Collaborative Innovation for Entering Emerging Markets

Anna Öhrwall Rönnbäck*

Linköping University, Department of Management and Engineering,
SE-581 83 Linköping, Sweden.
E-mail anna.ohrwall.ronnback@liu.se

* Corresponding author

Abstract: The aim of this paper is to investigate collaborative innovation in business networks for small environmental technology companies entering an emerging market (EM). Export of environmental technology solutions to emerging economies involves high investment opportunities and high growth potential, but also high risk. For example, large-scale demonstrator equipment proving the function of the environmental technology solution might be needed, which usually requires cooperation between several companies and supporting actors. Results from empirical studies presented in this paper confirm the difficulties to export environmental technology solutions to EMs for small and medium-sized enterprises (SMEs). Collaboration in business networks appears to be an efficient means to take on larger assignments, and business models built on principles of product service systems (PSS) where the technology can be integrated, and functionality is of main focus. A preliminary business development process model for small firms' environmental technology export to EMs is developed and presented.

Keywords: SMEs; environmental technology; open innovation; business networks; product-service-system (PSS).

1 Why collaborative innovation for entering emerging markets

The need for environmental technology solutions is huge as developing countries in Asia and Latin America are currently undertaking a fast urbanization process. In large countries such as China, India, and Brazil, cities and infrastructures are being built up in a tremendous pace. In developed countries, it is therefore encouraged to export environmental technology solutions eg. to enhance the creation of sustainable cities. In Sweden, for example, there are many innovative environmental technology companies developing and offering solutions for waste management, renewable energy production, water purification, and other environmentally preferable products (Swentec[1] 2010).

However, there are also obstacles to enter foreign markets in general, and even more so to reach emerging markets (EMs) with larger business risks (Arnold and Quelch 1998). Economic turbulence, cultural and language differences, together with poorly developed communication, and distribution infrastructure are some of the concerns that

[1] Swentec is the Swedish Council for Environmental Technology. The council "provides knowledge about the cleantech sector, promotes good examples, and acts for increased collaboration in the area" (Swentec 2010).

companies face when entering EMs (Arnold and Quelch 1998, Iyer, LaPlaca, and Sharma 2006). Emerging economies as markets are usually linked with high risk, but also high investment opportunities and high growth potential, since increased disposable income, especially from middle class consumers, and the growth of businesses in industrial and service sectors could provide long term growth opportunities in newly developed countries in Asia and Latin America (Arnold and Quelch 1998, Sakarya, Eckman, and Hyllegard 2007).

Practitioners point at another obstacle; Swentec reports that one of the major obstacles for small and medium-sized enterprises (SMEs) to export environmental technology solutions is that complete functioning demonstrators need to be built up on site in the developing country in order to "prove" the technology and attract customers to the offering (Ölundh-Sandström, Janhager, Öhrwall Rönnbäck, Sakao, Lindahl, Sundin 2008). In Sweden, 94 % of the environmental technology companies are small, i.e. have less then 50 employees (definition according to EU 2003, 2009). The majority of these are micro firms with less then 10 employees (ITPS 2008). Therefore, they have difficulties carrying out an entire establishment on their own. Indeed, only a few Swedish environmental technology companies export environmental technology outside of the OECD countries, which is the fact not only for this particular industry, but also for Swedish industry in general (ITPS 2008 and 2007a). Especially small and medium-sized enterprises (SMEs) are under-represented in export outside the OECD countries (ITPS 2007b), despite a number of government-funded activities to enhance exportation (Swentec 2010).

