

Mechanisms for Coordination
and Knowledge Sharing in the Networks of
Internationalising Biotech SMEs'

Abstract

A biotechnology SME's managers' ability to coordinate network partners with complementary knowledge bases is suggested to affect the organizational learning and the international growth of the firm. This multiple case study reveals that within the networks of internationalising biotechnology SMEs there are mechanisms that enable or enhance network coordination by means of (i) education of network partners, (ii) joint decisions with network partners and (iii) direct interaction between network partners. These activities render knowledge flows mainly within the biotechnology SMEs' network of customers. Knowledge sharing is a prerequisite for organizational learning by means of knowledge combining of network partners' complementary knowledge bases. Thus, this study may contribute to our understanding of how certain biotechnology SMEs are able to develop sufficient knowledge to compete on knowledge demanding markets and to grow internationally despite limited internal resources.

Introduction

International entrepreneurship research is concerned with innovative, proactive and risk-seeking firms that have activities that cross international borders (Jones and Coivello, 2005; McDougall and Oviatt, 2000). In this study findings from a multiple case study of eight internationalising biotechnology SMEs are analysed in order to further our understanding of how the business environment can influence strategic management and organizational learning of international entrepreneurship firms. In particular, there is a focus on biotech SMEs' ability to coordinate network partners for organizational learning purposes.

Researchers have noted that certain SMEs have an extraordinary ability to develop both the technical- and local market knowledge they need to internationalize despite limited internal resources (Johanson and Vahlne, 1992; Oviatt and McDougall, 1994; 2005). It has been suggested that the firms' extraordinary ability to gain knowledge and grow internationally stem from their ability to gain resources, and in particular knowledge, from their business network partners (Jones, 1999; Coivello and Munro, 1997). Accordingly, several researches have applied a combination of knowledge-based process theories and network theories to further our understanding of international entrepreneurship (Oviatt and McDougall, 2005; Crick and Jones, 2000; Coivello and Munro, 1997; Johanson and Vahlne, 1992). Adding a strategic management perspective to this line of international entrepreneurship research is vital (Crick and Jones, 2000) and there is a need to further study the interactions between managerial intentionality and knowledge accumulation in internationalising firms (Hutzschenreuter, Pedersen and Volberda, 2007). The international entrepreneurial firms that appear to have the most sustainable competitive advantage derive significant benefits from the capability to perform extensive coordination of multiple organizational activities across national borders. Management of such internationalising firms may however be a challenge as it requires extensive international coordination skills (Oviatt and McDougall, 1994; 2005). In this article coordination refers to the organizing of two groups or more so that they know what the others are doing in order to facilitate cooperation and increase work efficiency. Coordination thereby needs to include a certain degree of knowledge sharing. Network coordination is performed so that firms in a business network can increase their awareness of what other firms in the network are doing in order to improve cooperation and work efficiency. In this paper the management capability to

coordinate the activities of the focal firm's customers and suppliers is referred to as 'network coordination capability' and it is defined as coordination of network partners within and across dyadic business relationships for the purpose of knowledge combining and organizational learning. The study takes a stance in that the exceptional internationalization ability of some successfully internationalising high technology entrepreneurship firms can be a result of, among other things, these firms' ability to develop knowledge by coordinating network partners with complementary knowledge bases. Although each firm is assumed to have a certain network coordination *capability* the manager's actual *ability* to coordinate its network is expected to be dependent on environmental aspects. Within the entrepreneurship research field there is a need to further explore the role of environmental factors (Zahra and George, 2002; Fernhaber, McDougall and Oviatt, 2007). Moreover, it has been recognized that certain internationalising firms differ in the extent of their learning [compared with traditional firms] but the sources of these variations are not well defined and future studies need to examine how these firms learn (Zahra, 2005). To fill this gap in literature the aim of this study is to shed light on how the business environment can enhance internationalising biotech SMEs ability to coordinate their network partners for the purpose of knowledge combining and organizational learning in the internationalization process. The research question is thus:

What mechanisms can enhance internationalising biotechnology SMEs ability to coordinate network partners for the purpose of organizational learning and international growth and how?

The study contributes to existing literature as it adds a business environment perspective to research on strategic management in international entrepreneurship to explain how certain SMEs are able to develop sufficient knowledge to compete on technically advanced, knowledge demanding and international dispersed markets despite limited internal resources.

