Innovation-related Activities in a Low-tech Industry: A Study of the Electroplating and Surface Treatment Industry in Sweden

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Abstract

Given the complex and interdependent nature of innovation, it is a diverse phenomenon which takes place both in high- and low-tech industries. The purpose of this paper is to increase our understanding about low-tech industries' innovation-related activities and the specific capabilities of the companies that influence those. To achieve this purpose this study has performed an empirical analysis of the Swedish context of the Swedish Electroplating and Surface Treatment Industry (ESTI) and the characteristics of the companies operating in it. It investigated how the companies perceived their expertise and innovative activities in comparison with their main competitors. The main types of innovation the ESTI companies had undertaken in a three-year period (2004–2006) were studied. The research and development (R&D) and personnel qualification improvement expenditures were explored. The study looked into collaboration and the factors which companies perceived as important in order to collaborate. Our empirical evidence shows that innovation in the ESTI is shaped not by R&D but by other determinants, such as specific and rare capabilities in, for example, processing technologies, logistics, ability to spot, evaluate and exploit external knowledge as well as their ability to establish and sustain intercompany relationships. Strong relationships and integration with customers and suppliers emerge as pivotal for the innovation-related activities in the ESTI. Additionally, close collaboration, facilitated by a strong intermediate institution, such as the Swedish Association of Surface Treatment Companies (Svensk Ytbehandlings Förening – SYF, also shape the innovation-related activities in the ESTI.

Introduction

Contemporary economic development is characterised by rapid technological change leading to knowledge generation that highly intensifies the competition between companies (Castells, 2000). There is a constant development of new products, processes, technologies and relationships of a different nature, type and quality which contribute to the growth of the economy.

Studies investigating innovation and new knowledge creation focus on R&D-intensive industries such as information and communication technology (ICT) and biotechnology (Orstavik, 2004). High-tech industries are seen as the main drivers of growth processes, employment and productivity. Hirsch-Kreinsen, Jacobson & Robertson (2006) state that, as such, policy-makers believe that policy efforts shall promote these industries in high-cost industrialised countries. It would imply, as these authors explain, that low-tech industries have a subordinate or limited contribution to the growth of the economy and innovation processes, therefore receiving less explicit policy attention and support.

If we look how each industrial sector is defined according to the Frascati Manual by the Organization for Economic Co-operation and Development (OECD) (2002), it is stated that low-

tech companies have only limited or no independent R&D capacity. They lack in-house R&D-related personnel, costs and investments and they also have limited out-house R&D-related expenditures. So it might seem logical to suggest that the phrase "innovation in low-tech industries" is a contradiction in terms (see Mendonca, 2009). Not surprisingly, as Hirsch-Kreinsen, et al., (2006) state, the research interest to study innovation-related activities within low-tech industries has been rather limited. A search for "low-tech industry" as a key title phrase in five databases (Academic search elite, Ebrary, Science direct, Sage Journals on-line and Wiley on-line library) resulted in a total of only 111 publications.

However, as Sandven & Smith (2005) argue, low-tech industries persist as major sectors of employment and growth. According to the authors, low-tech industries have continued to play a major role in advanced economies due to constant technological upgrading in the form of continuous incremental product and process innovations, which account for their growth and trade performance. Furthermore, Hirsch-Kreinsen, Jacobson & Robertson (2006) claim that there are a number of convincing examples of sectors and companies that have been successfully innovating low-tech products in high-tech countries of the European Union (EU). These industries rely predominantly on incremental innovation, which does not require high R&D costs and allow firms to collaborate informally. Therefore, most of the authors of studies of low-tech industries call for the creation of a broader understanding of innovation that is not synonymous with high-tech and R&D excellence, as innovation is shaped not only by those companies with frontline technologies and R&D activities, but also by low-tech companies (see Mendonca, 2009; Sandven & Smith, 2005; Hirsch-Kreinsen et al., 2006).

All the arguments above are the basis for the purpose of this article: to increase our understanding about low-tech industries' innovation-related activities and the specific capabilities that influence those. In order to fulfil this purpose we have studied the ESTI – a low-tech industry located in an advanced economy (Sweden). We have used the results from other studies of low-tech industries and results from a self-administered questionnaire, as well as information gained from interviews with an owner-manager of a small, family owned company and a Swedish industry expert. Our population consists of 59 companies, all members of the SYF.

Innovation as a complex and collaborative process

In recent years, has been a great amount of interest around the area of innovation. The ability to be innovative is considered to be the key to companies' survival and growth. The fast-changing environment combined with increased competition and globalisation processes have led to the common wisdom "innovate or die".

The definition of innovation has been widely discussed in the literature and there is a plethora of variations. A common way to view innovation is simply as a new product, service, method or process that has been adopted by a user (individual and/or organisation). An adopted innovation creates value and a higher level of performance for the user. It is essentially a coupling process in which the firm/entrepreneur links the novel ideas to the market (Vuola & Hameri, 2006). Additionally, recent research views innovation as an interactive process based on tacit knowledge and skills (MacKinnon et al., 2002) and rejects its definition as a completely linear process, consisting of sequential activities done in a predetermined order (Nooteboom, 1994). In this study we use the term innovation in a broader

sense, i.e. any new product, service, method or process that is introduced to the market and is new to the company, but not necessarily to the industry or the world.

The traditional research approach to innovation builds on Schumpeter's theory about the routinisation of innovation in large firms, which have the resources to invest in R&D, develop innovation steering methods and build the necessary competences (see Schumpeter, 1947; Chandler, 1997; Miller & Olleros, 2007). This way of viewing innovation has the assumption of existence of market gaps, respectively on the customers' needs, just waiting to be filled by solutions as identified by market research. Additionally, R&D laboratories use scientific knowledge to develop and launch products and services, therefore innovation is basically an in-house affair as the complexity of products, services and processes is hidden from the customers who simply use them (see Cooper, 2001). Furthermore, Teece (1998) points out that firms rely on product superiority, strong patent protection or regulatory barriers in order to capture the value of innovation. Firms apply systematic processes in order to get the most out of R&D (e.g. stage-gate model), which have been quite popular over the past 50 years.

As opposed to the traditional approach, the alternative approach recognises that innovation is complex, heterogeneous, context bound and non-linear. The innovation process is proven to be highly iterative with many feedback loops and path-dependant constraints. As Darroch & McNaughton (2002) point out, innovation is a process of embedding knowledge in products, services, processes and management. Due to the asymmetric nature of knowledge, parts of it are possessed by various agents (Karlsson & Andersson, 2004). It means that there is not a single organisation which is in the position to independently develop a winning innovation. On the contrary, in order to overcome this knowledge asymmetry each company needs to interact and collaborate with other interested actors. Within this process, every organisation could be described as a bundle of knowledge and resources (e.g. Gupta & Govindarajan, 2000; Penrose, 1959) which is combined and recombined with the knowledge of other actors in order to boost the innovation process. This causes disintegration of the firms' innovation activities and existence of symbiotic relations which, in turn, guarantees that network-oriented firms with developed dynamic capabilities will be successful. Therefore, innovation is then seen as a result of a complex set of interaction and interdependence among various actors (Delmas, 2002; Salojärvi, et al., 2005). It suggests that any company, irrespectively of its R&D intensity, is not just a passive adopter of innovations but it has the power to shape them (Sandven & Smith, 2005). It also shows that the nature of innovation has become more complex and heterogeneous as well as the research associated with it (see Tushman, 2004). Other researchers further develop the concept of innovation and emphasise a systemic approach to innovation as a circular and complex system embracing interactive elements, which is also linked to the employment of complex elements of knowledge distribution (Lundvall & Johnson, 1994; Edquist et al., 2000). In that sense, innovation can arise through different innovation modes which Jensen et al., (2007) classify into "Science, Technology and Innovation" and "Doing, Using, Interacting". The latter relies on informal processes of learning and experience-based know-how, while the first is based on the production and use of codified scientific and technical knowledge.

