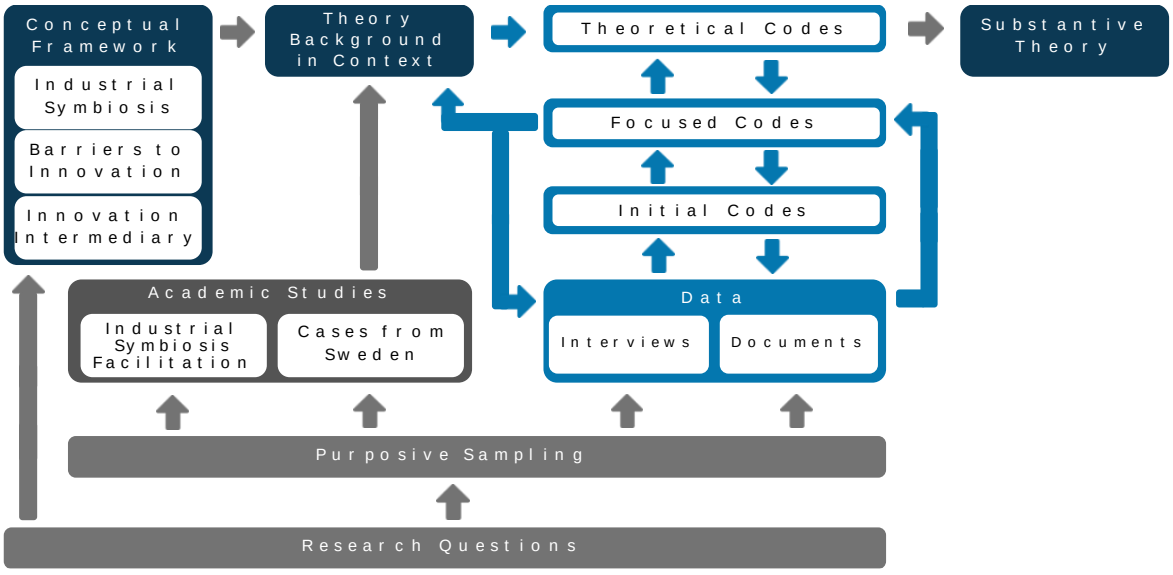

Figure 3-1. Analytical framework

Source: developed by author based on Charmaz (2014) and Blaikie & Priest (2019).

The features of the grounded theory approach have contributed to the research design of this thesis. According to Corbin & Strauss (2008), grounded theory represents a theoretical explanation "that was derived from data, systematically gathered and analysed through the research process". In this approach data collection, data analysis, and derived theory stand in close relationship to one another. The main features of grounded theory are that the theory is developed out of data and that the research process is iterative when the data collection and the data analysis repeatedly refer back to each other (Bryman, 2016). Both features were integrated into the research design of this thesis. First, the grounded theory requires methods for qualitative data collection to support theory development. According to Creswell (2007), the primary method for data collection in the grounded theory approach is interviewing. The researcher compares the data collected from interview participants with ideas about the emerging theory. In addition, qualitative data can appear in forms of documents and secondary qualitative data (Bryman, 2016). In this research, the data was collected through the selection of academic studies, interviewing and documents collection. Second, in the grounded theory approach, the research process is iterative. The data collection and the data analysis repeatedly refer back to each other (Bryman, 2016). The *analytical framework* for this study is presented in Figure 3-1. The analytical process started with RQs. The RQs lead to the *conceptual framework* (see Figure 2-1) and the purposive sampling for literature review (both theoretical background and context characteristics) and data collection (section 3.2). The collected data went through different stages of coding (3.3.1) and constant comparison (3.3.2). In Figure 3-1, the iterative process of constant comparison is shown by blue arrows. As a result, a substantive theory about possible roles and strategies of private IS facilitator was developed.

To receive a formal theory, the findings have to be tested in another setting (Bryman, 2016): the same data collection and data analysis will have to be done in another case study. The substantive theory is a theoretical interpretation or explanation of a delimited problem in a particular area (Charmaz, 2014: 344). The formal theory is a theoretical rendering of a generic issue or process that cuts across several substantive areas of study. The concepts in a formal theory are abstract and general, and the theory specifies the links between these concepts (Charmaz, 2014: 343).

An important part of the grounded theory approach is memo-writing. According to Charmaz (2014), memo-writing is a crucial method because it encourages the researcher to analyse the data and codes early in the research process. The researcher has to write down his reflections and new ideas during the data collection and analysis (Creswell, 2007). In this thesis project, the "memo bank" as suggested by Charmaz (2014) was created where all the appearing ideas were collected and filed. The audio format was the most comfortable form of recording all the appearing reflections. It was helpful during the data analysis and formulation of research results.

3.1.2 A Single Case Study Research Design

A research design used in this thesis is a single case study. According to Bryman (2016: 688), a case study is "a research design that entails the detailed and intensive analysis of a single case". Creswell (2007) states that a case study approach is an appropriate option when a researcher has a clearly identifiable case with boundaries and seeks for an in-depth understanding of specific aspects of this case. Case studies can provide detailed descriptions of social phenomena, especially with 'how' or 'why' research questions (Yin, 2014). This thesis aims for an understanding of the private facilitators' role in IS projects from different perspectives. Moreover, this thesis seeks to explore strategies of engagement for this type of facilitators. This research aim can benefit from using a case study approach.

According to Yin (2004), a case study can be combined with other methodological features. Moreover, it is stated that a case study inquiry can benefit from the development of theoretical propositions before the data collection and analysis for the case (Blaikie & Priest, 2019). Thus,

the research design of this thesis combines a grounded theory approach with a case study. In Figure 3-1, the light blue boxes represent the elements related to the case study. The figure illustrates how the case study was incorporated into an *analytical framework* in this study.

A case study approach sets five issues that need to be addressed by the researcher. That includes a case selection, case boundaries, type of analysis, data collection methods and data analysis methods (Bryman, 2016). First, a case selection depends on the chosen type of case study (Creswell, 2007). Among other types proposed by Stake (1995), an instrumental case helps to understand a specific issue related to a case. This thesis aims to explore a role of private facilitators in IS projects. That is why the instrumental case is the most applicable type for this thesis. A case represents a bounded system which is a person, an organisation, a group or community, a decision process or a project within a specific place and time (Yin, 2014). Moreover, Creswell (2007: 154) suggests using a *purposeful sampling* approach, when the sampling refers to research questions (see section 3.2. for a detailed explanation of the approach). Within this approach, the criterion sampling was chosen to select a case that represents a real-life facilitated IS project in Sweden. Several IS projects were considered. A Food Valley of Bjuv project ("Bjuv project") was selected. A selection process of the project considered several criteria presented in Table 3-1.

Table 3-1. The Food Valley of Bjuv Case and Selection Criteria

Criterion	Criterion Description	The Food Valley of Bjuv
IS project	A project meets the definition of IS given in section 2.2.2.	Yes, the project aims for exchange of heat, water and waste between different industrial facilities.
Facilitated IS	A project involves coordination between industrial companies	Yes, initially the project required coordination between Findus Sverige, Söderåsens Biogas AB, Vegafish AB, etc.
Private facilitators	The list of facilitators includes private consultancy company/companies	Yes, WA3RM, as a private environmental consulting company, was involved in facilitation.
Contemporary project	Activity in the project is ongoing or recent, starting no more than ten years	Yes, the project idea began to emerge around 2010, and the project is still in progress.
Access to information	The information about the project is publically available, participants agree to interviews	Yes. Findus left activities in Bjuv, and the key operating manager for the project left the company. However, he was available for an interview.
Physical access	A project's location should be accessible	Yes, the project is located in Bjuv, Scania region in Sweden, and accessible by the public or private transport.
Industry	A project should represent an important industry for Swedish and regional economy	Yes, the food production industry is the third-largest industry in Sweden in terms of production value and number of employees; and it is the leading industry in Scania.
Scale	A scale of a project should be significant for the regional economy	Yes, the project aims to create a production system with five hectares of greenhouse and a fish farm for 500 tons' annual production.

Source: developed by author based on Foodhills (2020), Regional Council of Scania (2014), Swedish Board of Agriculture (2017), and WA3RM (2017)

Second, a specific place, time, events, and processes set the boundaries for a case (Yin, 2014). Setting the boundaries is important because some cases are ongoing and do not have a clear beginning and ending points (Creswell, 2007). Setting the boundaries also helps to identify the strategy for data collection and analysis. For the Food Valley of Bjuv project, the place boundary

is Bjuv industrial site in Sweden. The time boundary is set from 2010, when the initial project idea appeared, till 2018. Only events related to project facilitation process are considered within this case study. This case explains the possible development of a new circular business area in Swedish food production. Once successfully implemented, the same pattern is planned to be applied to many other locations in Sweden (Regional Council of Scania, 2018).

Third, an embedded type of analysis was used for this case study. Yin (2014) offers two main types of analysis for a case study approach: a holistic analysis of the entire case and an embedded analysis of a specific aspect of the case. In this thesis, the Bjuv project's case study focuses on the role of private facilitators (namely WA3RM AB) in the project's development and explores their strategic options. As required by the embedded analysis type, the collected data relates to the aspect in focus.

Fourth, qualitative data was collected for this case study. According to Creswell (2007), data collection in a case study research typically combines multiple sources of information. Moreover, this information can be both qualitative and quantitative (Bryman, 2016). However, the use of grounded theory approach for this thesis (see section 3.1.1.) requires to employ the qualitative data only. Yin (2014) suggests six types of qualitative information that can be used: interviews, documents, direct observation, participant observation, archival records, and physical artefacts. In this thesis, the collected data includes semi-structured interviews with practitioners the Bjuv project (section 3.2.2.) and documents related to this project (section 3.2.3.).

Fifth, qualitative methods of analysis were used for this case study. As suggested by Stake (1995), the analysis starts with the detailed case description based on the collected data. The description includes the history of the Bjuv project, the project idea and objectives, the key stakeholders and facilitators, the chronology of events related to facilitation. After the description, the coding and constant comparison methods are applied for this case study as part of the grounded theory approach (section 3.1.1). As the findings from the case study the role of private facilitators in IS project and facilitation strategy options are described.

The main challenge of using a case study approach is a concern of its generalisability. Bryman (2016) states that findings from one single case do not represent potential findings in other cases. In this thesis, the findings from the Bjuv project cannot be statistically generalised to every IS project in the Swedish food industry. Instead, using of case study approach seeks for in-depth understanding and analytic generalisation (Yin, 2014). The theory generated by analysing the Bjuv project case can be further tested in different settings.

3.2 Data Collection Methods

This section describes in details the main data collection methods employed for this thesis. The choice of the data collection methods was determined by the requirements of a grounded theory approach and research design considerations. First, the grounded theory approach requires to use qualitative data to support a theory development (Bryman, 2016). The extreme version of the approach suggests that the data should be "raw", unstructured, and not shaped by prior concepts or theories. However, a moderate version of the approach allows the influence of the previous theories, concepts and the researcher's personal experience (Denscombe, 2017). That is why the *conceptual framework* and theoretical background information are included in the *analytical framework* (Figure 3-1). Second, to answer RQs, this thesis adopts a case study research design. In the case study approach, relying on one source of data is not enough to develop an in-depth understanding (Creswell, 2007). Thus, the data for the case study will include semi-structured interviews and documents. In general, this thesis uses three methods of data collection: academic studies collection, semi-structured interviewing, and documents collection.