The business challenge for environmental technology SMEs is to prove the advantages of their solutions by building large-scale demonstrator equipment in an initial phase, and in the long-term build up global presence with reference customers, and a global service organization (Ölundh-Sandström et al 2008). At the same time, however, earlier research indicates that small companies with limited resources and capabilities can unite within business networks and develop complete solutions in cooperation (Öhrwall Rönnbäck 2002). Through collaboration in business-driven networks with partners representing different skills (definition similar to "innovation-driven networks" by Oke and Idiagbon-Oke (2010), or "value-creation network" by Kothandaraman and Wilson (2001)), the required resources in terms of skills and knowledge can be created to operate in a foreign market. Here it is assumed that the firm is embedded in enabling business networks and that internationalization of companies is pursued within interwoven networks of users, buyers, suppliers, and horizontal partners (Johanson and Vahlne 2009). During the last decade the notion of open innovation (Chesbrough 2003) and user-driven development (von Hippel 2005) have gained territory in the new product development literature. Developing innovative solutions to specific problems require close cooperation between buyers and suppliers with user involvement. A trend in the manufacturing industry in general is that business models consists of an increasing service part (eg. Alonso-Rasgado, Thompson, and Elfström 2004, Kindström and Kowalkowski 2009). Manufacturing firms' develop so-called total offerings (Alonso-Rasgado et al 2004), product-service systems (PSS) (Tukker and Tischner 2006), or, the term preferred in this paper, Integrated Product-Service Offerings (IPSOs, cf Ölundh-Sandström et al 2008). An IPSO is defined as an integrated offering of physical products (artefacts such as hardware and software) and service activities (activities by people to provide customer value). The Integrated Product-Service Engineering (IPSE) methodology (based on the notion service engineering by eg. Sakao and Shimomura

2007) aims to create better prerequisites for firms to develop IPSO that are beneficial for the supplier firm, the customer, and for the society at large.

Purpose

The aim of this paper is to investigate collaborative innovation in business networks for small environmental technology companies entering an EM. The investigation includes the company's offering and field of business, experience of collaboration, and the company's role in collaborative innovation activities.

2 Theories serving as foundation

In previously presented results from this study (Janhager, Abullah, Öhrwall Rönnbäck 2010), it was suggested that business network of companies developing an environmental technology innovation could facilitate entering EMs. Of high importance to the network partners are knowledge shared between them for the purpose of successful commercialization, and knowledge that enhances the prospects for companies to consider EM for their business. A company with experience of the EM is a valuable partner for companies who have not operated on the selected market, and especially, the close cooperation with a Swedish Development Finance Institution (DFI) with experience of the EM and important contact networks was proved fruitful. It was also indicated that a business model based on a functional solution, instead of selling the equipment, could be a viable solution for environmental technology innovations exported to EMs (Abdullah, Ölundh Sandström, Öhrwall Rönnbäck 2010). This section, introduced by a classification of environmental technology enterprises, highlights previous research on EMs and business networks for collaborative development of IPSOs.

Environmental technology enterprises – a classification

Environmentally adopted products and services can be categorized in the following three branches (based on NUTEK 2003):

(1) *Pure environmental technology:* Technologies that deal with pollution and waste, mainly air and (waste) water treatment, but also waste-to-energy plants and emission monitoring. Companies in this category can be further split in solid, air, or liquid-based pure environmental technology.

(2) *Environmentally efficient products and services:* Technologies to reduce and minimize the environmental burden of polluting activities. This is done by minimizing material consumption and waste generation and by choosing more environmentally sound materials and incorporating characteristics that improve the environmental impact, e.g. products and services that are more energy efficient than competitors.

(3) *Innovative environmental solutions:* Environmentally excellent technologies that generate improvements in several steps throughout the value chain and creates new paths along traditional patterns. These innovations are often investment intensive and of high risk, but with great market potential. Typical innovative environmental solutions are Product-Service Systems and renewable energy sources.

Internationalization and Emerging Markets

EMs represent expansion opportunities and new sources of revenue for developed countries which have saturated their own growth possibilities. A broad definition of EMs is used in this paper, mainly based on GDP per capita, which means that all countries except 25 developed market economy countries (US, Canada, the 15 EU countries, Iceland, Norway, Switzerland, South Africa, Israel, Japan, Australia, and New Zealand) can be categorized as EMs. Translated into population numbers, this means all people, except the 800 million living in these countries out of total 5,5 billion, live in developing countries, or emerging economies. At the same time, this figure will decrease as the regions develop. Some of these countries have attractive growth rates (annual GDP more than 5 percent, sometimes up to 10 percent), however this figure varies over the years. (Arnold and Quelch 1998)