In line with the above discussion, more and more researchers emphasise that firms need to learn, interact and collaborate in the innovation process. Tushman (2004) provides an overview of the research effort related to collaboration for innovation. According to him, over the years researchers put great emphasis on research linking organisations' designs, learning and innovation (e.g. Brown & Duguid, 1991; Levinthal & March, 1993; Leonard-Barton, 1995;

Tushman & O'Reilly, 1997) as well as on research about the role of customers, suppliers and markets on innovation (e.g. Hipple, 1988; Bommor & Jalajas, 2004). In that sense, companies need to find a management model that encourages active interaction, collaboration, co-production and co-innovation involving large groups of different actors. In its 2004 study on innovation, called the Global Innovation Outlook (GIO), IBM (2004) outlines three crucial factors for innovation in this environment:

1) Developing standard ways to exchange information and knowledge between members of an economic system and across the economic system.

2) Establishing more open collaboration between economic system members and, at times, even among competitors.

3) Realising the primacy of the individual as a driver and user of scientific discoveries is paramount.

These factors emphasise even more the importance of collaboration for innovation or co-innovation. It is closely related to co-production, which focuses on the partners' contributions in knowledge creation, exchange and transfer, which itself is the source of the value in the relationship (Bettencourt et al., 2002). It also encompasses all collaboration formats between different actors from industry, academia, public and governmental bodies. Similarly, Bonney et al., (2007) and Petrou & Daskalopoulou (2009) explain that collaboration is only possible when there is a shared vision between the partners, compatible structures and processes, opportunities for mutual benefits from the collaboration and the presence of trust and commitment, all of which prove to be decisive factors for innovation activities. More importantly, companies must create a learning attitude and environment for collaboration. Pisano & Verganti (2008) state the new leaders in innovation will be those companies that figure out the best way to leverage a network of outsiders. In line with this, the perception that only competition would give maximised profits to the companies is replaced by the belief that collaboration and cooperation would, in the long run, bring the necessary success and effectiveness to the firm. Therefore, the number of mechanisms for encouraging inter-company relationships are employed, such as customer-supplier linkages, mobility of employees as well as the companies' embeddedness in contextual, social and institutional relationships (Petrou & Daskalopoulou, 2009).

Low-tech industries and innovation

Hirsch-Kreinsen et al., (2006) present the summarised results from an EU-financed project dedicated entirely on low-tech industries and their role in employment and growth. They point out that even though there has been a trend showing a decrease in the contribution of low-tech industries to employment figures in manufacturing (1980–1999), they still account for 60% of the total manufacturing employment. A similar trend is observed regarding the added value in manufacturing, which shows that low-tech industries are stable through time with a high share of employment and added value. Additionally, the authors find no positive correlation between the high-tech share in manufacturing added value and the rate of growth of gross domestic product (GDP) per inhabitant. They claim that it is wrong to assume equality between high-tech countries and high-growth countries. In fact, it implies that the high-tech, research-intensive sectors are not the only driver of employment and economy growth.

Low-tech industries used to be categorised as high-tech, employing cutting-edge technologies when they first emerged, before their technological bases became mature (see Mendonca, 2009). The few studies that have investigated low-tech industries emphasise that low-tech sectors and companies will keep existing in high-tech countries of the EU as they are far more dynamic and innovative than it is usually believed (e.g. Mendonca, 2009; Sandven & Smith, 2005; Hirsch-Kreinsen et al., 2006). Of course, if we conceptualise innovation just as science or R&D-based, creating new industries, low-tech industries have little to contribute. If, on the other hand, we conceptualise innovation as technology which is used to upgrade existing industries and activities that can lead to both incremental and radical innovation, then the low-tech industries have a significant contribution (Sandven & Smith, 2005). Not surprisingly, Hirsch-Kreinsen et al., (2006) conclude that the key to the competitiveness of the companies from low-tech industries is characterised by their specific capabilities, especially in processing technology and logistics.

A common question which is raised regarding the existing studies on low-tech industries and innovation is how companies manage to be innovative and what innovative activities they undertake (e.g. Hirsch-Kreinsen et al., 2006; Hirsch-Kreinsen, 2008; Mendonca, 2009; Petrou & Daskalopoulou, 2009; Sandven & Smith, 2005; Santamaria, Nieto & Barge-Gil, 2009). These studies approach these questions from two main analytical perspectives.

The first one is the resource-oriented analysis, i.e. looking at the resources and capabilities of low-tech firms on which their innovative capability is founded. Low-tech companies need to reinforce the internal skills, capabilities and resources towards a changing environment, therefore compensating for their resource scarcity (Delmas, 2002). As Hirsch-Kreinsen et al., (2006) point out, companies from low-tech industries focus on improving their ability to exploit external knowledge, which has been already tried by others. It requires them to have the capability to observe, obtain information, analyse and transform machines and adapt organisational structures from other contexts which can be considered as their specific and rare capabilities, employed to achieve their strategic goals. The authors discovered that recent scientific findings and knowledge were not the source of the innovation activities in the companies from their sample. On the other hand, they claim that innovations stem from the stock of already existing knowledge as well as based on solving practical problems. Based on this finding, it is concluded that innovation activities in the low-tech industries are most typically “a result of the transformation and reconfiguration of generally well-known internal and external knowledge and of components and technologies generated elsewhere”. It means that innovation activities of low-tech companies are influenced, to a large extent, by their ability to successfully discover, evaluate, adopt and integrate external knowledge into their knowledge base, i.e. innovation activities are influenced by their absorptive capacity (Santamaria, Nieto & Barge-Gil, 2009). This underpins the central role of interactions for knowledge creation, exchange and transfer in the innovation process and high levels of cumulativeness, learning by doing and collective sharing (MacKinnon al., 2002). It implies, as Hirsch-Kreinsen (2008) and Santamaria, Nieto & Barge-Gil (2009) explain, that the relevant knowledge for low-tech industries is primarily practical (consisting of both tacit and explicit elements), where efficiency, functionality and failure-free use, as well as application and utilisation context, are vital. The authors refer to, as an example, the installation of equipment which is based, to a large extent, on the accumulated practical knowledge of the respective user company. Additionally, Hirsch-Kreinsen et al., (2006) have found out that, most commonly, the strategic knowledge in low-tech companies is highly concentrated at the top

managerial level and by specialised technical staff, while typically the workers are merely less-skilled operators.

The second perspective is the network-oriented analysis, bearing in mind the vital need for a constant inflow of knowledge from other places. Hirsch-Kreinsen et al., (2006) and Santamaria, Nieto & Barge-Gil (2009) have found that companies in low-tech industries aim to compensate their limited resources by gaining access to resources and knowledge, which are otherwise inaccessible, through interaction and interpretation, therefore creating value. Hirsch-Kreinsen (2008) points out the growing importance of networked relationships between companies for their specific capabilities in order to be able to overcome knowledge fragmentation. As the author explains, the efficiency of such relationships depends on how the companies are equipped to deal with the demands of intercompany relationships, i.e. the employed communication channels, personnel responsibilities, professionalism and reputation of the respective managers etc. In this respect, Hirsch-Kreinsen et al., (2006) determine that cultural and organisational proximity are important prerequisites in the process of exchanging and transferring knowledge between companies, which is facilitated by a strong intermediate institution. In this context, collaboration and networking between companies is shaping the innovativeness and competitiveness of each company (Santamaria, Nieto & Barge-Gil, 2009).

