



## KNOWLEDGE DYNAMICS AND INNOVATION: CASE STUDIES IN A SPARSELY POPULATED AREA

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### ABSTRACT

**Purpose:** *This study describes the sources of essential knowledge for the innovation cases in three micro companies and analyses the knowledge dynamics in these cases. This study seeks to answer the following questions: What are the sources of essential knowledge for the innovation cases in the three micro companies selected? What kind of knowledge is required in these cases, and what phases can be identified in these innovation cases? These questions are answered through a multiple case study that uses the knowledge biography technique.*

**Method:** *This is a multiple case study with holistic strategy. The unit of analysis is the innovation case. We analyse innovation cases in three micro companies operating in the Oulu South region. At the heart of the study is the knowledge biography technique, an innovative approach that provides a deeper understanding of knowledge dynamics in firms and regions. The empirical data was gathered through semi-structured interviews and public archives related to the case company. The interviews with key informants were mainly conducted face-to-face during fieldwork in 2013. The data was analysed using an inclusive and iterative process, and the main findings were summarised.*

**Findings:** *We tracked the sources of essential knowledge for the three innovation cases and the knowledge dynamics of these cases were described by using the knowledge biography method. This study will serve as an interesting benchmarking tool for any public organisation that offers business services to companies. The findings suggest that public actors should pay more attention to the case-specific needs of innovative micro companies while developing their services.*

**Value:** *In the future studies, it would be interesting to analyse more innovation cases using the knowledge biography technique and make comparisons among these cases.*

**Keywords:** Knowledge dynamics, knowledge biography, innovation, micro company, growth, Finland

**Category:** Case study

### INTRODUCTION

Knowledge is generally connected to innovation. In fact, changes in knowledge can be seen as the driving force behind innovation, and the general product/innovation lifecycle can be divided into generic phases, stages or states in multiple ways (e.g. Dean, 1950, Golder and Tellis, 2004, Markusen et al., 1986, Schutjens and Stam, 2003). This study aims to describe

the sources of knowledge that are essential for the innovation cases in three micro-companies located in Oulu South region and analyse the knowledge dynamics in these cases.

The Oulu South region is situated in the southern part of Northern Ostrobothnia in Finland. This region is not a governmental unit or area but was formed to increase inter-municipal cooperation and development and to gain the required critical mass to ensure national and international competitiveness. The region comprises three subregions and 14 municipalities, with approximately 90,000 inhabitants and 4,600 active companies. Oulu South is one of Finland's main rural areas; however, because it offers sufficient employment to its inhabitants, it is known as the 'industrialised countryside'. Furthermore, although the unemployment rate in this region is the lowest in northern Finland, it is likely to retain a large proportion of its younger population because it has the highest birth rate in Finland, despite the demographic challenge of widespread emigration from the region. This distinguishes the Oulu South region from other rural areas in Finland, many of which are dealing with significantly ageing populations.

In this study, we investigate three innovation cases in micro companies located in the Oulu South region:

- Case 1. Development of a vertical lifting fabric fold-up outer door.
- Case 2. Development of a method to process and convert the ash generated by power plants to end-of-waste products.
- Case 3. Development of an internet application for electricity price comparison and contract rating.

This study focuses on the knowledge dynamics of these three innovation cases to garner a better understanding of how knowledge is developed and transferred at a firm level. The aim of studying knowledge dynamics is to unravel the processes of knowledge interactions and to identify the types of actors that are involved in these processes. Therefore, we defined the following research questions:

1. What are the sources of knowledge that are essential for the three innovation cases?
2. What kind of knowledge is required and what phases can be identified in the three innovation cases?

To address these research questions, multiple case studies were conducted. This was deemed the optimum approach for the purposes of our study. According to Yin (1989, p. 23), 'a case study is an empirical inquiry that investigates a contemporary phenomenon within its real-life context, when the boundaries between phenomenon and context are not evident and in which multiple sources of evidence are used'. An essential part of this study was to conduct in-depth interviews with the key informants of each innovation case. Because this study deals with interactions among actors and particularly aims to evaluate knowledge exchange and development, this was deemed the best way to obtain considerable information regarding these processes. The information obtained through the interviews was analysed by predominantly using the knowledge biography technique.