Besides the data collection methods, suitable data sampling techniques were identified. A purposive sampling approach is suggested for the qualitative data (Creswell, 2007). *Purposive sampling* is a non-probability form of sampling that deals with the selection of samples (people, organisations, documents, studies, etc.), using a direct reference to RQs. It can involve more than one sampling technique (Bryman, 2016). In this thesis, the purposive sampling approach included theoretical, snowball, and criterion sampling techniques. *Theoretical sampling* is one of the key methodological concepts in the grounded theory approach (Bryman, 2016; Charmaz, 2014; Corbin & Strauss, 2008; Creswell, 2007). Theoretical sampling is "a process of data collection for generating theory whereby the analyst jointly collects, codes, and analyses his data and decides what data to collect next and where to find them, in order to develop his theory as it emerges" (Bryman, 2016: 411). Thus, data collection in this thesis was driven by the concepts emerging from data analysis. The theoretical sampling continued until theoretical saturation. *Theoretical saturation* is a research condition when a new data does not add any valuable content to the emerging categories; the categories are well developed; the relationships between the categories are established and validated (Corbin & Strauss, 2008). In this thesis, theoretical sampling was used for studies collection, interviewing, and collection of documents. *Snowball sampling* technique is close to theoretical sampling. It is a non-probability method that is also called network, chain referral or reputational sampling (Blaikie & Priest, 2019). It also starts with a small group of samples relevant to the research questions. However, the focus of snowball sampling is on how to generate the amount of data (Bryman, 2016). This small group of samples (people, studies, organisations) should refer to potential samples that can also be relevant to the RQs. In this thesis, the snowball sampling was used to collect studies for the literature review, identify interview participants for a case study, and to collect the documents.

To collect the initial group of samples and screen the potential samples, a criterion sampling technique was applied in this thesis. *Criterion sampling* is a method to sample "all units (cases or individuals) that meet a particular criterion" (Bryman, 2016: 409). This sampling technique was employed to select a case for the case study (section 3.1.2.) and to screen studies for the literature review.

Collecting the data also raises the question of generalisation from the findings based on the collected data. Denscombe (2017) suggests distinguishing between representative and exploratory sampling. Representative sampling involves a cross-section of the population. This sampling is used in quantitative data collection. This type of sampling helps to draw a conclusion about the population in whole (*statistical generalisation*). In contrary, *exploratory sampling* provides new insights about unexplored topics but does not represent the population. This thesis aims to explore the role of private consulting companies in IS projects in Sweden, collecting the insights from a case study and developing in-depth understanding (*analytic generalisation*). Thus, data collection in this thesis is based on exploratory sampling.

3.2.1 Selecting Studies for Literature Review

To conduct a literature review in this thesis, two groups of studies were selected based on theoretical coherence with RQs and purposive sampling. Theoretical coherence with the RQs means that only studies related to the research problem that launched the literature review were included (Noblit & Hare, 1988). The first group relates to the roles of different facilitators in overcoming barriers to IS development. The second group relates to the context characteristics of IS projects in Sweden. The collection of studies is reflected in Figure 3-1 as "Academic studies".

Both groups of studies were selected using criterion, snowball and theoretical sampling. Criterion sampling has set screening topics for studies selection. This technique helped to identify the first small groups of studies related to the research area. Snowball sampling was

used in reference search to create a broader corpus of studies. Theoretical sampling was incorporated in a literature review. The literature review started with the initial small group of studies, as suggested by Stafford & Farshadkah (2020). During the process, the new data was taken from the broader corpus of studies until theoretical saturation was achieved (Bryman, 2016). Selection processes are described below separately for each group of studies.

Studies on Industrial Symbiosis Facilitation

The corpus of academic studies related to IS facilitation was selected through 6 steps (see Table 3-2). The review started from a basic search in Scopus and Web of Science databases. The choice of databases was based on the fact that Scopus and WoS have long-term worldwide coverage and the largest number of peer-reviewed journals (Chappin & Ligtvoet, 2014). The selection process is described below.

Table 3-2. Selection of studies on industrial symbiosis facilitation

Steps	Criterion	Scopus	Web of Science
1	Industrial ecology /industrial symbiosis /eco-industrial park[1]	14,110 articles	6,037 articles
2	Barriers /challenges /hindering factors[2]	1,281 articles	887 articles
3	Facilitation /intermediation /operator /moderation[3]	20 academic articles	9 academic articles
4	Reading abstracts, looking for relation to the RQ	6 academic articles selected	5 academic articles selected
5	Combining searches	8 academic articles – initial group of studies	
6	Cited reference search	58 relevant articles – broader selection for further review	

Source: developed by author based on sampling techniques suggested by Bryman (2016).

On the first step, the articles related to IS were screened. The keywords "industrial ecology", "industrial symbiosis" and "eco-industrial park" were used (Table 3-2). This step identified 14,110 studies in Scopus and 6,037 studies in WoS. The second step was screening for barriers to IS development within those large groups defined on the first step. On this step, the keywords "barriers", "challenges", and "hindering factors" were used; and 1,281 and 887 papers were found in Scopus and WoS respectively. The third step screened for facilitator's perspective and role in IS connected to specific barriers. The search used the keywords "facilitation", "intermediation", "operator", and "moderation". The logic behind the order of steps 2 and 3 was that the literature on barriers to IS development is much broader than on IS facilitation. As a result, 20 papers were found in Scopus, nine papers – in WoS. After reading abstracts and checking a relation to the research question in step 4 and combining the two lists in step 5, only eight academic articles were selected. This corpus represents the initial group for the review. After reviewing the initial group, a search through references has selected 50 more articles for

1 The search script is: TITLE-ABS-KEY (industrial AND symbiosis) OR TITLE-ABS-KEY (industrial AND ecology) OR TITLE-ABS-KEY (eco-industrial AND park)

2 The search script is: TITLE-ABS-KEY (barriers) OR TITLE-ABS-KEY (challenges) OR TITLE-ABS-KEY (hindering AND factors)

3 The search script is: TITLE-ABS-KEY (facilitation) OR TITLE-ABS-KEY (intermediation) OR TITLE-ABS-KEY (operator) OR TITLE-ABS-KEY (moderation)

further review. Most of the studies from the broader group are published in the Journal of Cleaner Production and the Journal of Industrial Ecology.

Case Studies from Sweden

To select the studies on IS projects in Sweden, the Google Scholar search was the most efficient. The initial search results in Scopus and Web of Science databases with different keywords combinations rarely indicated any case studies from Sweden. In Google Scholar, the keywords "industrial symbiosis" and "Sweden" have initially identified many case studies from Sweden. Thus, the choice was made in favour of the Google Scholar search.

The corpus of academic studies selected through 4 steps (see Table 3-3). The Google Scholar search finds almost 3 mln. results with the keywords "industrial symbiosis OR industrial ecology". Thus, it was decided to limit the first step to the keyword "industrial symbiosis". The second step has filtered the results with the keyword "Sweden". This broad selection limits the results to 25,800. Following the theoretical sampling technique, the first 5 case studies were selected through reading abstracts of the first 50 results. Theoretical sampling allows collecting new data during the process of analysis. In step 4, after the cited reference search, 12 more case studies were selected. In general, 17 case studies on IS implementation in Sweden were used in this thesis.

Table 3-3. Selection of studies on industrial symbiosis in Sweden

Steps	Criterion	Google Scholar
1	Industrial symbiosis	121,000 results
2	Sweden OR Swedish	25,800 results
3	Reading abstracts and selecting case studies on IS projects in Sweden	5 case studies selected – initial group: (Aid et al., 2017; Baas, 2010, 2011; Hatefipour et al., 2012; Mirata & Emtairah, 2005)
4	Broader selection through cited reference search	17 case studies selected – broader group

Source: developed by author based on sampling techniques suggested by Bryman (2016).

3.2.2 Semi-Structured Interviews

Interview in the most widely employed method in qualitative research (Bryman, 2016). The *research interview* is "an interview, where the knowledge is constructed in the interaction between the interviewer and the interviewee" (Brinkmann & Kvale, 2015: 2). According to Creswell (2007), interviewing is the key data collection method in a grounded theory approach. Other sources of information typically play a secondary role.

The purpose of the interview is more than the collection of factual information. This data collection method is better exploited when it is applied to explore a complex phenomenon (Denscombe, 2017). In qualitative interviewing, there is an interest in interviewee's perspective and point of view (Bryman, 2016). For this thesis, the purpose of interviewing was to explore the role of private consulting companies in IS project facilitation. *Semi-structured interviewing* help to have a clear focus on the investigated issue through interviewee's perspective (Denscombe, 2017). This type of interview requires an interview guide with the main questions that need to be asked (see Appendix B). However, in a semi-structured interview, the questions' order may change, and the researcher can follow-up the answers and ask new deeper questions (Brinkmann & Kvale, 2015; Bryman, 2016). This approach lets the interviewee develop ideas and speak more

widely on the issues related to research (Denscombe, 2017). The semi-structured interview type was chosen for this thesis.

A selection of participants for the interviews combined snowball and theoretical sampling techniques. As mentioned before, snowball sampling helps to develop a list of interview participants starting with a small group of people relevant to research questions (Bryman, 2016). This technique suggests that these selected participants will recommend other participants also relevant to research. Thus, the first interviewee was a business coordinator from Bjuv municipality (personal interview 4). He was chosen because he was the author of public press-releases about the "Bjuv project" and his job position is related to the coordination between companies. During this interview, the respondent recommended to talk to representatives from Söderåsens Bioenergi AB (pers. int. 2) and Swedish Surplus Energy Collaboration network (pers. int. 6 & 7) and shared their contact details. The new suggestions and contacts were screened for relevance to RQs and availability. With every new interview, the list of interviewees was developing (see Appendix A for the full list of interviewees). It was discovered during the collection process that the "Bjuv project" engaged all different types of facilitators: self-organisation, public, academic, and private. The theoretical saturation was achieved when all the different perspectives were presented in data (Charmaz, 2014). For this thesis, 11 interviews were conducted.

All the conducted interviews were *one-to-one interviews*. This means that the interviews involved a meeting between one researcher and one informer (Denscombe, 2017). The one-to-one interviews have three main advantages. First, this interview is easy to arrange and to control. Three interviews were conducted in person; eight others were conducted via Skype and Zoom online platforms. The average time for the interviews was 50 minutes. Second, the focus of the researcher's attention is on one person only. This is important when an in-depth understanding is needed. Third, a recorded interview is easier to transcribe when just one person is answering the questions (Brinkmann & Kvale, 2015). All the interviews were audio-recorded with interviewees' permissions and transcribed.