The finding of Hirsch-Kreinsen (2008) which describes the influence of the relationships between low-tech and high-tech industries to the innovativeness of low-tech companies is in line with the network-oriented analysis. It is pointed out that the technological flow is not only running one way, i.e. from high- to low-tech companies. On the contrary, the low-tech industries have a strategic role for innovation in high-tech industries. As explained by Hirsch-Kreinsen et al., (2006) and Santamaria, Nieto & Barge-Gil (2009), low-tech companies can boost the innovative capabilities of high-tech firms by requesting the development of a new product and/or having an active influence in the process of new product development in the case of customer-supplier relationship. Therefore, low-tech companies themselves can offer innovative solutions instead of simply following the product specifications of their customers. Geographical, cultural and organizational proximity are important here.

Method

Sample

This paper sheds light on the ESTI – a low-tech industry located in an advanced economy. The choice of a single industry is based on the fact that the Frascati Manual by OECD (2002) recommends that all research should be grouped into separate industries. It helps with the collection of data and, at the same time, also takes into consideration the specific characteristics of each industry. Additionally, as Casillas & Acedo (2005) explain, companies in a single location or industry tend to become similar over time, as they are willing to engage in interactions and cooperation.

Medium- and low-tech industries are defined by the OECD Frascati Manual, OECD (2002) as sectors which have R&D intensity below three per cent. Examples of such sectors are the manufacture of metal products, wood and the furniture industry. They lack in-house R&D-related personnel, costs and investments, as well as having limited out-house R&D-related expenditures.

The data collection was started by contacting the SYF in order to identify the names and the addresses of the ESTI companies in Sweden. The association provided a list, containing 64 companies, with all its members that had electroplating and surface treatment activities. This number was eventually reduced as five companies changed the scope of their activities. Our population consisted of 59 ESTI companies.

Two criteria were used to select the sample. First, only companies that were members of the SYF were targeted. Second, the companies included in our sample were only those that performed surface treatment and electroplating activities.

The target respondents of the questionnaire were the CEO or the managing director of the company as they usually have knowledge and understanding of the company (Eddleston & Kellermanns, 2007). We also included a voluntary section at the end of the questionnaire which asked for information about each respondent. Our aim was to determine each respondent's educational background, their position in the company and experience in the ESTI. The respondents in our sample were part of the founding team in 41.90% of the cases. The majority of the respondents (84%) stated over 20 years of experience within the ESTI. Similarly, the majority (51.60%) had worked for the same company for more than 20 years.

Questionnaire design

A postal questionnaire was used to collect data from the 59 companies. We conducted a minor pilot study prior to sending out the questionnaire. The pilot study was conducted in two stages. First, the board members of the SYF were asked to fill in the questionnaire and state their comments about each question, as well as to state the approximate time needed to complete it. They were also asked to give their recommendations for improvements and highlight unclear or inappropriate items. The board members of the SYF represented individuals with a strong knowledge and experience of the ESTI. Second, we asked four university colleagues with experience in questionnaire design to go through all of the questions and give their comments and recommendations for improvements. As a result, the number of questions was reduced and the design of the questionnaire improved based on the feedback we received.

The final version of the questionnaire was translated into Swedish, from English, in order to improve the response rate. The translation was carried out twice, in order to ensure it was accurate and reliable. The first translation was performed by a native Swedish-speaking person with a business administration degree. The second was a control translation from Swedish back to English. It was performed by a non-native Swedish-speaking person without any knowledge of the ESTI or business administration. This was a simple and effective way to prove the reliability and accuracy of the translation. The result was that there were no significant differences between the questions in English and Swedish. Therefore, the Swedish translation of the survey was reliable.

Finally, the questionnaire was divided into five sections, each of them marked with a letter – A, B, C, D and E. At the beginning of each section there was a brief description explaining what the group of questions referred to. This was created in order to maintain the respondents' interest and motivate them to fill in the questionnaire, i.e. a respondent-friendly questionnaire was created. The first group of questions referred to general information about the company (A); the second (B) to market conditions; the third (C) to innovation activities, R&D and the technological strategy of the company; the forth (D) to cooperation and

knowledge exchange that the company was involved in and the last section (E) required more information about the respondent answering the questionnaire. The total number of questions included in the questionnaire was 181. Just over 33% of these were included in section D and were related to the company's involvement in cooperation and knowledge exchange.

This study did not attempt to include a comprehensive set of innovation-related activities, but rather focus on number of important issues which are highlighted in the literature. The questionnaire contained both closed and opened questions. Continuous five-point Likert-scales were used for the questions, mapping the main issues of interest. The other questions were either open-ended or close-ended (categorical and with unordered response categories) in order to provide additional information for each company. Given that the population of the study included mainly small companies, no firm secondary data was available for all observations. We primarily used self-reporting data for mapping the main issues of interest in the form of a postal questionnaire and two interviews. Secondary data was used to describe the general trends and characteristics in the ESTI.

The group of questions referring to companies' environment and market conditions were composed by adapting questions from Zahra & Bogner (1999) and questions from the Third Community Innovation Survey (Ribaille & Durvy, 2004). Respondents were asked about their target customers, the nature and intensity of competition, different demands that are the company had encountered as well as the types of changes in the company environment that occurred during a three-year period (2004–2006). This group consisted of 32 questions in total.

The group of questions referring to company competences, innovations and R&D were based on the work of Aylward (2004) and Zahra & Bogner (1999). Respondents were asked 18 questions about the types of innovations they were involved in, to compare their competences and innovation activities with their main competitors, the ways they acquired technology as well as the availability and the quality of R&D resources.

The group of questions (48) referring to innovation factors, knowledge sources (frequency and importance) and places for knowledge exchange were based on the work of the Third Community Innovation Survey (Ribaille & Durvy, 2004) as well as from Zahra (1996), Bommer & Jalajas (2004) and Wei, Zhu & Wang (2005). The questions presented lists with innovation factors, knowledge sources and places for knowledge exchange that the respondents had to rate on a five-point Likert-scale.

The group of questions (14) referring to collaboration factors and collaboration with competitors were based on the work of Third Community Innovation Survey (Ribaille & Durvy, 2004). Respondents were asked about the nature of the cooperation with their competitors as well as to rate different factors that stimulated the collaboration.

Questionnaire implementation

The questionnaire was sent out, with the cooperation of the SYF, on 22.01.2007. The last completed questionnaire was received one month later. Each company received a packet consisting of a printed questionnaire; a cover letter encouraging participation and assuring confidentiality; a stamped addressed envelope and a letter from the SYF, signed by the chairman, in order to stimulate the response rate.

Of the 59 questionnaire that were sent out, 31 questionnaires were returned, resulting in a 52.50% response rate. We considered the response rate as high, bearing in mind the small size of our sample and the reported in literature average response rate of 15.90% (Zahra & Bogner, 1999).

Results and discussion

The Swedish context of the ESTI

Nowadays, the level of finishing offered by the ESTI is very common and it is considered a traditional, mature industry. The European Committee for Surface Treatment (CETS, 2006) has stated an approximate market structure of the ESTI consisting of automotive, construction, food and drink containers, electrical industry, electronics, steel semis (components for other assemblies), industrial equipment and aerospace, among others (See Figure 1). As the chairman of the SYF, Jan Skogsmo explained at a conference in Elmia, Jönköping (16.11.2006), that this is mainly due to its feature of altering the surface of the metal products and enhancing their corrosion resistance, electrical conductivity, reflectivity, appearance (e.g. brightness or colour) etc. It is evident that a product's life will be much shorter without the surface treatment that the ESTI provides, due to corrosion and wear. Moreover, the importance of the ESTI can be illustrated by the fact that each car contains over 4,000 surface-treated components, including body panels, while an Airbus aircraft contains over two million (CETS, 2006).