This study may enable public actors to ask essential questions for developing their services for micro companies, thereby fostering regional development and economic growth. According to Crevoisier and Jeannerat (2009, p. 1228), those regions that are capable of imagining their local activities within a global environment are categorized as innovative

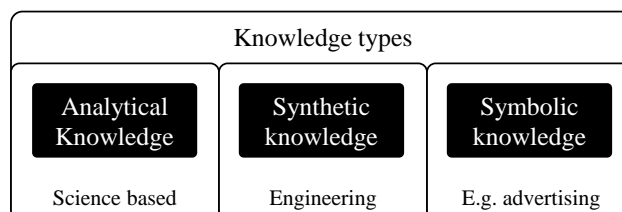
regions. To be innovative, a region must be capable of matching its dynamics to the generation and utilization of knowledge.

This study is made up of five sections. In the introduction, the background, motivation, research problem and research questions are presented. In the second section, the theoretical background of the study is presented, and a brief survey of the relevant knowledge dynamics, types and phases is conducted. In the third section, the method undertaken in this study is described. In the fourth section, a description and analysis of the data garnered in case studies are undertaken; these findings are then examined in light of the research questions. In the final section, a discussion of the main results and opportunities for further research is presented.

### KNOWLEDGE DYNAMICS

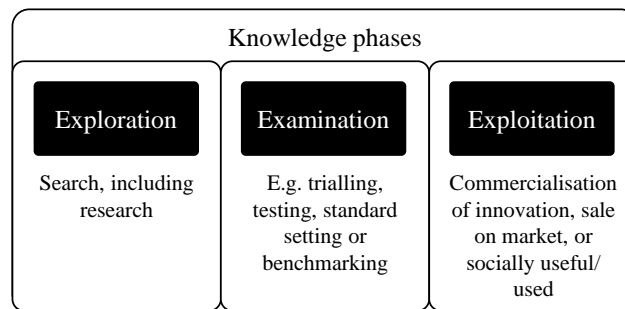
Knowledge is widely regarded as a useful economic resource. In this context, it has been defined as the learning process in human brains, which is generated and used in personal and collective interactions in various contexts and uses given individual and firm competences to appropriate new and necessary economically useful knowledge (Dahlström and Hedin, 2010, p. 6). Therefore, knowledge is seen as both a resource and a process, both of which are linked to the interactions that occur among actors in the concept of knowledge dynamics. According to Strambach (2008, p. 154), the visible results of knowledge dynamics are innovations in products, services or processes. Knowledge dynamics can be understood as the dynamics that emerge from the processes of creation, usage, transformation, movement and diffusion of knowledge. Knowledge is not static; rather, it is constantly changing and dependent on context and application.

For the purposes of this empirical case study, analytical, synthetic and symbolic knowledge were considered most relevant. Analytical knowledge is defined as research-based knowledge, which is developed through scientific exploration. Synthetic knowledge is considered a combination of analytical and (perhaps) symbolic knowledge. Engineering knowledge is a good example of synthetic knowledge, because it is derived from application and scientific research. Symbolic knowledge is largely recognised in research on cultural or creative industries. It deals with ideas, symbols and socially constructed commodities. It has been referred to as the knowledge about representation (Asheim and Coenen, 2006, Strambach, 2008).



**Figure 1.** Types of knowledge

Knowledge phases seldom progress linearly. Usually, development progresses in such a way that various phases occur at the same time. In fact, there may even be loops between these phases. To understand the complexity of knowledge dynamics as a part of the process of innovation, the following three knowledge phases are examined in this study: exploration, examination and exploitation.