The literature on internationalization emphasizes a gradual process in the development of international operations over time. Internationalization typically occurs in a stepwise manner, which could start, for example, with export through an agent and end up with production in the foreign country (Johanson and Vahlne 1977). Also, presence is put forward as important to increase the possibilities to succeed; *"foreign market entry at arm's length often leads to costly intervention later"* (Arnold and Quelch 1998:19). The Nordic school suggests that psychic distance and experiential learning has an influence on international market selection. Psychic distance can be defined as *"the sum of factors preventing the flow of information from and to the market. Examples are differences in language, education, business practices, culture, and industrial development"* (Johanson and Vahlne 1977:24). Besides these two factors, Dow (2000) found that geographical distance also affects market selection. Such distances lead companies to choosing foreign markets that have similar culture, economic and political systems (Dow 2000, Sakarya et al. 2007). However, there are strong indications that the psychic distance effect decreases substantially after the first entry into a foreign market, and that companies have tendencies to approach markets in which they have already established economic presence (Dow, 2000).

In order to succeed on a foreign market, two types of knowledge need to be perceived: general operational knowledge, and specific market knowledge (Sakarya et al. 2007). The general knowledge can often be transferred between countries, whereas the market knowledge is experienced-based and gained by operating within a particular market (Johanson and Vahlne 1977). Companies that increase their knowledge about foreign markets usually become more willing and capable to enter other foreign markets (Sharma and Blomstermo 2003, Iyer et al 2006). Jansson and Sandberg (2008) state that there is a lack of studies on the internationalization process for SMEs. With an SME's limited resources in terms of financial, production and strategic position (Alpkan, Yilmaz, and Kaya 2007), a possible market strategy can be free-riding, or strategic alliances (Lee, Lim, Tan, and Wee 1999, Gulati, Nohria, and Zaheer 2000). This is also suggested for companies that lack presence and experience in a foreign market, network connections are potentially an essential source of relevant knowledge for entering the market (Sharma and Blomstermo 2003, Johanson and Vahlne 2009) and even more important for SMEs (Dow 2000).

SMEs need to be part of networks in order to build bridges into foreign markets. This is because many SMEs, when alone, have insufficient resources to acquire knowledge about EMs. Good relationships in the foreign market with e.g. local representatives and

customers are great advantages (Jansson and Sandberg 2008). However, such relationships are difficult to create, and once established, require time and effort to maintain. Jansson and Sandberg (2008) declare the importance of strong business networks for SMEs in order to succeed in entering EMs.

Business networks for Open Innovation and Collaborative Development of ISPOs

Like for any firms, innovation in SMEs is crucial for long-term survival. For high-tech innovative SMEs the challenge is to maintain an advanced technological position with development activities required and conduct successful business activities at the same time (Teece 1986). In earlier research we have observed small companies' capabilities to unite within business networks and develop complete solutions in cooperation (Öhrwall Rönnbäck 2002). In an innovation project context, forming networks can also be considered as a strategic move for the purpose of avoiding failure, as well as to reduce risk and uncertainty through platform advantages (Wonglimpiyarat 2004). When required resources and capabilities are not available within the company, it is likely that companies will adopt a collaborative strategy, regardless company size (Quinn 2000, Rothwell 1975). It is argued that understanding interorganisational networks are crucial for understanding open innovation and also that more research is needed in this area (eg. West, Vanhaverbeke, Chesbrough 2006). Concerning strategic aspects of innovation, and a firm's relation to partners and competitors, recent research stresses the importance of information exchange and intellectual property aspects, as competition is increasingly global (Pisano 2006, Pitelis and Teece 2010, Oke and Idiagbon-Oke 2010).

Research and development within one firm is not the invaluable asset any more as it used to be (Chesbrough 2003, West et al 2006). West et al (2006) argue that *"neither the practices nor research on Open Innovation are limited to the level of the firm"* (p 14-5), as industry R&D undergoes a paradigm shift from closed to open innovation (Chesbrough 2003) and suggest using five levels of analysis of open innovation from (1) the individual (or groups), (2) firm, (3) network, (4) industry or sector, to (5) the nation-state. Further, it is argued that a company needs to have an innovation process that involves actors outside its own company to become more successful (von Hippel 1988). The user is one important actor to involve, and using advanced users in order to become more successful is strongly argued (von Hippel 2005).