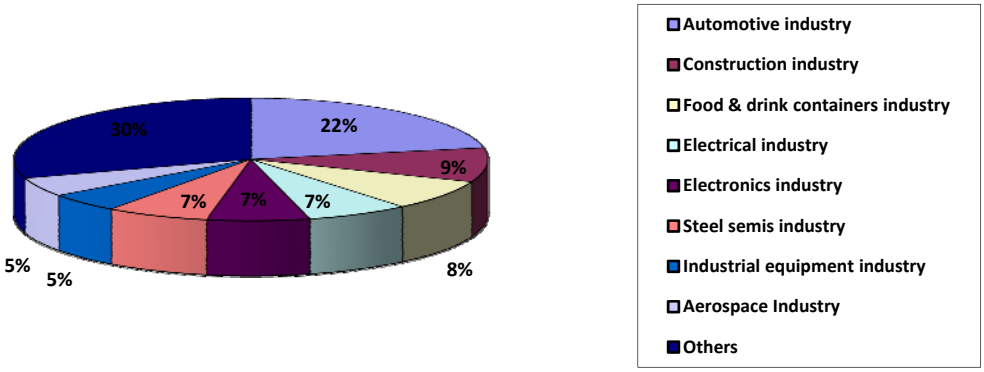

Figure 1 European Market structure of the ESTI (Source: CETS, 2006)

Due to the fact that the ESTI serves several manufacturing areas, there is a high concentration of customers in some regions (such as the automotive industry in Sweden) with highly competitive markets and an overcapacity of surface treatment (CETS, 2006). A small number of companies are large enough to serve more than three or four industry types. Consequently, they specialise in certain finish types. Moreover, the companies operating in the ESTI mostly comprise SMEs (CETS, 2006).

Askengren & Clarin (1991) state that there has been a decrease in the number of companies in the ESTI following the overall international trend for a decrease of the number in favour of the size (Askengren & Clarin, 1991). This is also supported by the fact that there has been a loss of engineering manufacturing in Europe, largely to Asia, which has caused a decrease in the industry by over 30% in recent years (CETS, 2006). However, the ESTI has not entirely followed this trend. The chairman of the SYF, Jan Skogsmo, states that the ESTI companies are mostly small, family owned companies with less than 20 employees and limited re-

sources (SYF Conference in Elmia, Jönköping, 16.11.2006). Compared with the European competitors in the ESTI which have more than 100 employees, the Swedish companies are also much smaller (Askengren & Clarin, 1991). This might be explained by the fact that traditionally small firms dominate in Scandinavia (Johannisson & Mønsted, 1997). Among these companies there are few that work closely together and have an intensive interaction and collaboration. The representatives of the ESTI companies describe them as "friendly (close) companies" (J. Skogsmo and B. Schimanke[6] , SYF Conference in Elmia, Jönköping, 16.11.2006). In line with Johannisson & Mønsted (1997), Sweden is a society dominated by a certain level of solidarity, collaboration and networking which is perceived to create more benefits for the contributing actors. In this sense, the collaboration between the ESTI companies, as expressed by the interviewees, might be explained by the fact that individuals build and exploit their own funds of social capital in terms of personal trust used for networking (see Johannisson & Mønsted, 1997). Additionally, there are certain regions in Sweden with a high concentration of small firms (e.g. Gnosjö). These regions exhibit some common characteristics, such as cooperation rather than competition, networking, mutual understanding and focusing on the collective (see Wigren, 2003). In such a context, as explained by the interviewee (B. Schimanke), the "friendly (close) companies" help each other, e.g. they borrow tools, machines, raw material and components from each other.

Askengren & Clarin (1991) describe the ESTI as not competitive enough compared with the biggest European companies. They believe that this is mainly due to the high environmental demands, high salary costs, less-efficient production and changes in the industrial production requiring other processes and products from the ESTI. This is also connected with the lack of resources for R&D work and limited possibilities for extensive investments. Furthermore, Askengren & Clarin (1991) state that, the ESTI has been dependent on external knowledge, due to the fact that all new processes come from the USA and Germany. Additionally, electroplating is a process where the final result is difficult to control entirely and a strict quality-control is needed. It requires a detailed knowledge of many parameters (thickness of the layer needed, colour and brightness, alloys, hardness, friction etc.). Mutual collaboration between the producer (electroplater), the customer (exchange of information about the requirements for corrosion protection, appealing outlook, wearing out, protection etc.) and the chemical suppliers (the right quality of the chemicals at the right time) also need to be in place. Parallel with the electroplating process, strict environmental standards and requirements should be followed and kept. Moreover, the price is directly connected with the quality of the final result and determines the process to be used. It means that all companies have to facilitate the interaction, communication and collaboration for knowledge exchange as a tool to stay competitive. This will allow the introduction of new processes and services, as Jan Skogsmo explains. However, the cooperation levels are not at the level the SYF believes they should be.

The SYF, as a focal point for all actors within the ESTI, has an important role in the light of the clearly identified challenge for the ESTI – how to become even more competitive in relation to their European competitors. It is an association that facilitates the interaction, collaboration and knowledge exchange, uniting all actors in the ESTI, including the ESTI companies, suppliers of chemicals and equipment, environmental consultants, customers and other

[6] Owner of a family controlled firm.

interested individuals. The SYF is a successor of Sveriges Galvanotekniska Förening (SGF) and underwent a major restructure in 1999. At present, the SYF is able to provide information via its website, services for members, an industry newspaper, brochures, articles, technical support, projects, customer information, environmental issues, conferences, standards, references, laws and regulations, education, field trips as well as an association with CETS (SYF Conference in Elmia, Jönköping, 16.11.2006). The main objective is to build relationships between all interested actors in the industry, to initiate a knowledge exchange among all actors in the industry and enhance the ESTI competitiveness by stimulating a collaboration to counteract the demands for lower prices, new processes development and decrease environmental disturbances. Furthermore, the representatives of the industry consider it as a "neutral arena" for interaction and knowledge exchange (B. Schimanke, personal communication, 25-03-2007).

The SYF and its role for the ESTI is another reflection of the solidarity of Swedish society. It can be described as a network, based on both personal and business relationships, organised around a common set of values and shared trust, mainly used to ensure resources needed to cope with recognised problems or identify ways of coping with known problems (Johannisson & Mønsted, 1997; Petrou & Daskalopoulou, 2009).

Profile of the companies in the ESTI

The companies in the sample were established between 1893 and 2004. The average company age was 44 years (founded in 1963), which was shortly before strict environmental laws were introduced in Sweden (J. Skogsmo, personal communication, 23-03-2007). These new environmental laws and regulations might be considered as a barrier for actors wanting to enter the industry, as high investments are required to maintain efficient water treatment plants. Additionally, the permitted levels of sediments in waste waters (e.g. zinc, chromium, nickel, lead etc.), according to the regulations, have been decreasing over the years. It means that the companies within the ESTI need to constantly modernise their water treatment plants in order to meet the regulations' requirements. This is a sign for the existence of dynamic innovation-related activities as the companies need to keep constant introduction of new or upgraded technologies which would allow them to keep up with the environmental requirements. This finding is a confirmation of the results from other studies on innovation in low-tech industries in Europe, stating that low-tech industries are more innovative than what is traditionally believed (e.g. Hirsch-Kreinsen et al., 2006; Hirsch-Kreinsen, 2008; Mendonca, 2009; Petrou & Daskalopoulou, 2009; Sandven & Smith, 2005; Santamaria, Nieto & Barge-Gil, 2009).