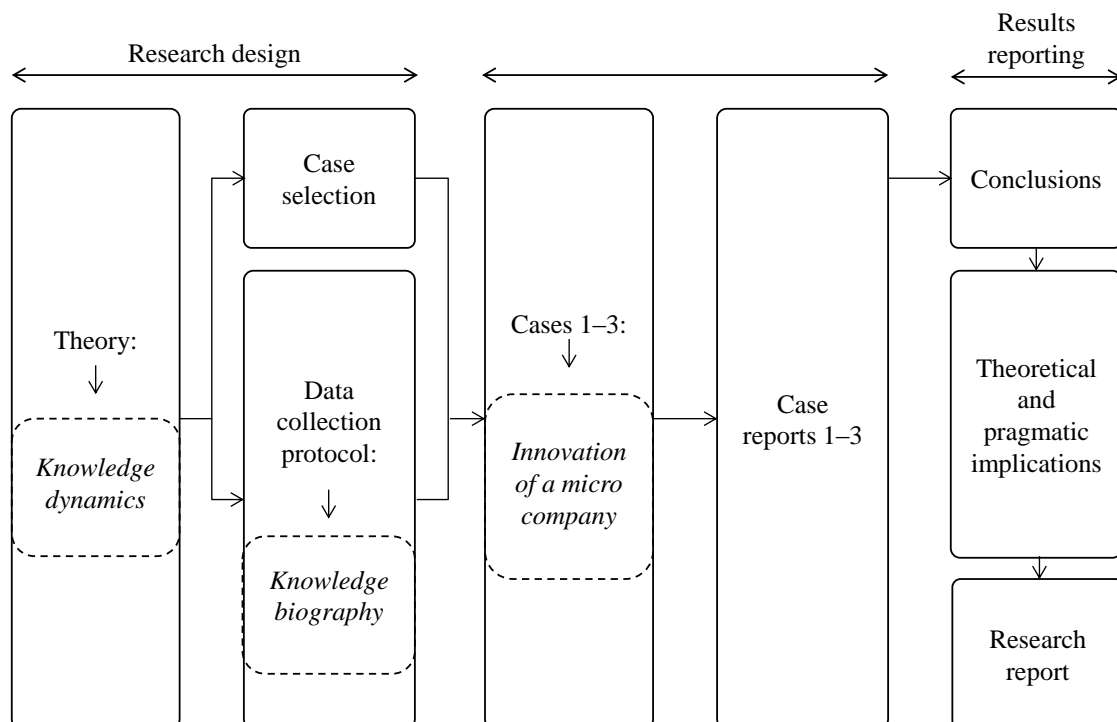


**Figure 2.** Knowledge phases

The exploration phase is often described as the first step in the knowledge chain. This phase usually involves searching for new knowledge or maintaining and developing existing knowledge. Examination is a testing phase in which the veracity and applicability of the knowledge is considered. Exploitation is regarded as a ‘selling’ and ‘using’ phase in which knowledge is applied to a situation in return for financial, status, position or recognition gains (Halkier et al., 2010, Strambach, 2008).

### METHODOLOGY

We used a multiple case study with holistic strategy. The case study followed the process presented in Figure 1.



**Figure 3.** The research process

The study analysed the process of innovation cases in three micro companies. The definition of a micro company (and SME) is different in different contexts. The US context, for example, offers many definitions of SME, depending on the industry. For example, in some industries, an SME is defined as any company having fewer than 500 employees. In the European context, an SME is defined as any company having fewer than 250 employees. The

same disparity applies to micro companies and should be taken into account when studying the SME-related literature. Ayyagari et al. (2007) cover this topic in their globally focused, statistical study on SMEs (p. 416): ‘The term SME covers a wide range of definitions and measures, varying from country to country and varying between sources reporting SME statistics. Some of the commonly used criteria are the number of employees, total net assets, sales, and investment level. However, the most common basis for definition is employment, and here again, there is variation in defining the upper and lower size limit of an SME. Despite this variance, a large number of sources define an SME to have a cut-off of 250 employees’. Because of the European context of this case study, we utilise the European definition. Within the SME category, the European Union defines medium-sized firms as having 50-249 employees, small firms as having 10-49 employees and micro-firms as having 0-9 employees (Storey, 2003).

In this study, the empirical data was gathered through semi-structured interviews and public archives related to each company in question. Most of the interviews with key informants were conducted face-to-face during fieldwork. The questionnaires were designed to obtain information from the informants on various questions including the following: How did the innovation process develop from idea to product? What important knowledge interactions occurred during the development of the product? Who were the main actors involved in the development process? Where were they located? What type of knowledge did they contribute to the process? What core knowledge was involved in the genesis and development of this innovation? How did the core knowledge of the innovation arise and how was it developed?