Theoretical Foundation

International Entrepreneurship

International entrepreneurship researchers study innovative, proactive and risk-seeking firms that have activities that cross international borders (Jones and Coivello, 2005; McDougall and Oviatt, 2000). Some entrepreneurship researchers have successfully applied a combination of process theories of internationalization (Johansson and Vahlne, 1977; Wiedersheim-Paul, 1975) and network theories (Håkansson, 1987) in order to study internationalising high technology SMEs that need to cope with knowledge dynamic and internationally dispersed markets (Johanson and Vahlne, 1992; Oviatt and McDougall, 2005). The Uppsala process model of internationalization suggests that firms internationalize gradually through increasing stages of commitment (Johanson and Vahlne, 1977; Johanson and Wiedersheim-Paul, 1975). A firm's ability to access knowledge is seen as a driver of the internationalization process as the firm's experiential knowledge, based on experiences on a foreign market, can reduce the firm's uncertainty and promote further commitment of resources to that market (Penrose, 1959; Johansson and Vahlne, 1977). However, Oviatt and McDougall (1994) in their widely recognized article on international entrepreneurship suggested that certain firms are able to bypass several stages in their internationalization process. Other studies claim that some high technology firms are able to precede though the internationalization stages more rapidly by creating opportunities together with network partners (Coivello and Munro, 1995). Regardless of whether the firms bypass stages in the internationalization process or proceed through the stages more rapidly, it is clear that certain firms have an extraordinary ability to develop both the technical- and local market knowledge they need to internationalize. It has been suggested that these firms' extraordinary ability to gain knowledge and grow internationally stem from their ability to gain resources, and in particular knowledge, from their business network partners (Jones, 1999; Coivello and Munro, 1995). Business networks can be used to overcome the liabilities of smallness associated with small firms as external resources, including knowledge, can be accessed from business network partners such as customers and suppliers. In accordance with the process theories of internationalization, this study views experiential knowledge as a driver of the internationalization process and in line with the network theories, it is recognized that knowledge

can be accessed from network partners.

Strategic Management in the Networks of Internationalising HTSMEs

A strategic management perspective on international entrepreneurship research is vital to increase our understanding of how high technology SMEs are able to gain a combination of both technical and local market knowledge in order to grow internationally (Crick and Jones, 2000). The knowledge based view (Kogut and Zander, 1992; Nonaka and Takeuchi, 1995; Spender 1996 Cohen and Levinthal, 1990) states that knowledge more than anything else determines the success the firm. However, organizations that need to cope with dynamic markets need not only process existing knowledge efficiently but also create new knowledge to adapt to the changing circumstances (Oviatt and McDougall, 2005; Nonaka, 1994). The survival of a firm depends on whether the firm can manage the organizational knowledge evolution that is necessary due to environmental changes (Leonard-Barton, 1992). Moreover, not only internal resources but also external resources are vital for the international growth of entrepreneurial firms (Oviatt and McDougall, 1994; Bell, 1995; Coivello and Munro, 1997) and this moves the focus from what resources the firms possess to how they can access resources, knowledge in particular, from their business networks. Internationalising HTSMEs limited internal resources in combination with their need of both technical progress and foreign market knowledge development (Yli-Renko, Autio and Sapienza, 2001) favours the establishment of international networks of firms that cover complementary technologies as the firm thereby can spread cost while retaining some control over new technologies that they develop in the network (Buckley and Casson, 1998). However, a firm that rely on its business network depend on the firm's ability to manage not only the firm but also, to the extent that it is possible, its network partners (Håkansson, 1987; Ritter, 1999; Ritter and Gemünden, 2003).

Network Coordination Capability- A comprehensive management concept

Interorganizational partnerships can be a means for organizational learning (Teece et al., 1997; Doz and Shuen, 1990; Moody, 1993). Moreover, successful internationalising high-technology firms 'demonstrate timely responsiveness and rapid and flexible product innovation, coupled with the management capability to effectively coordinate and redeploy *internal and external* competences' (Teece et al., 1997, pp. 515 italics added). Thus research indicates that network coordination, of interdependent firms in a business network, is a management capability that can enhance the organizational learning and the international performance of a firm. Van den Bosch,

Volberda and de Boer (1999) claim that coordination capability is type of combinative capability (Kogut and Zander, 1992) that enhance organizational learning within a firm and Ritter (1999) explained that management of network relationship can enhance the performance of a firm. Thus it is recognized by researchers that the management of networks and the integration of knowledge from external network partners requires some skill (Ritter, 1999; Ritter and Gemünden, 2003; Hillebrand and Biemans, 2003) and that organizational learning can be enhanced by a firm's coordination capability (Van der Bosch et al., 1999). Furthermore, research has shown that the international entrepreneurial firms that appear to have the most sustainable competitive advantage derives significant benefits from the capability to perform extensive coordination of multiple organizational activities across national borders (Oviatt and McDougall, 1994, 2005). In this paper this management capability is referred to as 'network coordination capability' and it is defined as 'experiential knowledge about how to coordinate the activities of business network partners within and across dyadic business relationships for the purpose of knowledge combining'. This study takes a stance in that the exceptional internationalization ability of some successfully internationalising high technology entrepreneurship firms can be a result of, among other things, these firms' ability to develop knowledge by coordinating the activities of network partners with complementary knowledge bases.