The wide span in the companies' age, with the youngest founded just three years ago at the time when the empirical material was gathered, shows that this industry is still seen as profitable and attractive for new entrants despite being low tech, coupled with high environmental requirements. The wide variety of possible applications of the plated parts could also be also seen as one reason for that, along with the stable contribution in the added value in manufacturing, typical for low-tech industries, as stated by Hirsch-Kreinsen et al. (2006).

The biggest share of the respondents perceive their companies as subcontractors, which implies that they do not have any manufacturing process of their own, except in applying an appropriate plating type to a prefabricated metal component. The rest of the companies indicate that they perform manufacturing processes either for producing components or

final goods. Less than one quarter of the respondents state that their companies produce both components and final goods (see Figure 2).

The way the ESTI companies define themselves has important implications for the type and scope of the knowledge base they have. The narrowly specialised companies (subcontractors) perform an exclusive range of electroplating processes. The latter are determined by the customer base that each company has. As discussed above, each company typically specialises in two to three different plating processes (e.g. chrome-, nickel-, zinc-plating, either by tumbling or in a plating line). This narrow specialisation allows the companies to develop an in-depth practical, learning by doing, knowledge as well as contingency plans in case of a quality problem related to the processes they work with. This could categorise them as process specialists according to the differentiation made by Hirsch-Kreinsen (2008).

All other companies that manufacture components and final products typically work with plating processes suited to their own needs. Their lines and tumbling equipment are often adapted to the size and shape of their own manufactured components. Therefore, they rarely sell only plating services. Their knowledge base is also narrowly specialised, but of course one could assume that companies only doing electroplating are better process ex-perts. Therefore, these companies (especially, the ones that have installed plating capacities quite recently) might lack sufficient experience and contingency plans in case of quality problems related explicitly to the plating processes.

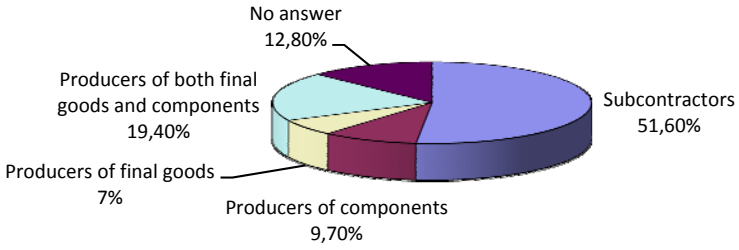

Figure 2 Types of companies

As shown in Figure 2, the ESTI companies operate mainly in business-to-business markets, which makes managing customer relationships vital, as well as the important role of customers as a source of ideas and knowledge. The focus on strong customer relationships is also supported by the fact that each company specialises in just a few plating processes, which can serve a limited number of industry types. This finding confirms what Kirner, Kinkel & Jaeger (2009) have pinpointed for low-tech German companies – they aim to provide high-quality customised products and services in order to create extra value for their customers. Additionally, these close customer-supplier relationships can be the base for the involvement of the ESTI companies in the innovation processes and a contribution to boosting their customers' innovation. This supports Hirsch-Kreinsen et al. (2006) and Kirner, Kinkel & Jaeger's (2009) argument for two-way impulses for innovation, both towards the low-tech companies but also from low-tech companies to other actors (e.g. high-tech companies, such as the automotive industry, chemical industry, aerospace etc.). Our study also indicates such tendencies, because the interviewees state that the ESTI companies are interested in participating in the new product development (NPD) activities of their customers as well as con-

centrating on service innovations which will create value for their customers. These are also two issues that the SYF actively works to promote among its members.

When it comes to the number of employees, the data confirms the industry expert statement that the majority of the ESTI companies in Sweden are small. On average, each company had 26 full-time employees (working 35 hours or more per week). This predetermines the limited resources that these companies have, including resources for innovative activities. In relation to their limited resources, our study also showed that, on average, less than 10% of the employees in ESTI companies had a higher education or university degree. It shows that there is a shortage of highly educated and trained personnel as well as the fact that workers on the production floor are merely less-skilled operators (Hirsch-Kreinsen et al., 2006). This fact was also stated by the interviewed industry expert. It also shows how knowledge is created and transferred in the industry – on the production floor, while working and solving problems. In essence, it is practical knowledge obtained through learning by doing. It is most common that employees have worked for many years within ESTI. Through learning by doing and trial and error they have gained valuable practical knowledge which makes them experts in plating, i.e. they have specific and rare capabilities in processing technology, typical for low-tech industries, as outlined by Hirsch-Kreinsen et al. (2006). Additionally, it illustrates what Hirsch-Kreinsen (2008) and Santamaria, Nieto & Barge-Gil (2009) have found out to be the nature of the relevant knowledge in low-tech industries. It is primarily practical with a focus on efficiency, functionality, failure-free use as well as application and utilisation of the context. It also shows that innovation-related activities within ESTI are based on the "Doing, Using, Interacting" innovation mode as defined by Jensen et al. (2007).

Our interviewees identified one problem related to this discussion. Most of these "self-educated" experts are close to pension age, therefore the industry risks losing valuable knowledge. Due to the nature of the industry, young people are not attracted to apply for work. Additionally, there is a lack of formal educational programmes specialised in surface treatment processes as the industry expert states. This is posing one challenge in the industry which needs to be addressed, especially due to the fact that this knowledge contributes to the rare capabilities in processing technology which shape the innovation-related activities in the ESTI and contribute to their competitiveness.

Our study showed that the management team is well educated and, consequently, it is most probable that they, together with the "self-educated" experts, would be the ones who will be involved in every activity in the company (from solving quality issues on the production line to deciding which new plating process might be adopted to conceiving development strategies). This would mean that the knowledge base is predominantly concentrated in the management team and specialised technical staff (Hirsch-Kreinsen et al., 2006). It makes their relationships and networks for spotting, evaluating, adopting and integrating external ideas and knowledge (i.e. all the determinants of absorptive capacity) essential for the competitiveness of the company and innovation-related activities (Santamaria, Nieto & Barge-Gil, 2009).

When it comes to the performance of the companies during the three-year period (2004–2006), our questionnaire looked at the growth in sales turnover levels. In order to distinguish between subcontractors and manufacturing companies, a difference was made between total sales turnover levels and the sales turnover generated only from plated parts. The aim was to determine the significance of the plating activity for the companies within the sam-

ple. This distinction set a limitation due to the fact that the respondents considered this as confidential information and in most of the cases did not state the value of sales turnover generated only by plating. By looking at the mean, minimum and maximum values per year, since 2004 there has been a positive trend in both companies' total sales turnover levels and the ones generated only by plated components. This is in line with the overall trend in Europe for growth of the ESTI since 1995, which also shows the stability in the added value in the manufacturing, which is pointed out in the study of low-tech industries by Hirsch-Kreinsen et al., (2006). It also shows that despite the tendency of moving low-tech activities towards countries with lower labour costs and the loss of manufacturing capacity to China, the Swedish companies from the ESTI have specific and rare capabilities in process technology which gives them a competitive advantage and keeps them in business within a high-tech country. This positive trend suggests that the ESTI companies are adapting in order to provide extra value for their customers as well as building strong relationships with them, as discussed earlier in this article. Our interviewees revealed that one way to do that is through introducing process and service innovations (e.g. logistical solutions) as well as offering consistently high quality. This is in line with the findings of Hirsch-Kreinsen (2008) and Kirner, Kinkel & Jaeger (2009), who state that the low-tech companies' simple strategy to compete against their counterparts from low-cost countries is to provide high-quality, customised products and services.

The main export markets and their share in the companies' international sales were also investigated by the questionnaire through open-ended questions. The data about export activities might give a good indication of the innovation-related activities (Aylward, 2004; Beise-Zee & Rammer, 2006). The majority of our sample generated their sales within Sweden – on regional and national markets, whereas only 19.93% of the sales were attributed to international markets (see Figure 3).