The knowledge biography technique—an innovative approach that provides a deeper understanding of knowledge dynamics in firms and regions—was used as the main technique for interpreting and analysing the data. The essential sources of knowledge for each innovation case were tracked, and interviews were used to obtain basic information regarding the time and space dimensions of the knowledge dynamics that occurred as a part of the cases. The knowledge biography technique permitted us to capture the diversity of the social environment of each firm to determine the precise manner in which knowledge was transmitted and information was exchanged from various partners inside and outside the firm (Dahlström and Hedin, 2010, p. 11).

## **CASE STUDIES**

In this section, we describe the essential knowledge sources for the three innovation cases and analyse the knowledge dynamics in these cases. Moreover, the detailed knowledge biography of each innovation case is presented.

The three innovation cases analysed in this study are as follows:

Case 1. Development of a vertical lifting fabric fold-up outer door.

Case 2. Development of a method to process and convert the ash generated by power plants to end-of-waste products.

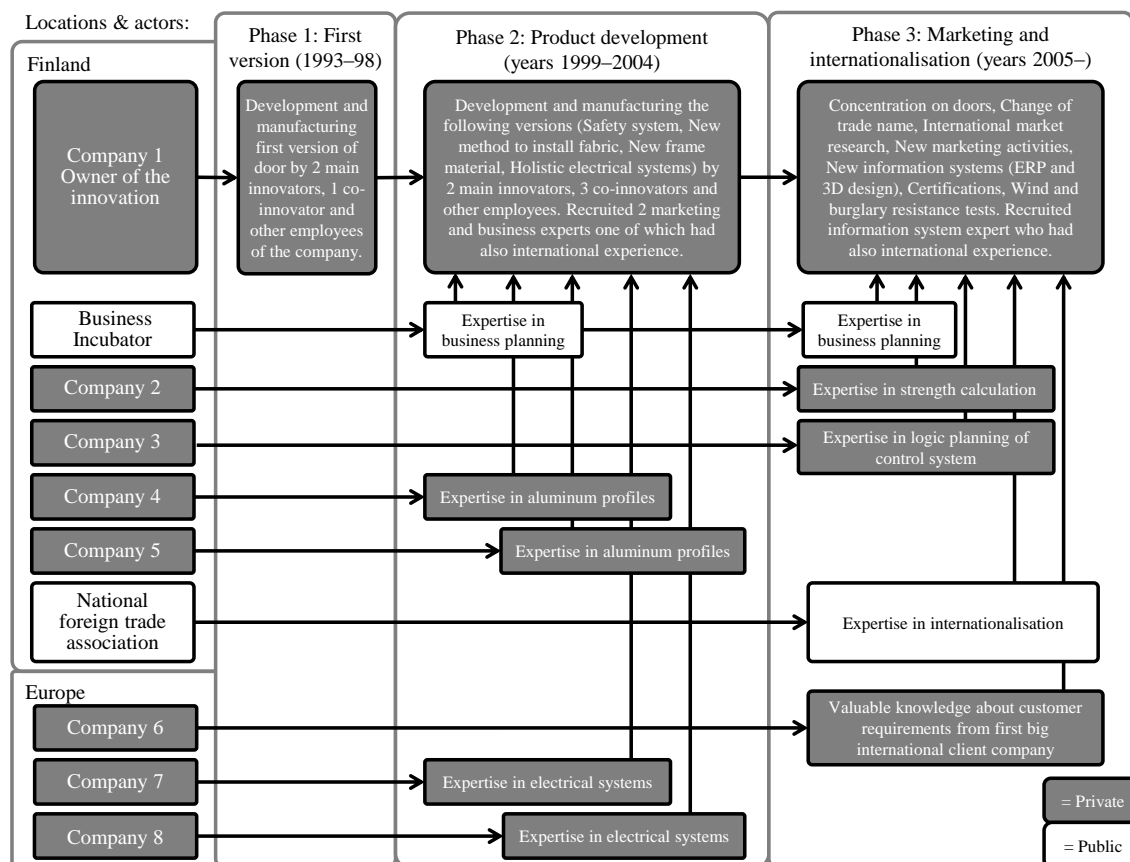
Case 3. Development of an internet application for electricity price comparison and contract rating.