Manifestations of Network Coordination Capability in the Networks of internationalising Biotechnology SMEs

It is assumed that each firm has a certain network coordination *capability* but the managers' actual *ability* to coordinate its network is, however, expected to be dependent the business environmental. Within the entrepreneurship research field there is a need to further explore the role of environmental factors (Zahra and George, 2002; Fernhaber, McDougall and Oviatt, 2007) and it may thereby be rewarding study how network coordination capability can be manifested in biotechnology SMEs' networks of customers and suppliers. Although literature on coordination on a network level is limited, research on related areas offers some directions for research when taken together.

Education of Network Partners

Training and education is maintained to enhance a firm's coordination capability and the organizational learning of a firm because these activities indirectly has the same functions as

rules and procedures since it facilitates control, coordination and knowledge absorption (Van den Bosch, et al. 1999). Adding a network management perspective (Ritter, 1999) to this line of argument gives that network coordination capability can be manifested by measures of *(i) education of network partners*. In this study education of network partners is delineated as a focal firm's efforts to educate its customers, customers of customers, and suppliers in areas the focal firm is knowledgeable in.

Joint decision processes with network partners

Subordinates participation in decision-making increases knowledge sharing and the absorptive capacity of the firm and similarly liaison devices regulate mutual adjustments between individuals or units and they result in lateral communication and joint decision processes that increase the capacity to process- and absorb information (Van den Bosch, et al., 1999). This study takes on a network perspective and focus on the relations between firms and therefore it may not always be clear which firm takes the role of a 'subordinate' and whether a relation is lateral or vertical. Liaison devices and joint decision processes are consequently studied as one aspect and it is suggested that a firm can manifest its network coordination capability through *(ii) joint decision processes with network partners*. In this study joint decision processes with network partners is delineated as decision processes, that are of some significance for the focal firm, and that relies on input from the firm's network partner(s) to a certain extent.

Direct interaction between network partners

Hierarchical lines may be sufficient as means of coordination of external relationships in firms with only a limited amount of external cooperation but the hierarchical structure will prove ineffective when there is more extensive external cooperation (Hillebrand and Biemans, 2003). Thus, hierarchical lines and other formal coordination mechanisms may be insufficient for the network coordination needs of internationalising biotechnology SMEs due to their dynamic and complex network environments. One alternative to hierarchical lines and other formal structures is direct contact between network partners as it has been shown that when external parties can interact directly with each other, coordination is facilitated (Hillebrand and Biemans, 2003). Network coordination serves to ensure that a firm's network partners know what the other network partners are doing. A focal firm's awareness of their network partners' direct connections is expected to increase their ability to draw on these connections for network coordination purposes. Thus, from a network management perspective it is suggested that a firm

can manifest its network coordination capability by means of an awareness of *(iii) direct contact between the firm's network partners*. In this study, direct contact between network partners refers to situations where the focal firms' customers, customers of customers or suppliers can interact and share knowledge and information without the focal firms as a necessary intermediary.

Summary of the theoretical line of argument

In summary, the theoretical line of argument indicates that internationalising HTSMEs depend on network coordination capability in order to develop sufficient knowledge to handle the combination of technical challenges and new foreign market adaptations. Moreover, it is argued that network coordination capability can be manifested by means of:

- (i) Education of network partners
- (ii) Joint decisions with network partners
- (iii) An awareness of direct contact between network partners

A focal biotechnology SME's ability to coordinate its network partners is further expected to be affected by the international biotechnology environment. Thus it may be rewarding to empirically investigate which mechanisms within the international biotechnology networks can enable or facilitate network coordination by means of education of network partners, joint decisions with network partners and direct contact between network partners.

Methodology

This study takes on a multiple case study approach in order to investigate how various mechanisms can enable or facilitate network coordination and organizational learning in the networks of biotechnology SMEs. The multiple case study approach was chosen as I empirically identified a phenomenon that I could not find explanations for in existing literature and therefore I saw a need to expand existing theory. I further consider it an advantage that multiple case studies are more deeply grounded in varied empirical evidence (Eisenhardt and Graebner, 2007). Multiple case studies moreover provide a more robust base for theory building (Yin, 1994) and may yield more generalizable and testable theories compared to single case studies (Eisenhardt and Graebner, 2007).

Case selection

The phenomenon of interest in this study is biotechnology SMEs with the seemingly impossible combination of resource demanding product development and successful internationalization despite limited internal resources. The case firms were chosen so as to reflect strong examples of the phenomenon of interest. In other words, a replication logic rather than a sampling logic (Eisenhardt and Graebner, 2007) was applied for case selection. In multiple case studies it is highly recommended that cases should not be chosen randomly so as to represent a larger universe, on the contrary cases should be chosen because similar results are expected to be found so that the cases can stand as exemplary cases of the phenomenon of interest (Eisenhardt and Graebner, 2007). From an initial sample of 12, data from eight firms was included because little new insights to the studied phenomena could be found in the data from the reminding firms as they provided similar data as firms already included. In other words, the point of saturation was reached (Eisenhardt, 1989). All the studied firms are situated around the Stockholm area in Sweden and this location was chosen for reasons of proximity but also because it is an area with a high concentration of biotechnology firms.