The interviews followed the same structure. The specific purpose of the interviewing for this thesis was to explore the role of a particular private consulting company WA3RM in the "Bjuv project" (see section 3.1.2.). The interviewing was starting with practical issues: an ask for permission to audio-record the interview and an explanation of what is understood as "Bjuv project" in this interview. This explanation was important to describe the research area (Denscombe, 2017). The main structure of the interviews included the questions about personal and organisational engagement into the project; a history of the project; different barriers experienced during the project; the role of public, academic and private actors in the process from interviewee's perspective (see Appendix B for Interview Guide). However, some questions were specific for different types of facilitator's perspective.

All the interviews were audio-recorded using Voice Recorder application, copied, stored in specific folders and later transcribed. All the interviews were automatically transcribed and manually corrected word-by-word. Word-by-word correction helps to avoid mistakes of automated transcription and to start identifying the patterns in text that can be coded during the analysis (Brinkmann & Kvale, 2015). The transcribed interviews (83 pages) were copied to NVivo software for computer-assisted qualitative data analysis (section 3.3).

3.2.3 Documentary Data

An important part of the data collected for this thesis is represented by documents. *Documents* are materials mostly in text format (more rarely also in the picture, video, or sound format) that were not produced specifically for the social research; available for analysis; and relevant to the research question (Bryman, 2016).

Documents as a source of data are underutilised for theory generation (Charmaz, 2014). There are two main reasons for this. First, the creditability of the source needs to be proved before using the document. Second, documents are produced for some other purposes; they represent secondary data (Denscombe, 2017). However, documents are used by researchers due to accessibility. Most of the documents are publically available so that the information can be checked. Documents contain useful factual knowledge that can be relevant to RQs (Bryman, 2016). Besides, documents can complement the use of interviews for a case study approach, as suggested by Yin (2004). The documents collected for this thesis provided factual information for a case study.

Several types of documentary data were collected for the case study on "Bjuv project". The selection process used theoretical and snowball sampling techniques (Bryman, 2016). As suggested by Denscombe (2017), the factual data was obtained from government publications, press sources, and corporate website pages.

First, general information related to the project was gained from press-releases and website pages of Bjuv municipality[1], Skåne Regional Council[2], Innovation Skåne[3], Skåne Food Innovation Network[4], and Sweden's Innovation Agency Vinnova[5].

Second, several online newspaper documents provided information related to the "Bjuv project's" history, a current situation and planning information, companies and other stakeholders engaged. The main press sources included newspapers "Sydsvenskan"[6] and "Norra Skåne"[7], and the radio broadcaster "Sveriges Radio"[8]. "Sydsvenskan" has a special online section publishing the news about the "Bjuv project"[9].

1 Bjuv municipality is a municipality in Scania county in southern Sweden. Web-page: https://www.bjuv.se/. Official information on "Food Valley of Bjuv" on Bjuv municipality's web-page: https://www.bjuv.se/Jobb-och-foretag/Foretagare/Food-Valley-of-Bjuv/ (in Swedish)

2 Region Skåne is the regional council of Scania county in Sweden; its assembly is the highest political body in Scania. Web-page: https://www.skane.se/

3 Innovation Skåne is the regional innovation company owned by Region Skåne, provides management and support for Region Skåne's operations and employees. Web-page: https://www.innovationskane.com/

4 Skåne Food Innovation Network is a regional development initiative, partly financed and supported through Vinnväxt, the programme on regional innovation systems of Sweden's Innovation Agency Vinnova. Web-page: http://www.livsmedelsakademin.se/

5 Vinnova is the Swedish government agency that administrates the government's funding for R&D. Information on "Food Valley of Bjuv" on Vinnova's web-page: https://www.vinnova.se/p/motesprojekt-food-valley-of-bjuv/

6 Sydsvenska Dagbladet Snällposten (Sydsvenskan) is a private Swedish-language local daily newspaper headquartered in Malmö, Sweden. The circulation in 2013 was 99,800 copies. Web-page: https://www.sydsvenskan.se/

7 Norra Skåne is a private Swedish-language local newspaper based in Hässleholm, Sweden. Web-page: https://www.nsk.se/

8 Sveriges Radio is Sweden's national publicly funded radio broadcaster. Only the published text versions were used in this thesis. Web-page: https://sverigesradio.se/

9 The Sydsvenskan's "Food Valley of Bjuv" online section web-page: https://www.sydsvenskan.se/organisation/food-valley-of-bjuv (in Swedish)

Third, factual and conceptual information on the project was collected from corporate website pages of FoodHills AB[1], Swedish Surplus Energy Collaboration network[2], and from representatives of WA3RM AB[3]. The WA3RM representatives shared the final report from the project "Recirculation based production and processing of vegetables and fish". This project was an initiative by Findus AB to create a recirculating food production. This report has first documented the project idea for the "Food Valley of Bjuv". The WA3RM representatives also shared the project's presentation in PPT format and the project's description.

Besides factual data, the collected documents provided important conceptual information for the case study from different perspectives. As with interviews, the theoretical saturation was achieved when all the different perspectives were presented in data (Charmaz, 2014). For this thesis, 15 documents were collected.

All the collected documents were stored in text format in specific folders. After collection, the documents were copied to NVivo software for computer-assisted qualitative data analysis (section 3.3.).

3.3 Computer-Assisted Qualitative Data Analysis

This study followed the main principles for qualitative data analysis. All the methods for data analysis were conducted with the use of NVivo 12 software. NVivo is commonly used for qualitative data analysis (Bryman, 2016). This software provides several ways for coding text information. However, the grounded theory approach required to create codes (nodes in NVivo) while reading through the collected data (see Appendix C for the coding structure).

Denscombe (2017) described three main principles of qualitative data analysis. First, the research process should be iterative. Thus, data collection and data analysis phases of the research should be conducted in parallel. In this study, the interviewing and documents collection started earlier than the analysis. However, once the analysis started, it was continually identifying a need to collect more documents and interview more practitioners. Second, qualitative data analysis is inductive. The analysis starts with a detailed analysis of localized data from FVoB and proceeds towards a more abstract and generalized understanding of roles and strategies of private facilitators in IS. Third, the analysis should be researcher-centred, influenced by the values and experiences of the researcher. In this study, a personal background helped to collect and interpret the data, find patterns and categorize. Therefore, data analysis in this study was iterative, inductive and researcher-centred.

The methods of analysis in this study were defined by the grounded theory. Different methodological approaches in social sciences offer different visions for data analysis (Creswell, 2007). The choice of the grounded theory approach for this study was explained in section 3.1. This choice has defined the characteristics of data analysis. All approaches to qualitative data analysis are mostly concerned with the analysis of talk and text. However, the grounded theory approach is unique in terms of the purpose of analysis, units of analysis, and treatment of data (Denscombe, 2017). First, the purpose of grounded theory is to develop concepts or theory by

1 FoodHills AB is currently a company-operator of Food Valley of Bjuv. Owned by Backahill AB, Lantmännen AB, Magnihill AB, and Health RunnerAB. Web-page: https://foodhills.se/

2 Swedish Surplus Energy Collaboration is a sustainable food production network of public and private actors that aims to enable innovations in Sweden's food industry through the use of residual heat and other unutilised resources. It is administrated by the Swedish University of Agricultural Sciences (SLU). Web-page: https://sse-c.se

3 WA3RM AB is an environmental consulting company that was engaged in "Food Valley of Bjuv" project. Web-page: https://www.linkedin.com/company/wa3rm-ab/

interpreting the text. In contrast, a content analysis approach aims to find a hidden message by quantification of the text. Second, the units of analysis in grounded theory are sentences and paragraphs as opposed to words and phrases in content analysis and the whole story in narrative analysis. Third, only the grounded theory approach treats the text with coding and constant comparison. In contrast, content analysis measures frequencies and position of words and phrases, and narrative analysis looks for the symbolic significance of the story. Therefore, in this study, the main methods of analysis were *coding* of sentences and paragraphs from data (section 3.3.1) and *constant comparison* (section 3.3.2) to develop concepts and theory. The three levels of coding and constant comparison method are presented in Figure 3-1 and explained below.

3.3.1 Coding

Coding is the process of taking data apart, defining and labelling, what these data are about. The coding can be used both in qualitative and quantitative research. Unlike quantitative researchers, who apply preconceived categories or codes to the data, a grounded theorist creates qualitative codes by defining what he or she sees in the data. Thus, grounded theory codes are emergent. During the interviews, there was no specific question concerning actions. The actions had to appear unforced. Researchers develop codes as they study and interact with their data. The coding process can take a researcher to unforeseen areas and research questions. Grounded theory proponents "do not pursue previously designed research problems that lead to dead-ends" (Charmaz, 2014: 342). In the grounded theory, the coding includes initial, focused, and theoretical levels.

Initial coding

The first stage of the analysis was initial coding. The aim of initial coding is to sort the collected information from 11 interviews (83 pages) into first-order codes (see Figure 3-1). According to Charmaz (2014: 343), through initial coding "a researcher defines what is happening in the data and begin to understand what it means". This was an iterative process of reading through the texts and looking for statements related to RQs (Brinkmann & Kvale, 2015). Through this process, several categories of initial codes were identified (see Appendix C: Coding structure in Nvivo). Those categories included motivations to participate in IS project by different participants, barriers to project's development, actions performed by different participants (self-description and description by others), a mutual assessment of the participants' contribution, arguments to engage a private facilitator, strategy elements of the private facilitator, and success factors for the private facilitator's strategy.

Focused coding

The focused coding included the second reading through the data and all the initial codes to identify categories among them (Charmaz, 2014). The new, more specific information appeared from data to enrich the categories. For instance, all the initial codes related to the barriers to the project's development were split into six identified categories (informational, technical, financial, regulatory, financial, organisational, cooperation). Inside every category, the data was also structured. The barrier categories included sub-categories. For example, the informational barriers category included sub-categories "lack of awareness about IS", "lack of information sharing", and "lack of practical knowledge". And each of these sub-categories included statements about how those barriers were addressed. As a result, the focused codes contained structured information related to RQs.

Theoretical coding

The focused codes were compared to the background theory information on IS facilitation and context characteristics (chapter 2) from the literature review to get theoretical codes (see Figure 3-1 and Appendix C). This comparison allowed to make conceptual connections and answer the RQs (Charmaz, 2014).

3.3.2 Constant Comparison

The constant comparative method is a method that was used in this study to compare information between different levels of codes with data, theoretical background and the context. The method generates abstract concepts and theories through inductive processes of comparing data with data, data with code, code with code, code with category, category with category, and category with concept (p. 342). In the last stages of analysis, researchers compare their major categories with those in relevant academic literature. Comparisons constitute each stage of analytic development. Grounded theorists use this method to reveal the properties and range of the emergent categories and to raise the level of abstraction of their developing analyses (Charmaz, 2014, p. 342). The method is illustrated in Figure 3-1, where the blue arrows represent the iterative process of constant comparison.

3.4 Credibility of Research

The research quality evaluation is essential since this study seeks for practical application. The credibility strategies applied in this thesis are defined by the nature of qualitative analysis (Bryman, 2016). These strategies include *triangulation*, *transparency and coherence*, and *sensitivity to context*.