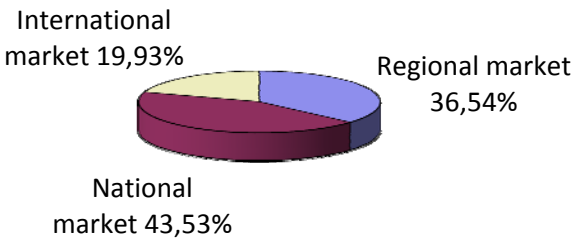

Figure 3 Main markets

This could be explained by the fact that the biggest ESTI customers are located in Sweden (e.g. Autoliv, Volvo, Scania etc.) and the findings of CETS (2006) that the ESTI companies tend to concentrate in areas where their biggest customers are. The automotive industry in Sweden, accounting for the majority of sales of the ESTI companies, predetermines the low level of export activities, as shown in the questionnaire results. The low export activities are not seen as limiting the innovation-related activities of the ESTI companies. On the contrary, the geographical proximity with their customers is a prerequisite of creating close relationships

and establishing an element of trust which would help the exchange of ideas for innovation and complementary knowledge, which facilitates and shapes the ESTI companies' innovative activities (see Kirner, Kinkel & Jaeger, 2009). These strong supplier-customer relationships, geographic proximity as well as the companies' embeddedness in the contextual social relationships (the same national context, which in the case of Sweden is quite homogeneous according to Johannisson & Mønsted, 1997) are mechanisms for encouraging intercompany relationships and networking, which are seen as vital by the authors who conceptualise innovation as a complex set of interactions and interdependence between various actions (e.g. Delmas, 2002; Tushman, 2004; Lundvall & Johnson, 1994; Edquist, Eriksson et al., 2000). These relationships and networking opportunities help low-tech companies to gain access to external knowledge and resources, which in turn are seen to constitute their rare capabilities according to the resource-oriented analytical perspective as presented in section 3 (e.g. Hirsch-Kreinsen et al., 2006).

The most attractive international markets for the ESTI are Europe (average 70.78% of the companies' international sales); Asia (6.05% of the companies' international sales); North and South America (3.18% of the companies' international sales); Africa (0.18% of the companies' international sales) and Australia and New Zealand (3.41% of the companies' international sales). It was not surprising that the European market accounted for the biggest share of the international sales of the ESTI companies. The main reasons for Europe having the biggest share are the free trade between all members of EU as well as the shortest distances and lower transport costs within Europe. Taking into consideration the specific characteristics of the ESTI production, there is a high corrosion risk for plated parts during marine transport due to high humidity, which most companies wanted to avoid. This might explain the low interest for overseas markets as export destinations as well as the need for geographical proximity as a mechanism for establishing intercompany relationships.

ESTI companies' R&D and improvement of employees qualification expenditures

The intensity of R&D activities and spending is considered to be a strong indicator for knowledge exchange and companies' innovative activities (Zahra, 1996; Wei et al., 2005). Therefore, the questionnaire included questions about the annual spending of the company budget for in-house R&D. The majority of the ESTI companies in our sample (71%) invested in the lower range of the scale used in the questionnaire (between 1% and 5% per year), which is to be expected given their limited resources and small size. At the same time, it is a confirmation that the ESTI could be defined as a low-tech industry in line with OECD's Fras-cati Manual (2002).

It must be noted that the scale used in the questionnaire had too wide intervals which did not precisely capture the amounts invested in R&D. Nevertheless, the fact that the respondents acknowledged investment in R&D shows that they do have investments in innovation-related activities, which are not necessarily formally organised and are related to the reconfiguration and exploitation of already existing knowledge for the creation of incremental and service innovations. This finding indicates that innovation activities in the industry arise by the "Doing, Using, Interacting" innovation mode as defined by Jensen et al. (2007), i.e. they rely on informal processes of learning and experience-based know-how. This is also in line with our findings about the primarily practical nature of the relevant knowledge in the ESTI.

As discussed earlier, the management team and the "self-educated" experts were the ones with the highest level of knowledge and expertise. Consequently, it was not a surprise that the top- and middle-level management staff were actively involved in any innovative-related activity carried out in the company, therefore strongly influencing its absorptive capacity. This result could be explained with the specifics of our sample, consisting of mostly small companies where top-level management is directly involved in every activity that needs to be performed. Additionally, Sweden is a country with a traditionally high number of small, family businesses which is coupled with the fact that the ESTI has not followed the European trend for consolidation and increase in size as opposed to number of companies. It provides an explanation of the small size of the companies with a concentrated knowledge base held by top-level managers and specialised technical staff.

As with the annual spending for in-house R&D, the yearly budget for employees' training and education is less than 5% in most of the cases. Around 10% stated that their companies did not have any budget for them during the three-year study period. These results could be again explained mainly by the structure of the ESTI, comprised predominantly by SMEs. It again illustrates the scarcity of resources as well as not considering improving employees' qualifications, through formal training and education, as a priority. Such behaviour could be explained by the findings of Wong & Aspinwall (2004) and Sirmon & Hitt (2003), who state that the owner-managers of small companies are focused on core operational activities rather than strategic issues. They prefer to invest in main production resources rather than in qualifications. This explanation is also in line with that fact that the expertise in processing technology is one of the specific, rare capabilities, which give low-tech companies their competitive edge (Hirsch-Kreinsen et al., 2006). So, for company managers in the ESTI, it would make more sense to focus on core operational activities in order to strengthen their companies' specific capabilities in processing technology, rather than providing formal training and education for their employees.

Additionally, if we take into consideration the "self-educated" experts and the primarily practical nature of the knowledge base that was discussed earlier in this paper, one could assume that any training is done informally and internally on the production floor. This also could be explained by the observations of Wong & Aspinwall (2004) for low degree of employees' specialisation in small companies, i.e. everyone in the company can do almost everything, including the top-level managers.

ESTI innovation-related activities

Regarding the companies' expertise in technology, new products and services, marketing, innovative markets and customer services, in some areas the respondents did not feel confident when compared with their main competitors. The areas considered as a priority, respectively the companies' expertise varied from better to much better, were the latest technology (54.80%) and customer services (89.70%). It implies that the ESTI companies perceive to have an in-depth knowledge of the latest plating technologies, which shows that they follow all improvements and developments in the industry. This is confirmed by the business practices that Berndt Schimanke had implemented. In a personal interview he explains that, for him, the most important technologies are those used in production as well as in customer services. He explains that his business idea is to create value for his customers by providing a complete service: from advising the customers about the shape of a part to be plated, the most appropriate type of plating to optimal logistic solutions. This finding is in line with

Kirner, Kinkel & Jaeger (2009) who, in their study of low-tech German companies, outline the process specialists as a specific group of low-tech companies which direct their innovation activities towards process technologies, which are often the most modern and/or complex ones, as well as logistical solutions. According to the authors, it is their main means for ensuring and sustaining their competitiveness as well as a main contributor to innova-tiveness (see also Hirsch-Kreinsen et al., 2006; Hirsch-Kreinsen, 2008). Additionally, it also confirms the focus on the specific and rare capability, not only in processing technology, but also in logistics, as well as in strong customer relationships, as discussed earlier in this paper. These are seen as particularly important for low-tech industries as those give companies improved changes and flexibility to supply their customers and offer added value, which is also confirmed by our findings. Additionally, as Hirsch-Kreinsen (2008) concludes, the control over the logistics, providing flexibility, is also found to be one of the core, specific and rare capabilities of low-tech companies. The above discussion is also in line with Nooteboom (1994), who clarifies that small businesses are much better at minor innovations such as new product-service combinations (e.g. combinations of a new process and appropriate logistical solution).