There are different types of business networks that aim at improving the competitiveness and profit for all actors involved, e.g. collaborative integrated product development networks, innovation or value-creating networks, local networks (clusters), business-giving networks and business-driven networks (Håkansson 1990, Kothandaraman and Wilson 2001, Öhrwall Rönnbäck 2002, Oke and Idiagbon-Oke 2010). However, one could argue that these different types of networks are just different constellations of a focal firm and its relationships to vertical and horizontal partners (e.g. suppliers, distributors, or venture capitalists). All firms have this kind of network, but previous research claims that firms focus too much on internal activities, and competitiveness is measured between two competitors instead of focusing on the environment and the business network of these two competitors (Gulati et al. 2000, Håkansson and Snehota 1989).

Previous research suggests that the infrastructure for delivery, services and operations of IPSOs needs to be carefully developed with regard to user and customer (Isaksson, Larsson, and Öhrwall Rönnbäck 2009). If local third party service providers are engaged,

it is important to ensure quality in service delivery, since their behavior may have an impact on how the customer perceives value delivery and performance, and there is a risk to loose valuable potential for further innovation if the customer interface is not carefully managed (Kindström and Kowalkowski 2009). This might be even more crucial when developing IPSO for EMs, for which special approaches are suggested (Arnold and Quelch 1998, Sakarya, Eckman and Hyllegard 2007). In previous research, the supply chain management perspective has served to illustrate the information flow over time in the collaborative innovation process, to label the different partners (Lambert and Cooper 2000, Öhrwall Rönnbäck 2002, Oke and Idiagbon-Oke 2010). Figure 1 is a schematic visualization of the positioning of a network of suppliers developing solutions in a larger business context with many parties in a supply chain. The illustration shows that user involvement can be a complex issue to manage; not only end-users but several tiers could be involved. The open innovation literature does not clearly state *who* or *which parties* in such setting that are referred to, although eg West et al (2006) suggest many areas for investigation. Moreover, since information flow and communication is one key to efficient product development, regardless of context, managing the firm's knowledge base becomes quite complex. On one hand, there are contractual issues to solve for the development project, but the product lifecycle perspective is also needed to take into account in the early development phases, since long-term guarantee agreements need to be agreed upon by the collaborating parties already at conceptual stages (Alonso-Rasgado et al 2004, Pisano 2006).

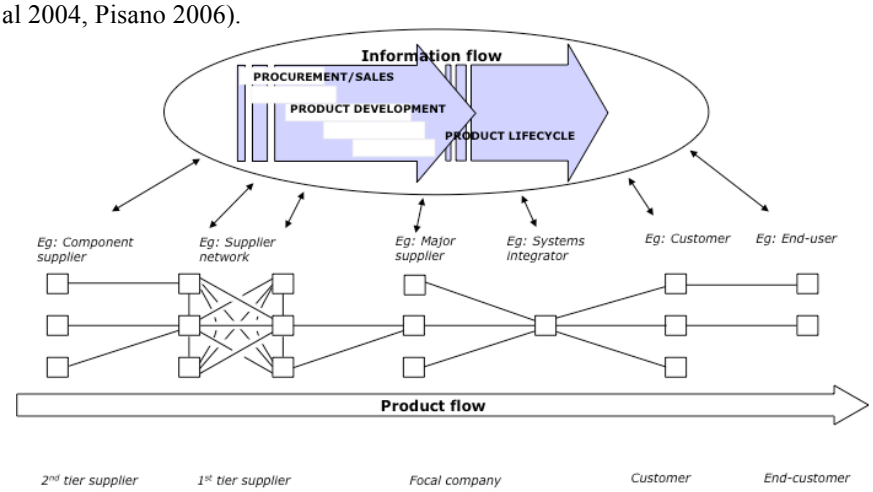

Figure 1 Information flow in collaborative product development from a supply chain perspective (Öhrwall Rönnbäck 2002, Lambert and Cooper 2000).