The *triangulation* is a strategy that includes using multiple data sources and presenting different perspectives in research (Bryman, 2016). This strategy addresses the criteria of "truth value" that is qualitative research analogy of validity in quantitative research (Noble & Smith, 2015). In this study, the data was collected both from primary and secondary sources. The primary data consist of 11 semi-structured interviews. The secondary data include 15 documents. Both interviews and documents represent different perspectives within the case study. Those perspective include industrial companies, public authorities, academia, and private consulting firms. The equal representation of different perspectives was achieved.

The *transparency and coherence* is a strategy of providing a detailed and open description of methods and data utilised in research (Bryman, 2016). Chapter 3 present a detailed explanation of research methods used in this thesis, decisions about the choice of methods, and selection criteria for the case study, the literature review, and data collection are presented. Appendixes A presents a detailed list of interview participants, the duration of the interviews and the number of pages in every transcription. Appendix B shows the interview guide with the interview structure and examples of questions.

The *sensitivity to context* is a strategy that addresses the issue of generalizability. The generalizability is a consideration whether findings can be applied to other contexts, settings or groups (Bryman, 2016; Noble & Smith, 2015). Both the grounded theory approach and case study research design are problematic when it comes to generalizability. In this study, the context characteristics are an integral part of the theoretical background and impacted the generation of theoretical codes (see Figure 3.1). Within the case study, the analysis started with the case description to understand the context in which the case exists. This strategy helped to reflect on the case study results and assess how these results can be applied to other settings.

4 Results: Emerging Industrial Symbiosis in Bjuv

The chapter presents the results of the case study. Section 4.1 describes the case of the Food Valley of Bjuv (FVoB) including the context characteristics, the IS idea behind the project (4.1.1), and perspectives of different stakeholders within the project (4.1.2.). Section 4.2 focuses on RQ1 and explores possible strategies that can be used by private consulting firms to get involved in the IS facilitation by describing the steps of a company WA3RM to engage in FVoB project (4.2.1) and strategic considerations that were derived from this experience (4.2.2). These strategic considerations can be seen as guidelines for other private consulting firms willing to facilitate IS projects. Section 4.3 focuses on RQ2 and RQ3. It explores the role of private facilitators in IS emergence by describing the relevance of these actors to IS projects (4.3.1) and their action-by-action contribution to IS projects' development (4.3.2).

4.1 Food Valley of Bjuv as Industrial Symbiosis Initiative

The initiative for the Food Valley of Bjuv (FVoB) originates from Bjuv, Sweden. The town of Bjuv is located in the Scania region. The food industry is an integral part of both the Scania's economy and Swedish food production. Around 45 percent of Sweden's food sector turnover comes from Scania (Martin & Moodysson, 2013; Scania County Administrative Board, 2015). It is estimated that food production and supporting industries in Scania employ around 40,000 people (Nilsson et al., 2002, p. 63). The food production industrial area in Bjuv occupies 100,000 square meters with pilot factories, laboratories, offices, lounges, and conference rooms, wastewater treatment plant, access to cold storage, biogas plant, and packaging lines (Foodhills, 2020). The Food Valley of Bjuv initiative aims to create an innovative circular food production system.

4.1.1 The Idea of Aquaponics Production System in Bjuv

The emerging innovative system of FVoB can be defined as circular production and processing of vegetables and fish (WA3RM, 2017). The system is designed to include greenhouses and a fish farm (see Figure 4-1). This circular system has to reuse waste heat and CO_2 from the surrounding industrial facilities in Bjuv. Moreover, the FVoB should become a full-scale demonstration facility. After 2022, the idea has to transfer to other locations in Sweden (Regional Council of Scania, 2018).

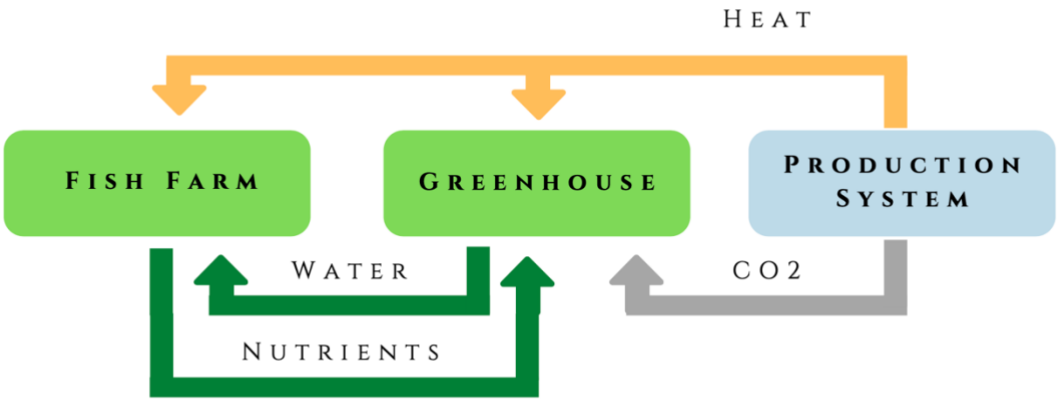

Figure 4-1. Aquaponics production system designed for Food Valley of Bjuv

Source: Author based on WA3RM (2017) and Foodhills (2020)

Bjuv's initiative has developed over the years and absorbed many ideas. In 2004, the Foodvalley of Netherlands was established in Wageningen, the Netherlands. The Foodvalley of Netherlands is described as a knowledge-intensive agrifood system (Foodvalley, 2020). First, this system is characterised by innovative solutions in agriculture and food production. Second, this system includes the cooperation between industrial companies, knowledge centres, educational institutions and governments. However, the integrated agriculture-aquaculture farming system (known as *aquaponics*) was implemented before in many countries (ICLARM et al., 2001; Zamora, 1997). This idea was developed further to an aquaponics production system. Technically, the system includes four main components: a heat from industrial facilities is captured and distributed in series by degrading temperature quality to the greenhouse and fish farm; CO_2 from industrial facilities is extracted and reused to stimulate growth in the greenhouse; rainwater that falls on the greenhouse is stored and used in the fish farm; the nutrients in the water from fish farming are used in the greenhouse (WA3RM, 2017). The potential benefits from this innovation include lower CO_2 emissions through recycling and lowering of international transportation, new jobs in the food industry, a decrease in the import of vegetables and fish.

The composition of participants for FVoB initiative has experienced changes. Initially, the food processing company Findus was the "anchor tenant" of the development. Supported by Bjuv municipality, Findus was active in organizing a network around this initiative. In 2015, the Sweden's Innovation Agency Vinnova financed two stages of the project "Recirculation based production and processing of vegetables and fish" (RePro Food). The first stage aimed to frame the initial idea, and the second focused on technical feasibility and investment opportunities for FVoB (WA3RM, 2017). This feasibility study was conducted in 2015-2017 and coordinated by a private consulting company WA3RM AB. In March 2016, Findus announced that it shuts down production in Bjuv. In December 2016, a property development company Backahill AB formed Foodhills AB in Bjuv. In 2017, the Bjuv municipality and Foodhills AB signed a declaration of intent aiming to create a centre for circular food production, the Food Valley of Bjuv. Now, the discussion about the future of the initiative included the Sweden's Ministry of Industry, the Swedish Agency for Economic and Regional Growth, the Regional Council of Scania (Regional Council of Scania, 2018), a regional innovation company Innovation Skåne, and a research institute RISE. Later, an agricultural cooperative company Lantmännen takes an ownership part in Foodhills AB. In March 2018, Foodhills AB took over the Findus's property in Bjuv (Foodhills, 2020). This transition has changed the participant's composition for FVoB development. Currently, some of the services provided by Foodhills' partners are confidential (pers. int. 3). This study is focused on WA3RM's contribution to the project's development. However, understanding different perspectives and the composition of participants of the project is important for exploring the WA3RM's contribution.

4.1.2 Different Interests in Project's Development

The organisations that contributed to the emergence of the FVoB initiative include local public authorities, industrial companies in Bjuv, and different networks. First, the public authorities were supportive of this initiative for more than ten years (personal interview 4 & 5, see Appendix A for details). The municipality of Bjuv was engaged in many facilitation activities. In 2011, according to municipality's business coordinator (pers. int. 4), the local authority initiated a network called Söderåsens Biopark. Over the years, that initiative evolved into the Food Valley of Bjuv. The list of the engaged public authorities included the Sweden's Innovation Agency Vinnova and a regional investment platform Invest in Skåne AB. Second, many industrial companies took part in framing the idea (pers. int. 1, 2 & 3). The director of biogas company Söderåsens Bioenergi AB took many informational actions in discussing the initiative with other companies (pers. int. 2). Findus Sverige was an "anchor tenant" for the FVoB initiative until 2017. And a business development director from Findus was actively involved in the emerging

network (per. int. 1). Third, the academic representatives contributed to the idea (pers. int. 6 & 7). The Swedish University of Agricultural Sciences (SLU) has established the Swedish Surplus Energy Collaboration (SSEC) network as a platform for knowledge exchange between business companies and experts from SLU. Representatives from Findus, Söderåsens Bioenergi, and Bjuv municipality participated in this network (pers. int. 1, 2, 4 & 7). These three categories represent different perspectives and interests for FVoB development.

The municipality of Bjuv represents the public authority perspective. According to its business coordinator (pers. int. 4), the first motivation is to develop the infrastructure further. Many years there is a built infrastructure between some of the companies in Bjuv. Findus and Höganäs Borgestad have been connected by pipes to Söderåsens Bioenergi. This infrastructure can take care of the residual heat exchanges between companies. Otherwise, it can be used for other streams (wastewater or process water). The second motivation is to attract circular businesses into Bjuv. The municipality aims to show to other companies that after establishing themselves in Bjuv, they can be part of a sustainable business (pers. int. 4). On an early stage, the municipality understood the value of creating a logo trademark for the Food Valley of Bjuv (pers. int. 9). Moreover, this project is considered to be important to make a positive change for creating jobs, securing the city's economy, putting Bjuv on the map as a green municipality (pers. int. 1). Thus, the interests of the public participants include the development of the infrastructure and the attraction of circular businesses.

Industrial companies in Bjuv have a strong motivation to develop the FVoB idea. First of all, companies could make their profiles more environmentally sustainable. Findus wanted to make its assortment "greener" and more diverse. The company was in the segment of frozen food and tried to adopt new businesses (pers. int. 1). According to the former Findus business development director, having Swedish locally grown fish and vegetables was of high interest for Findus (pers. int. 1). Second, the Findus facility in Bjuv had excess capacity in terms of land and buildings that could be used in a smart way. The company had a vision where waste materials from industrial processes could become inputs to other processes. Third, industrial companies can make a profit from this system (pers. int. 4). The profit can come from decreasing the costs for getting rid of the waste streams, from selling the waste or heat excess, or (from biogas plant perspective) by having input streams close to the operation (pers. int. 1, 2 & 3). Moreover, FVoB is attractive for external and even foreign investors. For instance, the Dutch company Royal Pride specialised in greenhouse tomatoes was a potential investor for the initiative (pers. int. 1, 4, 8). Thus, the interests of the industrial participants include the "greening" the profile, the making use of excess capacity, and the profit.