Nevertheless, the sample companies were less confident about the companies' expertise in developing new products or services, marketing and serving innovative markets. They perceived their expertise in these areas as better and much better only in 45.20% (developing new products or services) and 35.50% (marketing and serving innovative markets) of the cases. One explanation of these results might be the widely held perception of innovation being based on the use of the latest, codified scientific and technical knowledge in a formal, systematic, stage-like innovation process which is mainly typical for larger, high-tech companies, i.e. the so called "Science, Technology and Innovation" mode of innovation (Jensen et al., 2007). If we assume that this perception is held by the managers in the ESTI companies, it is no surprise that they do not see their solutions to practical problems and incremental improvements in their companies as "real innovations". These results also reflect both the low-tech nature of the industry and the small size of the companies, where one would expect to find mostly incremental innovations. Additionally, the lack of resources, educated employees and gathering knowledge from learning by doing and a trial and error approach, could also account for a rather informal way of incremental technology upgrades and/or the adoption and implementation of new processes and equipment, which again could not be perceived as "real innovation and NPD" by the respondents.

The main strategies for defending the market were implementing new or improved technologies (32.30%). This finding is also consistent with emphasis on processing technologies within the ESTI and low-tech industries in general as a rare, specific capability, which provides value to the customers and sustains their competitive advantage. Large numbers of the respondents (41.90%) bought technologies from other companies; acquired other companies (41.90%) and used a licence agreement (22.60%) to gain access to new technologies. The least preferred option (6.50% – agree or strongly agree) for gaining new technologies was establishing joint ventures.

The industry expert and the owner-manager explained that a common way to cost-efficiently acquire technology is to buy equipment from a bankrupted ESTI company. Then this equipment is entirely rebuilt to suit the needs and processes of the company in question. This implies that the management team and the "self-educated" experts have a quite wide practical and context-specific knowledge base which allows them to rebuild equipment,

among other things, a result which is in line with Hirsch-Kreinsen (2008) and Santamaria, Nieto & Barge-Gil (2009). It could explain the finding that the equipment used in the ESTI companies is quite old (Figure 4). However, it has undergone major upgrades and has been almost entirely rebuilt to meet the requirements of the new process. This is also valid for the water treatment stations, which are constantly improved to be in line with the more strict environmental requirements. These findings are in line with Hirsch-Kreinsen (2008) who points out one of the core capabilities of low-tech companies, classified by him as process specialists, is the knowledge and expertise to ensure the failure-free employment of complex production lines and their continuous enhancement.

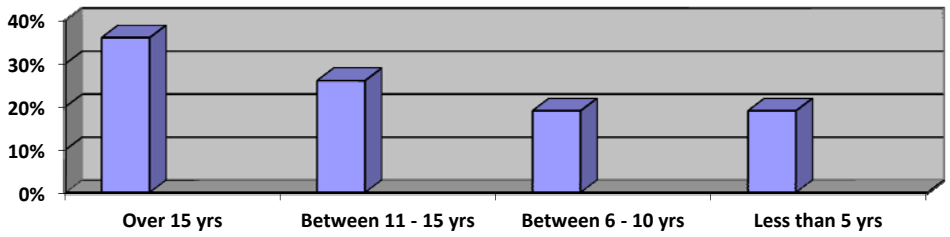

Figure 4 Age of the equipment in the ESTI

The results from our survey showed that the ESTI companies were relatively active when introducing new process upgrades during the investigation period. This was mainly due to the specifics of the ESTI production where, as explained above, a new type of layer (with different properties or enhanced qualities) may be introduced only by changing the chemicals and electrical current without any big adjustments in the machinery used or capital investments.

The innovation types in the companies were studied over a three-year period (2004–2006). The majority of the respondents (80.70%) stated (agree and strongly agree) that they monitored technological developments in the ESTI, which is in line with the findings that the processing technologies used in the production are very important for the management teams, an expertise which constitutes a rare capability for the companies. Over half of the respondents (58.10%) have offered new or improved processes within the studied three-year period. This could be explained by the fact that a new process within the ESTI is relatively easy to adopt and implement as no big capital investments are needed. Instead, the chemical solutions in the plating baths are changed or their concentrations adjusted, which results in a new plating process. Most of the ideas and knowledge for the new processes come from the chemical companies which work together with the platers to solve any problems related to the implementation of the new processes. This was also confirmed by Berndt Schimanke, who stated that at least one new process was developed annually, extensively in cooperation with suppliers (B. Schimanke, personal communication, 25-03-2007). It confirms the findings of Hirsch-Kreinsen (2008) that manufacturers and suppliers of materials and equipment play an important role for the innovation process of low-tech companies, which determines the close coordination, communication and learning processes between the partners concerned. These suppliers can also give important impulses for innovation. For example, the incremental innovation of the new plating process: chrome three (Cr3). Additionally, it is in line with the network perspective of the analysis of innovation in low-tech industries which sees collaboration and networking between companies as a way to over-

come knowledge fragmentation and shape innovation-related activities in each company (e.g. Santamaria, Nieto & Barge-Gil, 2009).

The new processes that were implemented were influenced by customer requirements and were specific to each ESTI company, which is explained by the close customer-supplier relationships and the narrow specialisation of each plating company. Nevertheless, only 29% estimated (agree and strongly agree) they managed to introduce new processes/products faster than their main competitors. Additionally, 45.10% of the respondents stated (agree or strongly agree) they introduced many upgrades (modifications) to the existing products throughout the investigation period (2004–2006), which is in line with Sandven & Smith (2005), who argue that low-tech industries have continued to play a major role in advanced economies due to constant technological upgrading in the form of continuous incremental product and process innovations.

An equal number of respondents (35.50%) develop their innovations independently as opposed to cooperatively during the development process. The latter could be explained by the fact that small companies have simple structures, rely on mutual trust and possess fewer resources, resulting in them actively looking for different ways of getting access to the information, knowledge and resources they missed that could contribute to their innovation activities (Sirmon & Hitt, 2003; Wong & Aspinwall, 2004; Eddleston & Kellermanns, 2007). Additionally, small companies are said to be particularly good at creating and maintaining relations with, among others, their customers (Cooper et al., 2005), employees (Arregle et al. 2007) and other stakeholders (Habbershon & Williams, 1999), which might be the key to their competitive advantage. It is their way of overcoming their limited resources, creating learning opportunities or accessing new capabilities. All the above-mentioned characteristics of small companies can be seen as efficient mechanisms for establishing network relationships, which are critical for shaping the innovation-related activities in low-tech companies (Hirsch-Kreinsen, 2008).

Cooperation with competitors related to innovation activities is considered as the key to success and an important predictor of intensive knowledge exchange (Maula, 2000; Laihonen, 2006). It is also seen as a strength of small companies (including family businesses) which are able to overcome their limited resources to cooperate with other companies (Sirmon & Hitt, 2003). It is especially true bearing in mind the fragmented nature of knowledge and that no company possesses perfect knowledge to create a winning innovation. The respondents considered the technological level of all collaborating organisations as the most important factor for collaboration (71% – important and very important), ranking it above trust and friendly relationships between the senior-level managers (70.90%), opportunities for frequent personal meetings (61.30%), cost reduction in the NPD and gaining knowledge (58.10%), the same professional language/jargon (51.60%) and a bigger output in relation to the input of the collaboration (48.40%). The physical distance between the collaborating partners was ranked as a less important factor (25.80% important). The results reveal that the ESTI companies are aiming to collaborate with technologically advanced companies in order to increase their knowledge base and successfully implement new, or upgrade existing, processes. This is also an illustration of the importance of the external knowledge for shaping the innovation process in low-tech industries (Hirsch-Kreinsen et al., 2006). Additionally, the importance of social networks and personal ties is emphasised because trust and personal relationships were perceived as quite important for the collaboration (Carney, 2005; Sirmon & Hitt, 2003).