3 Research design and methodology

The research design for this paper is (1) an in-depth case study of four SMEs collaborating in a business network to enter an EM, complemented with (2) a multiple case study of ten environmental technology firms, one large firm and nine SMEs of various sizes. The multiple case research approach aims to achieve more robust results than with a single case study (Eisenhardt 1989, Yin 1989), and the ten cases were purposively selected (as recommended by eg Eisenhardt and Graebner 2007).

The in-depth case, an interorganizational value network (a third level study of open innovation according to West et al (2003)), includes four represented parties, of which three are environmental technology companies and one is a state-owned Development Finance Institution (DFI). Together, they have formed a joint venture with the purpose of developing and constructing a complete plant, and to start up a subsidiary in China, which should construct and run a plant locally. The interviewees represented each company's key people for this joint venture, and further, one more interviewee was a representative of Swentec, who could give contextual information for Swedish companies entering EMs. In total, eight interviews of between 60-90 minutes each were performed, recorded, transcribed and analyzed.

Then, based on the results from this in-depth case study, ten (10) cases were selected through theoretical sampling (Eisenhardt and Graebner 2007), at the firm, level (according to West et al 2003) to further investigate propositions derived from the first indepth case study. Semi-structured interviews were conducted, about the firms' collaboration in product development, and their export, or potential export, to EMs. The source for case selection was a database of Swedish environmental technology firms provided by a DFI, containing some 130 Swedish environmental technology firms, with estimated potential for future investment in order to achieve business development on EMs. Also young innovative companies not yet established on the market were included. The DFI had prioritized the companies based on estimated potential to be a leading partner in business networks. The researchers updated the list with the most recent data about the firms, and reduced it to ten companies to represent various kinds of environmental technology (NUTEK 2003), and various size (within the SME criterion (EU 2003), except for one of the firms with more than 250 employees, kept due to its interesting growth from SME to large enterprise during the last two decades, its environmental technology-based business, and its presence on EMs). The selected companies were contacted for a telephone interview of between 15 and 45 minutes. As a complement, extensive data from databases and web sites were collection for each company about financial situation, ownership, offering, and markets. Interviews were held with one or two persons who had an overall view of the company, both internally and from an inter-organizational perspective. The interviewee was in most cases the managing director, and in some cases the technology or product development manager, or the marketing and sales manager. Questions asked derived both from the in-depth study and emerging theory on collaborative product development, and included company experience (or knowledge, used interchangeably, as suggested by Sharma and Blomstermo 2003) of collaboration projects, business networks, and emerging markets, and means of communication in collaboration projects (this latter suggested by eg. Öhrwall Rönnbäck 2002 and Oke and Idiagbon-Oke 2010).

4 Case studies

In-depth case study

Four environmental technology companies unified in a joint venture in order to develop a total solution and construct a plant. A subsidiary was established in China, designed to construct and operate the plant at customers' sites in China. The inventor and the four companies participating in the joint venture (see Table 1) are described below.

Table 1 Interviewees for in-depth case study (Janhager et al 2010, p 5).

Designation	*Description*	*Interviewees*
Coordinator	Owns the patent and coordinates the network; main shareholder of the joint venture company	2 (one is the Inventor)
Hardware provider	Develops part of the hardware; builds the plant in cooperation with the client in China	3
Operator	Operates the plant in China; the one with the client contacts	1
Financier	State-owned Development Finance Institution (DFI)	1
Swentec	Swedish Environmental Technology Council	1 (not part of the joint venture)

Source: LIAN research project (Janhager et al 2010).

The Coordinator is the managing company of the joint venture, which purchased the patent of the principle technology behind the function from *the Inventor*, who then was employed by the company. The Inventor was given the role of project leader for the technology development and the construction of the plant. At this time, the Inventor was already in close cooperation with another company, *the Hardware provider*, which supported the Inventor with equipment and vital components during the realization of the invention based on the patent. The Hardware provider continued as a supplier even after the Coordinator bought the patent, and continued to play an important role in the project as part-owner in the joint venture company.