The academic perspective is presented by SSEC from SLU. The network aims to be a part of discussions and interactions to develop new concepts for food production, to attract research funds currently and in the future, and to connect SLU students to real cases (pers. int. 7). The interests of SSEC include profit. The network represents a mixture of municipalities and companies. It has an agreement with every partner. A full member partnership costs 100,000 SEK per year. And they an annual budget around 1,5-2 million SEK (pers. int. 6). However, this network generates practical knowledge related to new concepts for the food production industry. And being able to apply this knowledge is the main incentive (pers. int. 6 & 7).

Every participating organisation had its vision of the process and interests. In 2015, the private consulting company WA3RM joined the project (pers. int. 8 & 9). The next section describes the WA3RM's strategies to get involved in the facilitation of the FVoB project and company's strategic considerations that can guide a private firm's participation in similar IS projects.

4.2 Private Facilitation Strategies for Industrial Symbiosis

The RQ1 relates to strategies that can be used by private consulting firms to get involved in the facilitation of an IS project. In this study, the strategy is understood as a course of a company's steps to achieve its interests. This section describes the results of the case study. Based on the experience of the private consulting company WA3RM and its engagement in FVoB project, the study identified possible strategies and success factors for private consulting firms.

4.2.1 Strategy to Engage in Industrial Symbiosis Facilitation

This section analyses strategic steps taken by private consulting company WA3RM to engage in FVoB project. These steps include identifying the innovation idea, finding a project through networking, involvement in the project, reflecting on results of the project, and updating the strategy based on lessons learnt from the project. The detailed description of each step is presented below.

To discover a business opportunity in IS projects, the company needs to examine its expert portfolio and identify the innovation area for engagement. In FVoB case, the experts from WA3RM were familiar with utilising waste streams for the production of food due to experience in ESS (pers. int. 8). The collection of the expert portfolio is essential to identify a specific area of environmental innovation where the company wants to contribute. This step aims to get an idea of what the company can do. WA3RM had the idea about the industrial heat excess that is useless for district heating but fits for greenhouses (pers. int. 1, 8 & 9). This step helps to realise what value the company can bring to a potential IS project.

On the second step, the company explores its connections within the identified area. The networking can start from listing existing contacts. Based on the experience in ESS, the experts from WA3RM were already in touch with researchers from SLU and its academic network (SSEC). That connection led to Findus Sverige that already had the idea of FVoB (pers. int. 1 & 8). Besides, the experts approached a regional trade and investment promotion agency Invest in Skåne (pers. int. 8 & 9). Through this agency, they got in contact with the Dutch company Royal Pride specialised in greenhouse tomatoes growing was looking for investment opportunities in Sweden (pers. int. 1, 4, 8). This demonstrates the importance of using public business collaboration platforms in the strategy. The regional examples of such platforms are Invest in Skåne and Skåne Food Innovation Network. The second step helps to increase the network connection for a potential IS project and find an IS project.

The company has to communicate the project idea to a potential customer. In the case of FVoB, the anchor company Findus was already aware of the concept. However, this step can reveal a lack of awareness about the IS concept. To get the attention, the consultants can offer taking care of the waste streams that represent a cost in every industrial company's economy (reps. int. 9, 10 & 11). The offer can refer to decreasing the incineration costs or even selling the waste to another company. Then, the explanation of how to do it should include the details about IS systems and their environmental and economic benefits. This approach can help to gain the interest of the potential customer.

On the third step, the company has to analyse the identified project's status, define its maturity level, and decide on the level of involvement in the project. As demonstrated in section 4.2.2, the options for consulting companies include a single-task performance or covering several functions within a project's emergence phase (see also Figure 4-2 and Table 4-3).

The fourth and fifth steps of the strategy are taken when a consulting firm completes its participation in an IS project. On the fourth step, the company has to analyse the results of its

engagement and overall contribution to the project, reflect on the results, and update the expert portfolio (pers. int. 8). For instance, WA3RM have learnt from the experience with FVoB that the inventory analysis is an essential part for further feasibility studies, and it has to be done by the consulting company itself (pers. int. 9). The portfolio updates include communicating the project's results on the company's webpage (pers. int. 8, 9 & 10). On the fifth step, the company corrects its strategy based on the lessons learnt from experience and applies its a new strategy to future projects.

This section described the strategic steps taken by private consulting company WA3RM to engage in FVoB project. These steps are presented on Figure 4-2 and include identifying the innovation idea, finding a project through networking, involvement in the project, reflecting on results of the project, and updating the strategy based on lessons learnt from the project. These results are not expected to be applied to every private consulting firm. In a different context, the strategy can also vary. However, these results explain the possible course of actions for a private consulting company to engage in an IS project. Moreover, these results help to derive strategic guidelines for a consulting company to succeed in the business of IS facilitation. These guidelines are described in section 4.2.2.

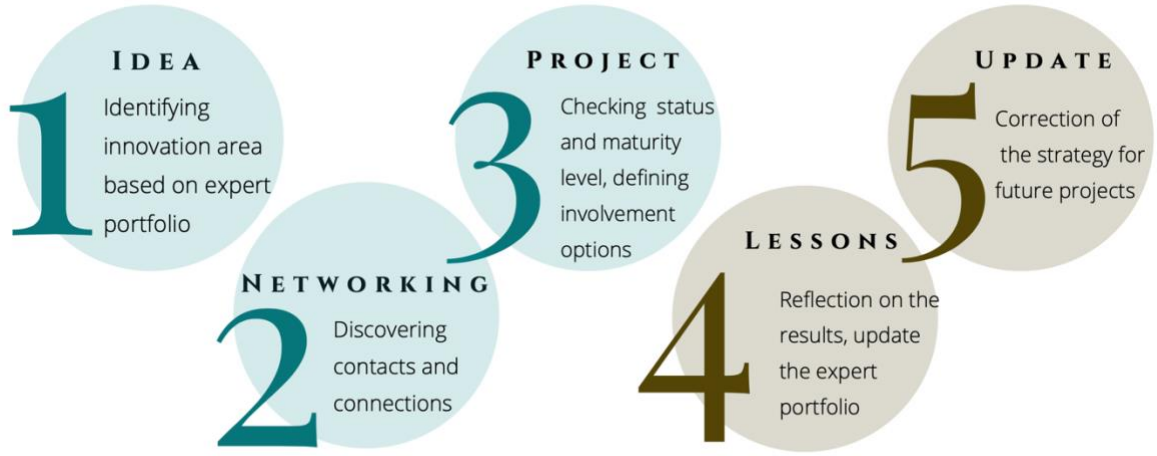

Figure 4-2. Strategic steps for consulting firms to engage in industrial symbiosis

Source: author.

4.2.2 Success Factors for Private Facilitation Strategy

This section presents the lessons learnt by the private consulting company WA3RM within the FVoB project. These considerations represent guidelines to other private companies that want to be successful in IS projects. Four success factors were identified.

The first factor is a *precise determination of goals* of every participant of the project. Within the synergy cooperation, different companies try to seek their advantage (pers. int. 9). When a collaboration starts, every project participant needs to have a definite gain from the project. This gain has to be described. Based on the goals, everyone should have a specific role. This aspect correlates with the intermediary dilemma "uncovering value" suggested by Patala et al. (2020). The value potential can be latent at the beginning of the process. The participation in IS programs can change a company's perceptions to view waste as a possible input to other industrial companies. The potential benefits can include cutting the costs of waste disposal, profit from selling the waste, by-product or heat excess, decreasing environmental impacts, increasing the company's public image and green profile, and job creation. The precise

determination of goals is associated with risk management for a facilitator. Often these projects are not critical for the participants. That is why some companies do not take the activities within the network seriously. The reason is that this is not their core business (pers. int. 9). A presence of the participants without determined goals disbalances the project. The clear understanding of the goals of every participant helps to avoid competitiveness inside the project, allocate the roles and stimulate the progress.

Second success factor is *risk management*. Initial risk analysis for the project should include the anchor industrial company (hosting for the waste streams), and the backup calculations in the case it shifts its production. The private facilitator has to have a concrete plan of how to handle risks from a financial perspective. The best option is to have a business model that supports and rewards the risks taken by the facilitator (pers. int. 9). The proper risk management can help to continue the project even after significant changes in participants composition.

The third factor relates to *collaboration with other facilitators*. WA3RM representatives emphasize the importance of the contribution to the project from the Bjuv municipality and the SSEC. It is essential to collaborate with all three categories and understand their advantages and disadvantages (pers. int. 9). In Sweden, the private IS facilitator needs to get the municipality on board early. The city takes care of the informational and regulatory barriers to the project, engages companies and a local community. At the same time, the municipality is hindered by regulations. For instance, every information communicated with the municipality goes public. To identify the potential synergies, companies have to share detailed data on the type, quality and quantity of materials and energy they have. However, this information can be confidential for some companies. According to Patala et al. (2020), this "openness dilemma" can be solved by making the inventory database accessible only to facilitators. Thus, strategic collaboration with both local public authorities and academia is a critical success factor.

Finally, *sustainability consideration* is a success factor for a private IS facilitator. The private facilitator makes a profit from the successful establishment of IS (WA3RM, 2017). In the case of FVoB, the Findus representative stated that WA3RM added value to the project because the provided solutions were "greener" (pers. int. 1). During the technical feasibility study, the project participants looked for the alternative source of the heat. One of the industrial facilities in the area had sufficient heat excess. However, WA3RM did not account this option, because the heat excess was a result of low efficiency in the system (pers. int. 8). The environmental consideration increases the reputation and trust from the potential customers that help the private facilitator to stay in business.

This section explored the strategic guidelines to private companies that want to be successful in the facilitation of IS projects. Four success factors were identified including precise determination of goals, risk management, collaboration with other facilitators, and sustainability consideration. Since these results were derived from a single case study, they are not explicit. In a different context, these factors can vary. However, these results contribute to the understanding of private facilitation strategies in IS.

4.3 Private Facilitator's Role in Industrial Symbiosis

The data indicates that before 2015 the project's participant composition included the industrial companies, the municipality, and the academic network. The private consulting company WA3RM was added to this picture in 2015. Section 4.3.1 aims to answer RQ2 about the relevance of a private facilitator for IS projects by exploring motivations of the industrial companies to invite a private consultancy firm into the project. Section 4.3.2 addresses RQ3 related to the private facilitator's action-by-action contribution to the development of an IS system.

4.3.1 Reasons to Engage a Private Facilitator

The relevance of a private facilitator for IS project (RQ2) refers to motivation for the IS participants to invite an external private company to facilitate the process. In this study, the motivation to engage private facilitators is identified through the barriers to the IS project implementation that could not be addressed without the private facilitator.

The development of FVoB has experienced several barriers. The indicated barriers include informational, technological, regulatory, financial, organisational, and cooperation. Some of the barriers were addressed by the industrial companies, the municipality, or the academic network. However, to overcome some of the barriers, a private facilitator had to join the process.