**Case 1**

Innovation case 1 is the development of a vertical lifting fabric fold-up outer door. Based on the data obtained from the interviews, three innovation phases were identified:

1. First version, 1993–1998
2. Product development, 1999–2004
3. Marketing and internationalisation, 2005–

Figure 4 illustrates the innovation phases and key knowledge interactions among the actors in case 1. The owner of the innovation remained the same (i.e. company 1) during the development process.



**Figure 4.** Knowledge biography of innovation case 1

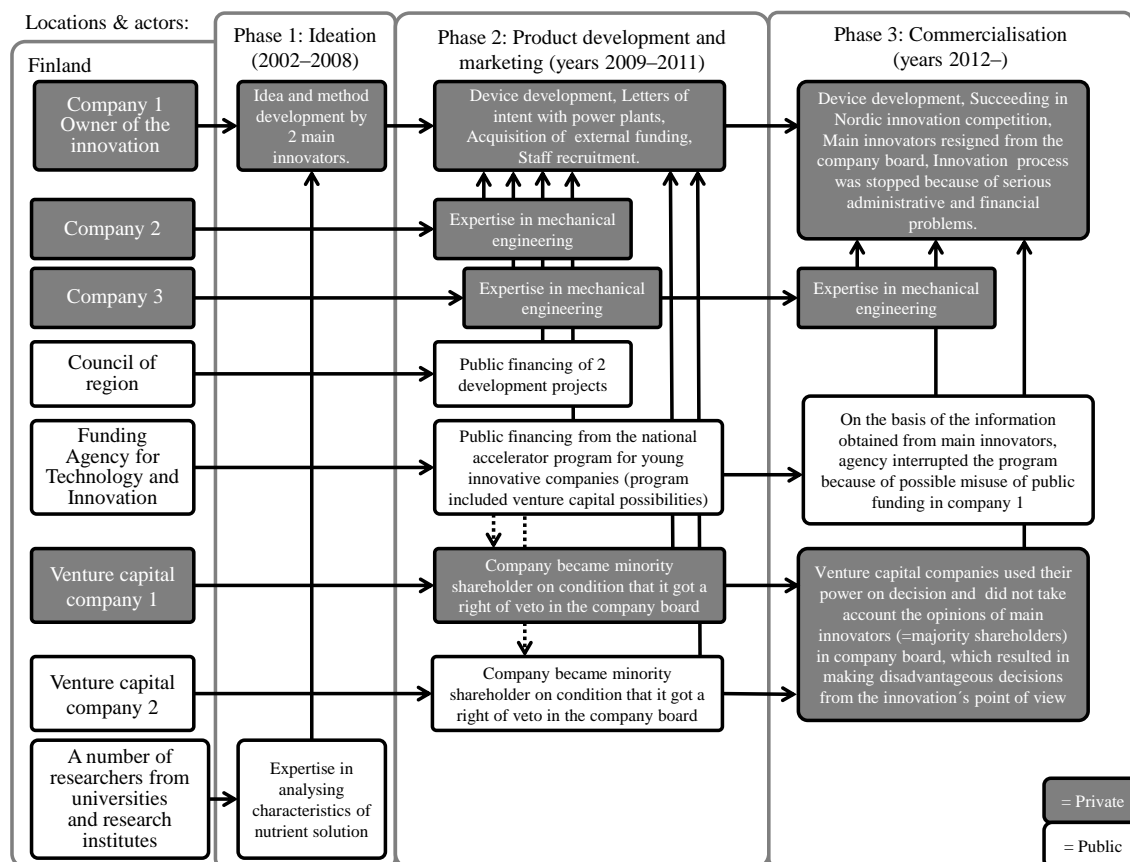
The idea was based on the following question posed by one customer in 1993: ‘Could you make us an outer door with a basic structure that is similar to your indoor divider wall?’ Two main innovators made a plan for modifying the divider wall to outer door. Subsequently, the first version of outer door was manufactured and sold to the customer in 1993. The entire planning and manufacturing process was completed by the staff of company 1 in phase 1.