The Operator is a subsidiary to a Swedish company, which already operates in China, which took the initiative based on its specific market experience for the network to establish the business in China. The Operator's main role was to establish local client contacts and operate the plant in China. *The Financier* is a DFI which together with Swedish companies aim to establish business or in some other way invest in EMs. Besides venture capital, the Financier provides advice and consultancy services regarding eg. legal aspects of business establishment on an EM. In this case, the Financier is a minority shareholder of the joint venture. One additional company, the *Chinese company*, had a central role, initially as a member of the joint venture, however, due to tax regulations making it unfavorable to stay as owner of the joint venture, bought out. In the network, the Chinese company can be regarded as the mirror company to the Coordinator, i.e. provides the same products. The Chinese company currently acts as a local supplier to the joint venture, and other members of the joint venture concur that it is an asset having the Chinese company with them, even though it is no longer an official member of the joint venture.

Marketing activities in China revealed that there was a need for a "total solution", i.e. a complete plant with the patented functionality built-in. The key actor in the Operator company, being familiar with the technology itself, having been a fellow student with the Inventor at the University, and already having presence in China, spotted the business opportunity for the total solution. When chanced upon the other companies (the

Coordinator and the Hardware provider) working on the total solution, their original plan was for the total solution to be applied in Sweden. However, the total solution did not receive much attention from the Swedish authorities. Thus, the companies decided to apply the total solution to a different market, i.e., China, where stricter environmental legislation was seen as a window of opportunities.

Multiple case-study

In terms of company size, refer to Appendix, the studied firms range from two micro companies (with less than 10 employees and turnover/balance sheet up to 2 M€), four small companies (less than 50 employees, turnover/balance sheet up to 10 M€), three medium-sized companies (with less than 250 employees, turnover up to 50 M€ or balance sheet up to 43 M€), and one large company. The studied companies' fields of business were categorized according to the three branches for environmentally adopted products and services presented in section 2. Four are pure environmental technology firms, five are innovative environmental technology firms, and one can be categorized as environmental efficient products. Six of the studied companies are already present on EMs, and the remaining four who are not currently present on an EM replied that they see a large potential in EMs, eg. both Companies 3 and 4 see large potential in countries where electricity infrastructure is missing. Company 6 shows interest in development towards Russia, South Africa (not defined as an EM according to Arnold and Quelch 1998), China, and Indonesia. Company 7 operates mainly in Sweden and Norway, but are now targeting a European development country (Poland).

Several of the studied companies (six out of the ten firms) offer IPSO, ie integrated turnkey or total solutions. Company 1 offers physical equipment and services (pre-study, environmental analysis, operations, service and control of installed system), ie IPSO. Company 2 offers physical equipment on their main target markets, which is a developed country in Europe, but provides technology as service, ie IPSO, to an EM, which the company recently is approaching. Companies 3 and 4 are young, have not yet launched any physical components nor services on the market. Company 5 offers mainly consultancy services (knowledge and R&D), but also physical products and total solutions, IPSO. Company 6 offers physical equipment and total solutions, IPSO. Company 7 offers total solutions, IPSO, where the industry waste products are sold as fuel. Company 8 offers different types of physical products based on a proprietary manufacturing method to extrude components made from 100 % recycled plastics. In some lines of business, the offering is bundled as IPSO, and it investigates through a pre-study the possibility to build and operate a plant in an EM. Company 9 provides physical equipment, spare parts, and accessories, i.e. not IPSO. Company 10 offers standardized physical products, which can be customized for specific customer demands.

All ten companies are experienced when it comes to collaboration for business and technology development together with external parties. Company 1 develops solutions together with many parties, e.g. customers, general contractors, architects, installation firms and environmental experts. Company 2 collaborates with heat, ventilation and air condition distributors, and hardware suppliers. For long-term innovation it collaborates with partners from specific industries where their proprietary technology could be integrated. Also the young development companies have large experience of collaborative development, Company 3 encouraged by its owner together with a strategic partner that supports the commercialization process, and Company 4 with many

horizontal partners that complement its core technology. Company 5 usually sets up specific collaboration teams for specific business cases. Company 6 always develops in collaboration with partners such as customers and a general contractor for a specific installation, and with different hardware providers. Company 7 develops solutions in close collaboration together with a few partner suppliers, but the main part of its development is carried out in-house without partners. It is also the initiator of a network with suppliers of complementary skills for new business opportunities, eg emerging market in Europe, Poland). Company 8 collaborates with end-customers and general contractors, and to some extent with strategic suppliers. It sometimes conducts pre-studies with private persons (inventors), but this is difficult due to lack of financing for such projects. Company 9 has extensive experience from previously conducted collaborative development projects, but today only a limited number of collaborations. Company 10 mainly has experience from collaboration with research institutes and universities. Sales is conducted through the large global company group it is part of, with presence on global market.