The informational barriers refer to lack of awareness, information sharing, and practical knowledge (see Table 4-1). First, to address a lack of awareness, a "communicational story" around the FVoB was created (pers. int. 1). The story was created by the business director from Findus and his colleagues from the communication department. This was an approach to communicate the idea with potential industrial partners. At the same time, Findus could set up its vision of further development (pers. int. 1). Second, the director of Söderåsens Bioenergi (pers. int. 2) emphasized the importance of learning the experiences of other countries. He was invited by the European Landowners' Organisation (ELO) to visit a collaboration energy project in the town of Güssing, Austria. Being impressed by the project, he contacted a business coordinator in Bjuv municipality to discuss the ideas (pers. int. 2). In 2011, the municipality organized a seminar and a study visit to Güssing. The list of participants included local politicians from the municipality, six representatives from industrial companies (CEO level), and researchers from Lund University (pers. int. 4). After joining the SSES, both Findus and Bjuv municipality had a chance to learn about the Foodvalley of Netherlands and the principles of the circular food industry (pers. int. 7). Third, the companies were active in collecting the inventory information and accounting the potential benefits (pers. int. 2). This was a way to save investigation costs on the early stage when the idea is not clear. The director of Söderåsens Bioenergi suggests that to some extent the available information from the Internet and maps was enough. For specific scientific details and calculations, the SSEC was useful (pers. int. 2).

When it comes to the lack of practical knowledge, the participants needed an expert with experience in implementation of the synergy projects. In FVoB's case, the collaborating partners lacked practical experience in the recycling of low-temperature heat from the industrial processes. The experts from WA3RM had this expertise from the project for the European Spallation Source (ESS), a research facility in Lund, Sweden (pers. int. 8 & 9). Thus, the motivation to engage the private consultancy firm into the project was its previous experience.

The technical barriers in the FVoB relate to technological uncertainty and lack of expertise. The issue of technological uncertainty refers to the possibility of FVoB implementation. As described in section 4.1.1, the system should reuse heat and CO_2 from industrial facilities and provide an exchange of rainwater and nutrients (WA3RM, 2017). For instance, the temperature of heat has to be high enough to be reused (pers. int. 8 & 9). In the world's practice, the existing greenhouse systems accept heat temperature at 80° or more; and 55° is usually a minimum temperature for a conventional design (Parker & Kiessling, 2016; Parker & Svantemark, 2019). However, the temperature of heat excess from Findus facility was around 25° (before closing the factory). Another option was the nearby ISOVER manufacturing factory of Saint-Gobain Sweden AB.

The financial barriers to the FVoB relate to limited access to financial instruments. Although the local industries were interested in the project, they would not invest in it. First, this project is not in those companies' core business. Second, the payback period is long (pers. int. 8). The

industrial companies in Bjuv did not plan to invest in the IS project. At the same time, Findus was ready to grant volumes for both greenhouse and fish farming (pers. int. 1). This means that the company would guarantee to buy a specific volume from the production. And that could be used to attract investors. One of the ideas was implemented. A fish producing company VegaFish has started to grow organic tiger prawns. The farm was using the waste material flows from the Findus site. The reinvestment was needed, and the company bankrupt (pers. int. 1 & 4). Third, none of the participants was ready to pay for a feasibility study. Findus with the expert support from SSEC applied for study financing from Vinnova, the Swedish Innovation Agency (pers. int. 1). The funding was granted. The conditions of Vinnova's financial contribution are designed to incentivize the research project's accomplishing and high quality. This inter-organisational innovational study took 1,5 years to accomplish. This task required a coordinator who could take a financial risk and complete a research project (pers. int. 8).

The regulatory barriers for the FVoB mostly relate to the waste materials treatment legislation and the need to obtain permits. As mentioned by the Bjuv municipality's representative (pers. int. 4), there are many ways to extract and reuse as a resource what was formerly known as waste material. However, the legislation can still consider it as waste. Thus, this material cannot be treated as a resource (pers. int. 2 & 4). The required permits include the building permits for the greenhouse and the fish farm and operation permits for the fish farming (pers. int. 4, 8 & 9). In Sweden, the cropland is valued very high. According to the Bjuv municipality's representative (pers. int. 4), it's difficult for a farmer or landowner to transform his agricultural land into a greenhouse. One should apply to the County Administrative Board (Länsstyrelsen) for a building permit and changing an area plan (pers. int. 9). This procedure can take 2-3 years. Bjuv's industrial area has lost some of the potential investors due to the long waiting time (pers. int. 4). The Bjuv municipality, together with SSEC network, were supporting the permits application and communicating the significance of the project idea (pers. int. 4 & 7). The main arguments for the area plan changing included efficiency of the land use, self-sufficiency, and increased demand for tomatoes in Sweden (pers. int. 1). The changing the area plan can also be stopped by residents. In Bjuv, the neighbouring residents were against the idea of greenhouse construction (pers. int. 1 & 4). The Bjuv municipality was organizing the meetings with the residents and communicating the project idea, its significance, and impact. Thus, the Bjuv municipality was the most helpful in addressing the regulatory barriers to FVoB.

Both industrial and academic participants experienced organisational barriers within the project development. The organisational barriers typically refer to incompatibility with a current management practice, lack of top management support and financial incentives. From an industrial perspective, the large companies in Bjuv are owned by international corporations. The local management cannot proceed with an investment or collaboration without approval from the Board of Directors. And the Board of Directors is abroad and doesn't share the vision (pers. int. 4). This was an issue in the case of Findus. According to interviewee from Findus (pers. int. 1), the CEO of Findus Sverige (Jari Latvanen at that time) shared the vision of FVoB. However, the company owners (Iglo Group before 2015, Nomad Foods after 2015) did not have the intention to invest in FVoB since it is outside of the core business (pers. int. 8). Moreover, in 2016 Nomad Foods announced the closing of its facility in Bjuv.

From academia perspective, the organisational barriers included a problem to engage researchers and teachers into the collaboration process (pers. int. 6). The academic researchers are not incentivised to participate in long-term projects that can potentially never pay-off. The academic funds with a standard application and result procedures are more attractive. The time allocation issue is the barrier from the industry perspective as well. Even with the support from the top management, the business development director in Findus could spend only 20% of his working time to the FVoB project (pers. int. 1). The data shows that the organisational barriers

were not addressed in the FVoB project until 2018. Nowadays, the management of FoodHills AB aims to address this issue by creating a separate unit for innovation (pers. int. 3). However, during the period 2015-2017, the engaging of the project management company WA3RM took the organisational pressure from the project participants.

The cooperation barriers refer to lack of trust, willingness to collaborate, or institutional support for integration. The former business development director of Findus (pers. int. 1) stated that the companies did not share the common interest. "No one needed everything" (pers. int. 1). One company wanted access to the waste heat, another company wanted access to the cold storage, the third company wanted access to the land, the fourth company wanted access to the knowledge, and so on. In practice, fish farmers and greenhouse growers do not communicate with the large industrial companies due to different spheres of interest (pers. int. 8). In this situation, the municipality tried to build trust between the companies through transparency and an open discussion about everyone's engagement (pers. int. 4). In the same way, the SSEC took the role of the discussion platform (pers. int. 6). Both platforms were important: one – for trust-building, another – for scientific knowledge transfer. However, the progress was hard to achieve due to different opinions and debates. The industry representative described the issue of cooperating with SSEC as "many experts on the same topic" (pers. int. 1). Besides the expertise, the discussions also related to costs and risks of the project (pers. int. 6). Thus, the main cooperation barrier was the lack of institutional support for integration. Without the common interest between partners, the project needed an independent project management company.

The identified categories of barriers and related actions are summarised in Table 4-1. Some of the actions identified in the literature were not performed ("quick wins" workshops, incentive scheme for implementation, including the project in corporate targets and policy, see Table 2-1). At the same time, the practice of creating a "communicational story" and granting volumes as an indirect investment (both from Findus) are new to the theoretical spectrum of actions. The column "Actor" in Table 4-1 shows the type of organisation that was active in addressing the related barriers. To be removed, most of the barriers needed collaborative efforts. Some barriers could be overcome only by engaging the company WA3RM (pers. int. 1 & 4).

Three main aspects define the relevance of the private facilitators to IS projects. First, IS project participants need an expert with experience in the practical implementation of synergy projects related to the same innovation area. In FVoB's case, the partners lacked expertise in the recycling of low-temperature heat from the industrial processes. The experts from WA3RM could offer this expertise after their experience at ESS. Second, an opportunity assessment for the IS projects requires a company who can take a financial risk and complete a research project fast. In FVoB's case, none of the participants was ready to pay for the assessment study. The conditions of Vinnova's financial contribution are designed to incentivize the research project's accomplishing and high quality. Third, IS projects need institutional support for integration. In FVoB's case, the project development progress was hard to achieve due to different interests and long debates between industrial companies in Bjuv and the academia representatives. Therefore, private consulting companies are relevant to IS projects development, if they have expert knowledge and experience in a specific innovation area, project management skills and a willingness to take a financial risk. The specific contribution of private facilitators is described in section 4.3.2.

Table 4-1. Actions to address barriers to Food Valley of Bjuv Development

Category	Barrier	Addressing Action	Actor
Informational	Lack of awareness	"Communicational story" Seminars on IS concept Study similar cases (Austria, Netherlands)	• industries • municipality • academia
	Lack of information sharing	Inventory analysis	• industries
	Lack of practical knowledge	Recruiting with IS knowledge Find a contractor	• industries • **consultants**
Technical	Technical uncertainty	Technical feasibility study	• **consultants** • academia • industries
	Lack of technical expertise	Connect with knowledge centres Recruiting with specific expertise	• academia • industries • **consultants**
Regulatory	Difficult regulation	Legal feasibility study	• industries • municipality • academia
	Obtaining permits	Permits application support	
Financial	Long payback periods	Economic feasibility study Finding a contractor/creating a synergy operator	• **consultants** • academia • industries
	Limited access to financial instruments	Granting volumes Applying for business innovation and research grants, green bonds, or business loans Eligibility check for subsidies	• industries • **consultants** • academia
Organisational	Lack of support from the top management	Communicating the potential benefits	• municipality • academia • industries
	Incompatibility with a current management practice	Creating separated unit Senior management supervision	• industries
Cooperation	Lack of willingness to collaborate	Communicating the potential benefits Informational campaigns	• **consultants** • municipality • academia
	Lack of an institutional support for integration	Regular meetings Finding a contractor/creating a synergy operator	
	Lack of trust among industrial companies		

Source: Author.

4.3.2 Private Facilitator's Contribution

The RQ3 relates to a private facilitator's contribution to the emergence of an IS system. This contribution can be understood as functions performed by the company to support the IS project development and scope of action associated with every function. In the case study, four main facilitation functions performed by the private company WA3RM were identified.

First, the function of a project manager for a technical and financial feasibility study was performed by WA3RM in 2015-2017 (pers. int. 1, 4, 8 & 9). As mentioned above, the cooperation barriers to the FVoB implementation were not addressed by the participants without engaging with an independent third-party company. The consultancy company WA3RM AB that was founded in 2015 to facilitate the FVoB project's feasibility study (pers. int. 1, 7, 8 & 9). The company is a private project development firm. Its business concept is based on the development of circular industrial systems and making a profit from the successful establishment of IS (WA3RM, 2017). To stay in business, the company needs to continually develop its expertise, contact base, and portfolio of successful projects. According to WA3RM representatives, they have got funding from Vinnova for stage 2 of the project and quarterly payments from Findus for consulting (pers. int. 8). Thus, motivation includes profit and the project's implementation. According to Findus representative (pers. int. 1), WA3RM didn't stop collaboration with the SSEC and SLU, but they have managed to speed up the decision making and the entire process.