The employees of company 1, who had considerable experience in manufacturing tailor-made sunblinds, sunshades and divider walls, contributed the most important knowledge to the development process. In phase 2, the expertise of several external experts was introduced to the process. In phase 3, internationalisation expertise was introduced to the development process by a public organisation and knowledge regarding customer requirements was introduced to process by the first big international client company *Case 2*

Innovation case 2 is the development of a processing method for ash from power plants. Based on the data obtained from the interviews, three innovation phases were identified:

1. Ideation, 2002–2008
2. Product development and marketing, 2009–2011
3. Commercialisation, 2012–

Figure 5 illustrates the innovation phases and key knowledge interactions among the actors in case 2. Two individuals (i.e. the main innovators) were the owners of the innovation in phase 1. Subsequently, the company (i.e. company 1), which was founded in 2009 by the main innovators, was the owners of the innovation.



**Figure 5.** Knowledge biography of innovation case 2

The innovation idea was based on a research that was initiated in the 1960s on the utilisation of ash in forest fertilization by one of the main innovators. In 2002, he asked the other main innovator to help him commercialise the nutrient solution, which he had been successful in separating from ash. The other main innovator immediately noticed the business possibilities associated with possessing expertise in ash processing. Subsequently, the main innovators independently began developing the method of ash processing in phase 1. The objective was to create a method and device that enables the processing and conversion of ash to end-of-waste products. The Ash generated by power plants is classified as waste, which causes significant waste handling costs for power plants.

The most important knowledge was introduced in the development process by the two main innovators, one of whom had significant working experience in the research sector. The other

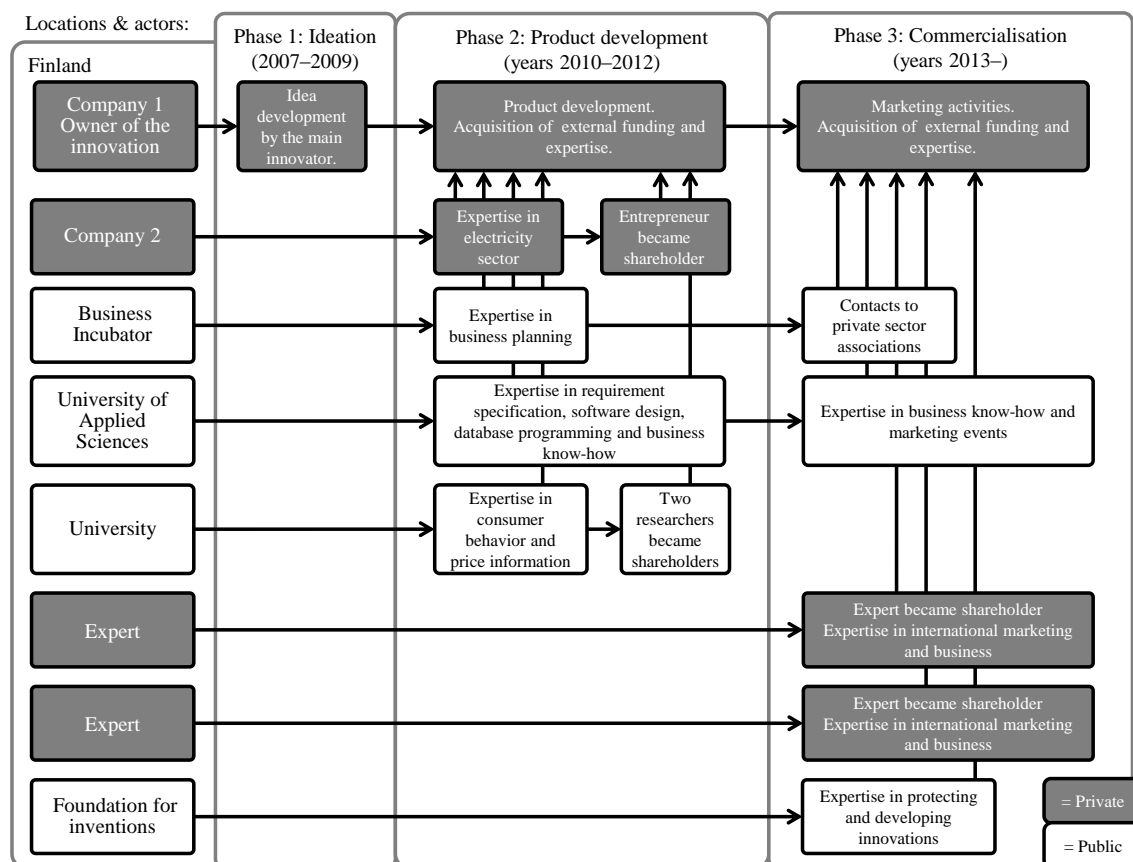
main innovator had considerable and varied experience in business, development and planning. He had a many-sided education and had also made 15 patented inventions. External experts mainly participated in the process in phase 2 when the construction of the device was in progress. Public actors participated to the process mainly by financing the development of the method and device. In this case, the influence of the venture capital companies was especially noteworthy. The venture capital companies displaced the main innovators from the operational decision-making in the board of the company 1, which caused serious administrative and financial problems and at the end the failure of the entire development process.