Many of the firms studied act as a lead partner in the collaborative product development projects, which confirms the selection criteria by the DFI. Company 1 is responsible for design of components and total system, configuration, and installation with several parties. Company 2 usually initiates business towards end-customer, but hands over the customer contact to a distributor who designs complete system. It strives to achieve end-customer involvement in R&D through after sales and customer support service. Even though it is very small, Company 3 has a "locomotive role" in collaborative development project, which eg. implies that it chooses suppliers that are best in their field to become development partners. It has access to new customers through its strategic partner. The young Company 4 is in a similar position, as responsible for the development, involving a distributor, complementary technology suppliers and industrial designers. Company 5 is usually the leading solution development partner, together with component and total solutions providers. Company 6 has the initial contacts with customers and partners, and hands over to a general contractor who takes full responsibility for the construction and installation. Company 7 designs, procures, delivers, installs and commissions a complete system. It is responsible towards the customer, and the driving part in supplier collaboration. Company 8 initiates collaboration, but finds few potential partners in its area, and therefore searches for strategic partners in its field. Company 9 is currently not involved in collaborative projects, but is open for maintaining and nurturing their strategic relationships in current business cases. Company 10 rarely participates in collaborative development projects, and if so as supplier, but it is a part of knowledge sharing networks.

5 Findings

Findings from the in-depth case study indicate that collaborative development of both technology and business model needs to go hand in hand for successful innovation towards emerging markets, similar to Iyer et al (2006). For small companies to develop total solutions, it is necessary to work in collaboration. It is also shown that supporting actors can mediate the collaboration between supplier firms, in this case a state-owned DFI. Having at least one company in the collaboration team with past experience of working in EMs also increases the prospects that the network will successfully enter the

same EM with their business (Sharma and Blomstermo 2003, Johanson and Vahlne 2009, Dow 2000).

Another empirical observation in this study is that an EM's environmental legislation may be tougher than developed countries, and therefore an opportunity for environmental technology SME firms. In the in-depth case, the choice of an EM instead of the companies' domestic market was based on stricter environmental regulations on the EM (exemplifying that a specific market approach can be beneficial, as suggested eg by Arnold and Quelch 1998, Sakarya et al. 2007). This latter is also supported in the multiple case studies, indicating large potential for small firms to develop their collaboration in networks in order to enhance export of environmental technology solutions from developed countries to EMs (as suggested by Jansson and Sandberg 2008). Some of the firms (Company 3 and 4, but also Company 2 to some extent) develop technology solutions that would be better off in countries where eg energy infrastructure is missing or poor, or at a stage of being built up (Company 1). A firm such as Company 2 could probably be referred to as a "born global", although its focus so far has been on Southern Europe. Envisaging emerging markets where the need is huge could be a viable strategy for several environmental technology firms instead of struggling with existing infrastructures and incumbents on the domestic market (Sharma and Blomstermo 2003, Pitelis and Teece 2010).

While the collaboration in company networks is proved to be an efficient means to take on larger assignments and to achieve successful business, the complexity when exporting environmental technology solutions to EMs are also confirmed both in the in-depth and the multiple case studies of SMEs. The empirical investigations indeed show that IPSO can be a solution. In the in-depth case this is a solution provided by the joint venture, and in the multiple case study, six out of the ten studied companies use this business model to some extent; four of the six companies that are present on EMs. However, only a few of the studied supplier firms manage directly the user and customer interface, except in initiating the business, but not during delivery and in use-phase. An explanation might lie in the psychic distant market (Johanson and Vahlne 1977), but cannot solely explain this result, since both companies exporting the EMs and those who work with close-by markets, show this pattern. The study does not include answers to why this customer and end-user contact is limited, but points at the need for further research along the open innovation and user-driven innovation paths in strategic networks (West et al 2006, von Hippel 2005, Gulati et al 2000). However, in a prolonged study of one of the firms, the managing director explained that it was a conscious strategy due to resource scarcity to choose a position upstream in the value chain, to strengthen its role as technology and innovation provider, but not working with installations and operations. Here, it might be hazardous not to take care of end-user contacts, both in short-term delivery and long-term new product and service development, since innovation possibilities may be lost (Isaksson et al 2009, Kindström and Kowalkowski 2009).