Second, the function of direct transfer of expert knowledge was performed by the WA3RM (pers. int. 1, 4, 8 & 9). The company's experts had experience in system solutions reusing the low temperatures. The low temperature of the heat excess was one of the technical barriers in the project. During the feasibility study, the project's team has developed and tested solutions that can use temperatures at 40° (WA3RM, 2017). The feasibility study has generated the investment calculations, production estimates, sales revenue estimates, profit and loss sheets, balance sheets and cash flow analysis for 20 years of infrastructure operations, calculations of returns for investor groups and a summarising investment memorandum (WA3RM, 2017).

Third, the experts of the company WA3RM shared the experience from the project for the ESS. As mentioned in section 4.2.1, this expertise was the reason why WA3RM was engaged in the project (pers. int. 8 & 9). Fourth, the function of "marriage brokering" was performed by the WA3RM (pers. int. 1, 4, 8 & 9). This function refers to providing specialised service contacts. As WA3RM representatives (pers. int. 8 & 9) stated, most of the collaborating partners were already in place. However, some parts of the study required specific solutions (pipes, heat exchangers, glass quality, etc.). In those cases, the external expertise was employed (for instance, Veolia Water Technologies, Hennan Yuhua new material Co.Ltd., etc.).

In the case of FVoB, the facilitation functions of the private consulting company include the project management, the direct transfer of expert knowledge, the experience sharing, and the providing contacts of specialised service companies. A comparing the collected data with theoretical background identified a broader spectrum of functions that can be possibly performed by private facilitators. As mentioned in section 2.1.3, at the initial phase of innovation, the diagnostic function can also be performed by a private consultancy (Bessant & Rush, 1995). In the IS context, this function is connected to overcoming the informational barriers by performing an inventory analysis and organizing "quick wins" workshop (see Table 2-2). However, in the FVoB case, the initial inventory analysis was performed by industrial companies (pers. int. 1 & 2). Thus, a level of involvement of WA3RM in the project was limited. Table 4-2 summerases the identified facilitation functions of private firms in the emergence of IS systems.

Table 4-2. Private facilitator's functions in industrial symbiosis

Function	Associated Scope of Action
Project management	• Coordination of feasibility study; • Speeding up the decision making and the cooperation process;
Direct knowledge transfer	• Sharing the knowledge of system solutions for reusing the low temperatures in circular food production;
Experience sharing	• Transfering the experience and ideas from one context into another;
"Marriage brokering"	• Providing contacts of specialised service companies;
Diagnistic function	• Inventory analysis; • "Quick wins" workshops.

Source: Author

With discovered scopes of action in mind, a possible IS facilitation plan for private consulting firms can be suggested. Based on the theoretical background and the case study information, private consulting firms can contribute significantly to the emergence of the IS system. However, when it comes to the construction and operation phases of a project, the collaborating companies prefer to establish a synergy operator. In FVoB, FoodHills is owned by Backahill and Lantmännen (pers. int. 3). The company was established as an industrial site operator. Thus, the facilitation actions of private consulting firms in IS projects are limited to the phase of IS emergence. The facilitation for the emergence phase includes the identification of opportunity, the assessment of opportunities, and the implementation support. Thus, Figure 2-4 from the theoretical background can be modified and applied to private facilitators. Figure 4-3 illustrates a possible facilitation plan and associated scopes of action for private consulting firms.

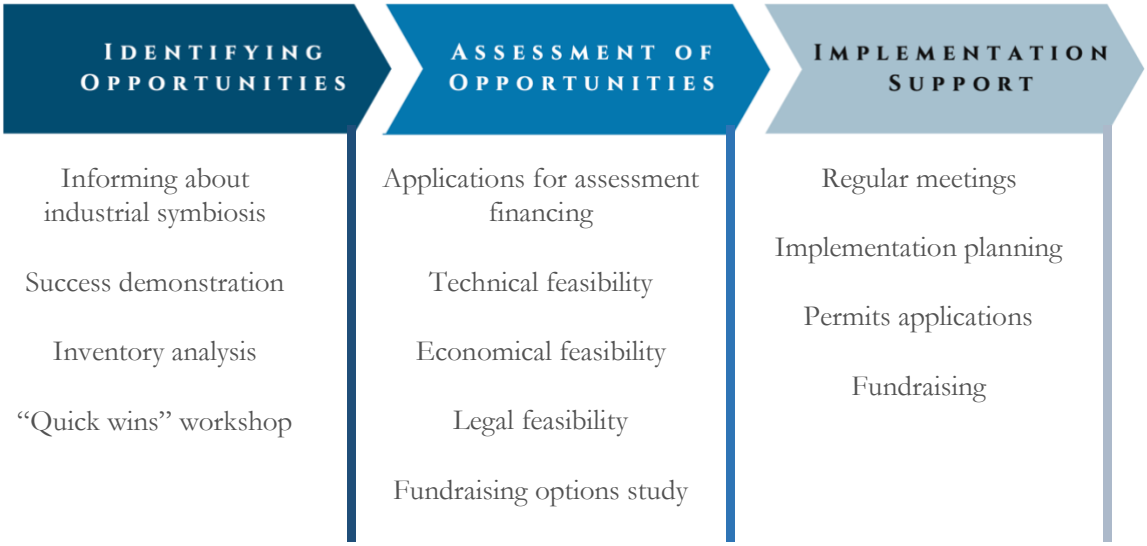

Figure 4-3. Possible facilitation plan for consulting firms in industrial symbiosis

Source: Author.

The scopes of action of various facilitation organisations (public authority, academia, industrial network, etc.) could overlap within one IS project (see Table 4-1). The overlap can accelerate or hinder the IS development. Every scope of action includes more specific facilitation actions that can be performed by different actors. A clear allocation of specific facilitation actions can support the IS project's development. Based on the possible facilitation plan and background information from section 2.2.1, this study describes specific actions that can be performed by private consulting firms or shared with other facilitators within one IS project. The full description is collected in Table 4-3.

In summary, a contribution of private facilitators to the IS systems is defined by functions performed by the company to support the IS project development and scope of action associated with every function. This study identified five main facilitation functions that can be performed by a private facilitator: project management, diagnostic function, direct transfer of expert knowledge, experience sharing, and providing contacts of specialised service companies. Private consulting firms can contribute significantly to the emergence of the IS system, including such phases as identification of opportunities, assessment of opportunities, and implementation.

Table 4-3. Facilitation actions for consulting firms in industrial symbiosis

Scope of Action	Actions
Informing about industrial symbiosis	• Meeting and conversation with potential IS stakeholders; • Presentation of concept, its application to the local industrial cluster, and potential benefits;
Success demonstration	• Presentation of successful IS systems in a specific industry that relates to to the local industrial cluster; • Study visits for potential stakeholders (top managers);
Inventory analysis	• Collection of life cycle inventory data from the national or international databases of material flows and waste streams (EPLCA, 2020; NISP, 2020; SLCC, 2020); • Collection of waste data from corporate environmental reports, local waste management companies' databases, national or international statistics; • Collection of industry attribute data related to local companies from a national statistical bureaus or other agencies; • Identifying input-output matches or/and a new production system;
"Quick wins" workshop	• Organizing joined workshops with all potential partners together using preexisting contacts; • Presenting the related case studies; • Discussing the inventory analysis results; • Sharing individual company's wastes, energy and material excesses and resource needs; • Identifying input-output matches or/and a new production system (by participants);
Applications for assessment financing	• Application for business innovation and research grants to innovation authority (e.g. the Swedish Innovation Agency Vinnova, the Danish Business Authority);
Technical feasibility	• Innovation technology searching and testing; • Identifying of technology suppliers;
Economical feasibility	• Cost-benefit analysis, life cycle assessment (LCA); economic input-output analysis; • Market calculations; • Finacial prognosis; • Financial risk assessment; • Investment memorandum;

Legal feasibility	• Checking regulations related to identified matches or/and a new production system
Fundraising options study	• Applying for business innovation and research grants, green bonds, or business loans • Eligibility check for subsidies
Regular meetings	• Schedule regular communications; • Setting a common information space for all participants; • Using a project management tool with common access;
Implementation planning	• Organizing discussion related to project planning among stakeholders; • Defining the steps and setting the deadlines;
Permits applications	• Applying for permits related to identified matches or/and a new production system;
Fundraising	• Looking for investor; • Applying for green bonds, business loans; • Applying for subsidies if eligible.

Source: Author

5 Discussion

This chapter presents the reflections on findings from the case study, comparing the results to the previous knowledge about IS facilitation strategies and roles (5.1), and discussing the use of methods in this study (5.2).

5.1 Results against Previous Knowledge

The concept of *innovation intermediary* provides an understanding of different actors supporting the innovation process and their functions (Kivimaa et al., 2019; Mignon & Kanda, 2018; Polzin et al., 2016). However, the connection of this concept to IS facilitation is unexplored. Only a few studies connected two perspectives (Aid et al., 2017; Patala et al., 2020). This study contributes to the understanding of the functionality of IS facilitators and links the empirical results from the Swedish food industry with the *innovation intermediary* concept.

Several studies described facilitation actions that can be performed by different organisations to contribute to the development of the IS system (Aid et al., 2017; Chertow & Ehrenfeld, 2012; Costa & Ferrão, 2010; Doménech & Davies, 2011; Grant et al., 2010; Paquin & Howard-Grenville, 2012; Zaoual & Lecocq, 2018). This study summarised both the previous knowledge and the case study information. In result, this study provided a spectrum of functions that can be performed by a private facilitator to support the emergence of an IS system. Every function includes an associated scope of action (Table 4-2). These scopes of action were allocated to different phases of the IS implementation process to create a possible facilitation plan (Figure 4-3). However, it was indicated that the scopes of action of various facilitation organisations (public authority, academia, industrial network, etc.) could overlap within one IS project. The overlap can accelerate or hinder the IS development. This study suggested to break down every scope of action into more specific facilitation actions (Table 4-3). With specific facilitation actions in place, an IS project's design can allocate the actions between different facilitators and accelerate an implementation process.

The *level of involvement* of a private consulting firm in the IS project can vary. According to Mignon (2017), in some cases, facilitator involvement includes only limited consultancy tasks, whereas in other cases, the involvement included coordination and management of the entire implementation process. First, it can be a single-task performer, when the company performs one or two activities (skill training, search for investment, cutting a waste stream, etc.). Second, the company can cover several functions within the project. In FVoB case, WA3RM was invited as a single-task performer. In result, its involvement included four functions. Third, the company can be responsible for the whole facilitation process. This strategy is described in the literature as a synergy management service company (Siskos & Van Wassenhove, 2017). In FVoB case, the company FoodHills AB can be seen as a synergy management service company. Thus, the level of private facilitator's involvement can vary based on other participants' interests and plans, private facilitator's goal and level of expertise, and the project's maturity level.