### Case 3

Innovation case 1 is the development of an internet application for electricity price comparison and contract rating. Based on the data obtained from the interviews, three innovation phases were identified:

1. Ideation, 2007–2009
2. Product development, 2010–2012
3. Commercialisation, 2013–

Figure 6 illustrates the innovation phases and key knowledge interactions among the actors in case 3. One individual (i.e. main innovator) was the owner of the innovation in phase 1. Subsequently, the company (i.e. company 1), which was founded in 2010 by the main innovator, was the owner of the innovation.



**Figure 6.** Knowledge biography of innovation case 3



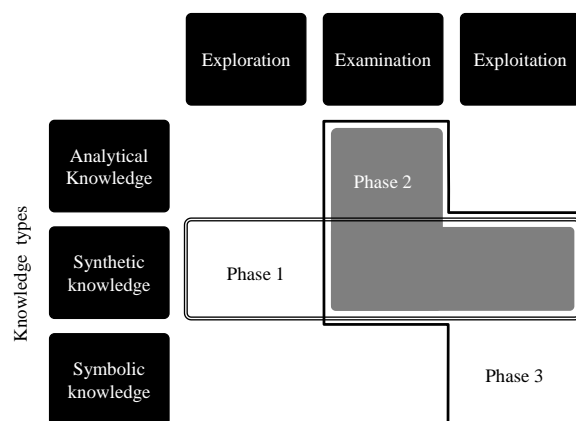
The main innovator got the idea of developing an internet application for electricity price comparison and contract rating in 2007 while working in a company that operated as an electricity supplier. At the time, the public believed that traditional internet applications for electricity price comparison only provided a minor benefit to the consumers. This belief of the public gave the innovator the insight that the criteria for price formation in the electricity sector are very non-transparent for customers. The main innovator also noticed that there was no internet service in the market that transparently presents the criteria for electricity price formation and contract rating. The main innovator independently developed the idea further in phase 1, after which he resigned from his job and founded a new company (i.e. company 1).

The most important knowledge was introduced in the development process by the main innovator, who had extensive and varied working experience in the electricity sector and was a certified electronics technician. In phases 2 and 3, several external experts brought many-sided expertise to the process. Public actors played an important role, especially in phase 2.

### DISCUSSION

This study described how the innovation process develops from the conception of an idea to a product in three innovation cases and analyses the knowledge dynamics within those processes. The detailed knowledge biographies of the three innovation cases, as presented in the previous chapter, answered research question 1.

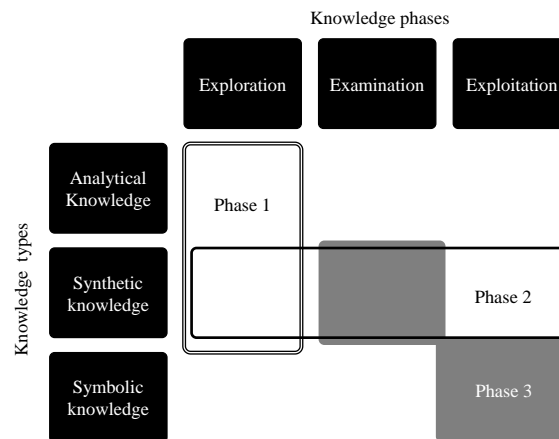
Figures 7–9 briefly answer research question 2. In Figures 7–9, the innovation processes occur within a framework of knowledge types and knowledge phases (See Figures 1 and 2), according to the theoretical analysis conducted in this study.