An interesting observation from both the in-depth and the multiple case study is that both small firms acting as leading partners. The small firms in the multiple case study drive the development in a business network established for their product or application. In case there would be a larger export business this small firm would perhaps change its role, and become more focused, perhaps further upstream in the supply chain like Company 2 or Company 5, or could stay as a leader as in the in-depth case. This role of leading firm was revealed both in level 2 and level 3 studies of open innovation, as suggested by West et al (2006). A mapping of strategic positioning as suggested eg. by Lambert and Cooper (2000), illustrated in Figure

1, could be useful for communication of strategic positioning, risk and potential leverage of information and communication flow, which could have important effects on knowledge management in the networks. The multiple study also confirms previous research by eg. Jansson and Sandberg (2008) with several of the firms responding that they see interesting market opportunities, but lack resources to take action towards theses market. A limitation though in the data collection is that only one firm in each of the network was interviewed.

6 Conclusions and Discussion

Swedish environmental technology SMEs have difficulties penetrating international markets (ITPS 2007b). This study reveals some successful firms, both small and larger, on the global market, offering solutions that are environmentally sound and efficient. The cases indicate that psychic or geographical distance is of less importance as companies work in global networks, reducing outsidership and uncertainty, enhanced by the information technology development and new communication behaviour (Arnold and Quelch 1998, Johanson and Vahlne 2009, Oke and Idiagbon-Oke 2010). Also, it is suggested that environmental regulations in EMs can be a business opportunity for small environmental technology companies as is indicated in the indepth case study presented in this paper. Although the issue of market selection is not fully penetrated in the multiple-case study, some of the studied cases show such development.

The results point at a need for a more useful classification of environmental technology firms for the coupling between technology development and business (models) development. All environmental technology firms could probably not lean on the same business model development recipe, and there is a need to further investigate which categories that might be appropriate. Anyhow, it can be concluded from the study that services and IPSOs are offered almost regardless the studied firm characteristics (eg. size, environmental technology classification, company maturity stage). Collaboration in networks appears to be an efficient means to take on larger assignments, and as mentioned, business models built on principles of product service systems and ISPO, where the technology can be built in, and the focus on the functionality seem to be useful although the motivation behind this offerings is not yet clear. Further research on IPSO development is therefore strongly recommended. Engineering methods taking into account business development, especially what renders customer value (Kothandaraman and Wilson 2001), for IPSO development needs to be elucidated.

The empirical results presented in this paper show that SMEs can cooperate in business networks in order to obtain the advantages of a larger firm in terms of e.g. larger resources and possibilities to set up demonstration equipment to reach new markets. The results also confirm the difficulties for SMEs to export environmental technology solutions to EMs in line with previous studies (eg Jansson and Sandberg (2008).

The research has both practical and theoretical contributions. Theoretically, this research can add new perspectives to the literature on open innovation concerning development of innovative environmental technology in company networks of SMEs targeting emerging markets. Managerial implications are based on the IPSE business and technology process model. In the on-going research project, which is the base for this paper, a methodology is being developed for step-wise mapping and decision-making for an environmental technology firm's development of innovative solutions alone and in networks of horizontal business partners, suppliers, customers, and users. Although

business networks cannot be "managed", managing the aspects of the complete supply chain for the focal firm is pivotal; since eg. local third-party contractors and distributors may have a key role in how the offering is perceived by the customer in terms of value delivery and performance in the short-term, but also in how important user and customer communication is taken care of for long-term user-driven innovation. When the small environmental technology firm operates on EMs with larger psychic distance the risk of loosing customer interface is high, and it is therefore suggested that the focal firm put a strong effort in managing important customer and user contacts, eg. through personal presence or otherwise efficient channels for direct dialogue.

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