The study discovered the relevance of a private facilitator for IS projects through the motivation of other participants. The motivation itself is identified through the barriers to the IS project implementation that could not be removed without the engagement of a private facilitator. According to Pinto (2019), consulting companies are valued for providing expert knowledge and access to other innovation players. In case of IS project engaging multiple organisational stakeholders, the private consulting company has to offer more value: expert knowledge and experience in a specific innovation area, project management skills and even willingness to take a financial risk. That is why engagement in IS projects is challenging for consulting firms.

From a business model perspective, Baldassarre et al. (2019) suggested a business model framework for IS clusters. This framework could be applied to analyse the business model elements for private IS facilitators. Different stakeholders in the project can have a different value proposition. The value proposition of private IS facilitators can include diagnosis, direct transfer of expert knowledge, experience sharing, providing contacts of specialised service companies, and project management. The revenue streams can include a charging fee for specific facilitation actions (Table 4-3) or as a payment for coordinator's role in feasibility study. Thus, the facilitation functions and actions described in this study can be used to analyse business model elements for private IS facilitators.

The *sustainability consideration* was indicated as one of the guidelines for a private IS facilitation strategy (section 4.2.2). According to Ellis (2005), the facilitators face a "trader's dilemma". That means that when the project enters the operation phase, the private facilitator's services may not be required any longer. To stay in business, the company needs to continually develop its expertise, contact base, and portfolio of successful projects. Moreover, the expert solutions provided by private facilitator have to be considerably more efficient and sustainable. From the environmental perspective, the IS has to utilise only the material and energy resources that would be wasted otherwise to avoid "rebound effect" (Mirata, 2005). If there is a chance to increase efficiency without applying an IS solution, this option should be considered first. The sustainability consideration has to guide the actions of private consulting firms and increase the firm's reputation and trust from potential customers.

5.2 Reflecting on Methods

Both the grounded theory approach and case study research design are problematic from a generalisation point of view. However, the *sensitivity to context* strategy helped to generate concepts that can be later compared to different contexts to complete a *formal theory*. The case is from the Swedish food industry. Several context aspects were considered in this study. In terms of cooperation, the trust between potential partners is an essential issue in the Swedish context. In several Swedish regions, cooperation networks are designed to support trust development between different industrial, public, and academic actors. It is vital for a private IS facilitator not to compete with these networks but cooperate with them. In terms of information, the development of national and local data centres supports the idea of data sharing between industrial actors in Sweden. These centres can provide an IS facilitator with LCI data, waste data, and industry attribute data required for inventory analysis. In terms of regulations, this study touched two main aspects of the Swedish context. First, a tax on waste sent to landfill incentivises industrial companies to look for solutions to re-use waste. Second, the Swedish regulation protects agricultural land from being altered. This regulation sets limitations to IS projects in food production. In terms of industry sector, the facilitation of IS in food production involves specific technologies (e.g. re-use of low-temperature heat) and actors (e.g. farmers and food processing companies). Therefore, to develop a *formal theory*, the results of this study can be tested in a different production sector in Sweden, or in the food production sector in a different country.

This study is focused on the role of a private consulting company WA3RM in the development of the FVoB. The period of the WA3RM's involvement in the project was limited to 2015-2017. This situation could be considered as a disadvantage for a data collection. However, this study benefited from analysing past events. Typically, private consulting companies do not disclose the details of their current business activities. In this research, the interview participants could openly talk about their perspective and contribution to the project without limitations of confidentiality. Thus, the data was sufficient to reach *theoretical saturation*.

The use of grounded theory approach typically requires to collect 20-60 interviews (Creswell, 2007). However, the primary purpose of conducting the interviews is to have enough information to develop the theory and achieve *theoretical saturation*. During the study, the interviews were conducted with representatives of different perspectives. The perspectives included industrial companies involved in the FVoB project, public facilitators, private facilitators, and academic network representatives. Moreover, the information from interviews was supported by documentary data. Therefore, the *triangulation* strategy was used to have a balance of different data sources and various perspectives within the collected data.

6 Conclusions

This chapter summarises the conclusions of the study, including practical implications for IS development (6.1) and future research opportunities (6.2). The research aim was to explore possible roles and strategies of private facilitators in industrial symbiosis projects based on a case study from the Swedish food industry. The practical implications of this study correspond with three RQs related to private strategies of involvement in IS projects, the relevance of the private facilitators for IS projects, and private facilitators' contribution.

6.1 Accelerating Industrial Symbiosis Development

Following the RQ1, this study described the strategic steps that can be taken by a private consulting firm to engage in an IS project. These steps include identifying the innovation idea based on firm's expert portfolio, finding a project through networking, involvement in the project, reflecting on the results of the project, and updating the strategy based on lessons learnt from the project. These results explain the possible course of actions for a private consulting company to engage in an IS project. Moreover, these results help to derive strategic guidelines for a consulting company to succeed in the business of IS facilitation. Four strategic guidelines included precise determination of goals, risk management, collaboration with other facilitators, and sustainability consideration. Thus, a private consulting company can become a valuable part of the IS facilitation process relying on its unique expertise and network.

Following the RQ2, this study discovered the relevance of private facilitators to IS projects. First, IS project participants need an expert with experience in the practical implementation of synergy projects related to the same innovation area. Second, an opportunity assessment for the IS projects requires a company who can take a financial risk and complete a research project fast. Third, IS projects need institutional support for integration. Therefore, private facilitators are relevant to IS projects development, if they have expert knowledge and experience in a specific innovation area, project management skills and a willingness to take a financial risk.

Following the RQ3, this study explored the contribution of private facilitators to the IS systems. The contribution was defined by functions performed by private facilitators to support the IS project development and scope of action associated with every function. The study identified five main facilitation functions that can be performed by a private facilitator: project management, diagnostic function, direct transfer of expert knowledge, experience sharing, and providing contacts of specialised service companies. This study suggested a detailed description of facilitation actions during the emergence of the IS system. The detailed description of actions helps to design a facilitation plan for an IS project and allocate actions between various organisations, including private facilitators.

Since the results of this study were derived from a single case study, they are not explicit. In a different context, the results can vary. However, this study explored the private strategies for IS, the relevance of private facilitators to the emergence of IS systems, and their roles in cooperation with other actors. This study contributes to an understanding of different roles and collaboration opportunities between public, private and academic actors in IS development.

6.2 Future Research

The conceptual framework (Figure 2-1) and analytical framework (Figure 3-1) developed for this study can be used further to explore IS facilitation strategies of different actors and discover an optimal combination of actors and roles that fosters the development of IS projects. Moreover, there are various opportunities for further research.

First, the results from this case study can be tested in a different context (see section 5.2). After investigating the same RQs in different case studies, the cross-case analysis can be conducted. Thus, further research can aim for the formulation of a formal theory concerning the roles and strategies of the private facilitators that can support IS development.

Second, the understanding of private facilitator's role in IS projects can benefit from using a different methodological approach. For instance, practice-oriented action research could be conducted for a deeper understanding of private facilitators roles in Sweden and other contexts, identifying best practices and discovering this emerging business area.

Third, different private consulting firms can have different impacts on IS project's outcomes. Some recent studies suggest that different aspects of collaborations between facilitator and an industrial company can affect the innovation implementation (Mignon, 2017; Mignon & Kanda, 2018). Further research can investigate the impact of private facilitator's scale (local firm or international company) and expertise on the IS implementation process and outcomes.

In general, exploring collaboration opportunities and clear allocation of facilitation actions between public, private and academic actors in IS can foster the emergence and implementation of symbiotic projects and enhance resource efficiency and low-carbon development, in Sweden and globally.

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Appendix A: List of Interviewees

Category	In-Text Reference	Organisation	Occupation	Procedure	Duration (min.)	Length (pages)
Industry	Personal interview 1	Findus Sverige	Business Development Director (2014-2015)	in person	64	13
	Personal interview 2	Söderåsens Bioenergi AB	Director	via phone	41	8
	Personal interview 3	FoodHills AB	Board Chairman	in person	61	12
Public authority	Personal interview 4	Municipality of Bjuv	Business Coordinator	via phone	49	8
	Personal interview 5	Skåne Energy Agency	Projects Leader	via e-mail	N/A	1
Academic network	Personal interview 6	Swedish Surplus Energy Collaboration / Swedish University of Agricultural Sciences	Projects Coordinator / Head of Faculty	via Zoom	26	4
	Personal interview 7		Program Leader	via Zoom	45	8
Consulting firm	Personal interview 8	WA3RM AB	Co-Founder / Project Leader	via Zoom	51	9
	Personal interview 9		Co-Founder	via Zoom	55	9
	Personal interview 10	Ensucon AB	Senior Consultant	in person	29	5
Waste management company	Personal interview 11	Econova Recycling AB	Environmental Integrator	via Zoom	34	6
Total					**455**	**83**

Source: Author

Appendix B: Interview Guide

Block	№	Question Examples
Interview practicalities	1.1	Ask for permission to audio-record the interview.
	1.2	Explain in general and specific terms what is understood by "the project".
General engagement in the project	2.1	What is your job position and responsibilities?
	2.2	When did you engage in "the project"?
	2.3	What was /is your task related to "the project"?
Project's Development	3.1	How did the project idea appear?
	3.2	How did you define your initial steps?
	3.3	Who initiated inventory analysis?
	3.4	Who participated in the feasibility study?
Collaborating organisations and their roles	4.1	What was/is the company's interest in "the project"?
	4.2	Did you use external recourses?
	4.3	What was the task for the external organisation?
	4.4	How was the external service paid?
Barriers and actions to address them	5.1	What challenges did you experience during "the project" development?
	5.2	How did you manage to overcome those challenges?
	5.3	How difficult was to engage different participants in "the project"?
	5.4	Was the information needed for this project available?
	5.5	Did you have enough practical knowledge about reusing the heat and waste?
	5.6	Did you experience technical difficulties?
	5.7	What regulatory issues hindered the process?
	5.8	Did you have any difficulties inside your organisation with "the project"?
	5.9	How was "the project" financed?
Context	6.1	What would you do differently for "this project" in another industry?
	6.2	Is it advantage to have this project in Sweden?

Source: Author

Appendix C: Coding Structure in NVivo

	Initial Codes	Focused codes		Teoretical codes
RQ	**Discriptive statements**	**Categories**	**Sub-Categories**	**Theoretical categories**
What strategies can be used by private firms to engage in IS projects as facilitators?	Any descriptions related to how did WA3RM engage in the project, and the lessons learnt	5 strategic steps	Activities inside every step	Concepts related to strategic steps
		4 strategic considerations	Lessons learnt for every category	Concepts related to success factors
Why are private facilitators relevant to IS emergence?	Problems in the Food Valley of Bjuv project's development	6 categories of barriers	Addressing actions related to specific actor/what could not be solved without WA3RM	Concepts related to the value of private facilitators for IS projects
How can private facilitators contribute to the development of IS system?	Any functions performed by WA3RM in the project	4 functions	Actions inside every function	Concepts related to facilitation plan and actions of private facilitator