**Figure 7.** Case 1: The phases of the innovation process, projected through knowledge types and knowledge phases

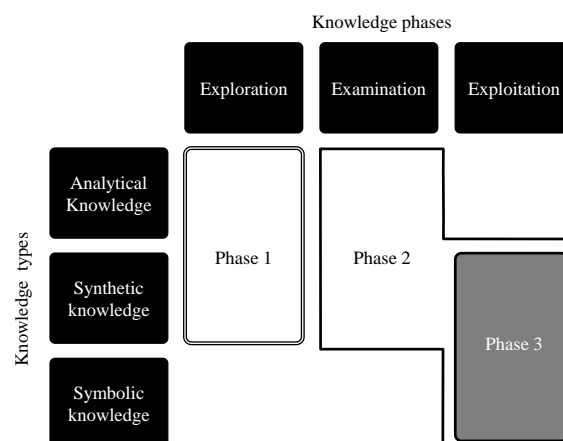
In case 1, during the first phase of the innovation process (first version), synthetic knowledge was essential and all the knowledge phases (exploration, examination and exploitation) were identified. The entire planning and manufacturing process was done by the staff, which had extensive experience in tailor-made manufacturing. The first version of the door was manufactured straight to the customer, which means that no prototypes were made. The second phase (product development) was an examinative and exploitative knowledge phase in which both analytical and synthetic knowledge was essential. External expertise was necessary when the door improvements were in progress. Two marketing experts were recruited by company 1 in phase 2, which accelerated the innovation process. The third phase

(marketing and internationalisation) was an examinative and exploitative knowledge phase and all knowledge types were essential. External expertise was especially required in internationalisation activities. One expert was recruited in phase 3 to help in planning and using the new information systems.



**Figure 8.** Case 2: The phases of the innovation process, projected through knowledge types and knowledge phases

In case 2, the first phase of the innovation process (ideation) was clearly an explorative knowledge phase in which both analytical and synthetic knowledge was essential. The main innovators were successful in independently developing the idea further because they had many-sided working experience and education. In the second phase (product development and marketing), synthetic knowledge was essential and all the knowledge phases (exploration, examination and exploitation) were identified. External expertise was required for device development and construction. The business experience of the other main innovator was useful when negotiating about letters of intent with power plants in phase 2. The third phase (commercialisation) was an examinative and exploitative knowledge phase in which synthetic and symbolic knowledge was essential. In phase 3, the peculiar behaviour of the venture capital companies resulted in the failure of the entire development process.



**Figure 9.** Case 3: The phases of the innovation process, projected through knowledge types and knowledge phases

In case 3, the first phase of the innovation process (ideation) was clearly an explorative knowledge phase in which both analytical and synthetic knowledge was essential. The main

innovator was successful in independently developing the idea further, because he had many-sided knowledge about the electricity sector. The second phase (product development) was much more complex; it was an examinative and exploitative knowledge phase wherein all knowledge types were essential. External experts introduced important knowledge to the process, especially for the planning and programming of the application. The third phase (commercialisation) represents the exploitative knowledge phase. In this phase, symbolic and synthetic knowledge was decisive. In this phase, external experts introduced important business and marketing knowledge to the process.

In cases 2 and 3, the owner of the innovation was a young company, which partially explains the fact that public actors and public funding were more important in the innovation process in these cases. The owner of the innovation in case 1 was an old company, which acted independently during the process. In case 1, other companies provided a large part of the expertise that was required during the process and numerous public actors were involved. In cases 2 and 3, the companies made several prototypes of the product; however, in case 1, the company manufactured the first version of the door straight to the customer. Despite the differences in the three cases, the basis of the innovations in all the three cases was the extensive working experience of the main innovators. It is also noteworthy that in all three cases, the companies naturally collaborated with the actors outside their home region.

The findings of this study suggest that while developing their services, public actors should pay more attention to catering to the case-specific needs of innovative micro companies. The results of this study show how micro companies can function effectively with limited financial and human resources.

In future studies, it would be interesting to use the knowledge biography technique to examine more innovation cases in micro companies. We hope to refine and develop this technique and subsequently apply it to future studies. We also suggest that future research examines the results of similar analyses made in micro companies in other countries.

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