When it comes to the level (international, country and county) of cooperation that was preferred by the respondents, the biggest share (25.80%) was with international competitors, while only 19.40% wished to work with competitors within Sweden on county level (12.90%) and country level (19.40%). The preference to collaborate with international competitors is again a confirmation that ESTI firms prefer to collaborate with technologically advanced partners. Bearing in mind that all new processes are not developed in Sweden but in Germany and the USA, a German or an American competitor would be an ideal collaborative partner regarding the development of new processes. However, most of the respondents (41.90%) did not answer this question at all. The ESTI expert clarified that even though no new processes are developed in Sweden, it is one of the first countries to adopt the new processes (e.g. adopting the environmentally friendly Cr3 plating).

As most beneficial collaborations with other institutions, according to the sample, was perceived to be on county and country level, the preferred partners for cooperation were universities and research institutes (45.20% country level); industrial chambers and associations (41.90% county level); quality-control laboratories (29% country level); consultants (38.70% country level) and science parks and business incubators (22.60% county level).

Conclusion

Given the complex and interdependent nature of the innovation process, innovation is a diverse phenomenon which takes place both in high- and low-tech industries. Innovation can take different paths, i.e. it does not only result from the production and use of scientific and technical knowledge, but also from the informal process of learning and experience-based know-how (Jensen et al., 2007). As Abernathy & Clark (1985) point out, some innovations destroy and make obsolete established competence while others refine and improve.

The purpose of this paper was to increase our understanding about low-tech industries' innovation-related activities and the specific capabilities that influence those. It contributes to the literature on innovation management by exploring companies and their innovation-related activities from under-researched industries, i.e. low-tech. Several studies on low-tech industries have shown that these companies have a significant contribution in the output and growth of the economy as well as the fact that they are much more dynamic and innovative than it is usually believed. Therefore, low tech and low growth cannot be seen as the same thing. Therefore, it is important that their innovative-related activities and their role for the growth of the economy are better understood.

If we take the broader view of innovation, i.e. any new product, new service, new method or new process that is introduced to the market and is new to the company, but not necessarily to the industry or the world, it is clear that even firms without formal R&D can be innovative. In particular, our empirical evidence strongly supports the view that, in the case of low-tech industries, innovation is shaped not by R&D but by other determinants, such as their specific and rare capabilities in, for example, processing technologies and logistical solutions as well as their ability to establish and sustain intercompany relationships. Strong relationships and integration with customers and suppliers emerge as pivotal actors for innovation-related activities in low-tech industries. Additionally, close collaboration and networking, facilitated by a strong intermediate institution (e.g. industry organisations such as the SYF), also contribute to innovation-related activities in low-tech industries.

The small size of the ESTI companies is perceived as an obstacle to remaining competitive in comparison with their European competitors. However, ESTI companies are united in an industry organisation – the SYF, with their main objective to increase the competitiveness of the ESTI as a whole. The SYF generated a unique common context that strengthened the ESTI innovation processes. The SYF, coupled with the geographical concentration of customers and competitors, enhanced communication, interaction and exchange of knowledge, led to a shared trust. Its establishment is a reflection of the specific national context which is known to be prone to collaboration and networking and is also a prerequisite for the existing cultural and organisational proximity. The ESTI companies are involved in intensive cooperation and interaction with various agents (e.g. customers, competitors, suppliers, personnel etc.), creating strong personal networks and relationships with these agents that help them to gain external knowledge and create a constant flow of incremental innovations in process technologies, water treatment facilities and logistical solutions. The collaboration in this network, facilitated by the SYF as an intermediary organisation, is founded on the relationship and the trust between the partners.

In fact, the ESTI is no different from other low-tech industries where knowledge generation is performed in practical ways by doing and using. The main knowledge base in the ESTI was found to be accumulated internally, based on learning via the trial and error method. Knowledge was concentrated in a limited group of people from the management team and "self-educated" experts who gained the knowledge through their long-term experience on the production floor. In contrast, the production workers were just skilled automatic line operators who were trained mainly internally in the workplace via learning by doing. The practical knowledge was combined with external in a suitable for the company way, considering the constant rate of adopted innovations within the ESTI. Specifically, this study has shown that it is, in fact, the ability to spot, evaluate and integrate external knowledge into the specific company context and needs (i.e. absorptive capacity) that constitutes a rare capability for the companies which influence the innovation-related activities (e.g. what upgrades will be undertaken, how the partner for collaboration and knowledge exchange will be chosen etc.). It is also supported by the expressed perception from the ESTI representatives that the industry was an early adopter of the latest plating processes, which also illustrates the ability for employing both external and internal practice-based knowledge in order to address new situations. In that sense the existing proximity (i.e. geographical, cultural and organisational) between the companies is a vital condition for sustaining and improving this rare capability as well as for exchanging and transferring practical and tacit knowledge.

This study found that there was a high interdependence between all actors in business-to-business markets, on which the ESTI operated, in relation to innovative activities, which was based on mutual trust. The ESTI's mode of innovation is the so called "Doing, Using, Interacting", which is characterised with incremental innovations, addressing the upgrading of technologies both in the plating process and the water treatment facilities as well as logistical services which were intended to create extra value for the customers. The strategy to provide extra value for the customers as well as close relationships with them is another rare capability that contributes to innovation-related activities in the ESTI companies. These innovations were not based on in-house R&D, but rather the reconfiguration and transformation of internal and external knowledge of technologies created elsewhere (e.g. USA, Germany). In most cases companies relied on collaboration within their innovation activities and preferred trusted partners with preferably higher technological competences.

The outlined specific and rare competences of the ESTI in processing technologies and logistical solutions; in accumulation of practical based knowledge; in the creation of strong relationships and network with various interested actors; in spotting, evaluating and integrating external knowledge into their specific context cannot be copied due to the fact they are deeply embedded in the national, social and organisational context as well as the ESTI companies' local environment. They constitute the rare, specific, unique capabilities of the ESTI which contribute and shape the innovation activities they undertake.

It is important to note the generalisability of these findings. Even though the current study covers only a small sample, which could be seen as limiting for the generalisability of the results as presented here, we found similarities in the findings and conclusions from the reviewed literature on innovation in low-tech industries, including the summarised results of a large EU study that is exclusively dedicated to low-tech industries. Therefore, we believe that our results could be generalised to other contexts as well and used as input for new policy development which will explicitly target low-tech industries in the same way as it is carried out for high-tech industries.

This study naturally leads to further research. The above findings refer to mapping of the innovation-related activities within a low-tech industry in a high-tech country and the specific capabilities that influence those. Moving beyond this study's snapshot of the ESTI, future research can longitudinally explore the innovation-related activities in low-tech industries in different industrial and national contexts which will contribute to general findings as well as spotting trends within the low-tech industries. An exciting area for future research would be to perform a comparative study between the innovation-related activities in the same low-tech sector in high- and low-wage countries. Another interesting avenue for future research would be to study the relationship between capabilities and innovation output in low-tech industries, i.e. an analysis of both the input and output side of innovation. As an addition, it would be interesting to study the relationships between different innovation-related activities and the growth of the companies. In the same line of thinking, it would be interesting to study how companies' intangible resources (e.g. corporate culture, values, innovative climate, reputation etc.) influence the low-tech companies' innovation-related activities and shape their attitudes towards change and risk. Last but not least, another interesting possibility for future research is to study the specific determinants of the absorptive capacity in low-tech industries as well as how it differs among various industrial and national contexts.

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