Table of case firms

Data collection and data analysis

In order to collect data from the sample firms, semi structured interviews of approximately 60-90 minutes were conducted at the firms' head offices. Informants included CEO:s and marketing

managers. Two interviewers, including the present author, were present during the interviews which can strengthen the reliability and enhance confidence in the data (Eisenhardt, 1989). The interviews were recorded, transcribed to text and thereafter analysed a number of iterations. Databases, printed information and information from the firms' home pages were also collected. I thereafter alternated between the existing theory and the empirical material. Eventually this led to a stage where I screened the empirical material for evidence of manifestations of network coordination capability in the form of education of network partners, joint decision processes with network partners and an awareness of direct interactions between network partners. Citations that captured this were translated, from Swedish to English, and put into a comprehensive table for each firm. These tables form the basis for the empirical presentation and empirical analysis of the study. All through the analysis process I repeatedly altered between the original data transcriptions, the data tables and theory.

A focal SMEs role as a network coordinator from a manager's perspective

The study is carried out from the perspective of a focal internationalising biotechnology SME. Hence the firms as well as their surrounding network environments are studied from the perspective of the firm. One disadvantage of such an approach is that one will not know whether the viewpoint of the studied firms corresponds with that of network partners. However, one advantage of this perspective is that it may be the perspective that best corresponds to that of managers and therefore the most relevant perspective for managers of internationalising SMEs. Finally, one also needs to recognize the limitations of the view of the focal SME as a node that coordinates the activities of the network as this implies that the firm is in control when, in reality, only so much of the activities and knowledge sharing processes can be controlled by one firm. Firms exist in changing environments that cannot fully be controlled. Moreover, knowledge sharing processes are generally reciprocal and based on a give and take in relationships which cannot fully be controlled by one partner only. However, in this study it is assumed that most firms can have *some* power to influence and coordinate its network to a certain extent.

Empirical Findings

Each firm is assumed to have a certain network coordination *capability* but firms' actual *ability* to coordinate its network is expected to be dependent on environmental aspects. The empirical findings demonstrate that there are a number of situations, settings and processes that can serve as mechanisms for network coordination by enabling or facilitating education of network partners, joint decisions with network partners and direct interaction with network partners. A summary and a description of the mechanisms for network coordination in the networks of internationalising biotechnology SMEs is presented in figure 1. The mechanisms were derived from a large number of citations from the data and appendix 1 includes a few examples of these citations.

Mechanism	Description
Conferences	<i>Conferences, management forums, and industrial fairs aimed at the science community.</i>
Seminars	<i>Customer aimed seminars, presentations, and lectures with at scientific and/or product oriented content.</i>
Courses	<i>Customer aimed courses or workshops that are arranged by the firm alone or together with a collaborating firm at the head office location or externally. The courses typically spans over a few days and covers advanced technical and science related subjects as well as practical training in how to use the product.</i>
Standardization	<i>International committees that sets standards and rules for each specific industry.</i>
Business	<i>A focal firms' network partners' business connections with each other. For example a focal firm's supplier may also serve as a supplier to one of the focal firm's customers.</i>
Research	<i>Basic research projects in various science subjects, including medical science, biochemistry and neuroscience. Not directly (but often indirectly) product related.</i>
Support	<i>Customer aimed support; either more resource demanding as in the case when a member of the firm travels to the customers' location in a foreign country to join a product team for a few weeks; or less resource demanding as in the case when researchers answer research related questions on the phone or by email.</i>
Product	<i>Product development process which is aimed at either developing an entirely new product or to further develop an existing product.</i>
Local Market	<i>Local market related decisions and concerns including legal protection issues and choosing a competent local distributor.</i>
Academia	<i>Universities, research institutes, university hospitals or other settings where academic professionals meet and work together.</i>

Figure 1: Mechanisms for education, joint decisions and direct interaction of network partners.

The sample firms rely on various mechanisms for network coordination which enable or enhance education of network partners, joint decisions with network partners and direct interaction between network partners. Figure 2 shows which of the sample firms that relies on which mechanisms in order to manifest their network coordination capability.

Firm	<i>Education of</i>		<i>Joint decisions with the</i>		<i>Direct contact between</i>		
	<i>Customers</i>	<i>Suppliers</i>	<i>Customers</i>	<i>Suppliers</i>	<i>Customers</i>	<i>Suppliers</i>	<i>Customers and Suppliers</i>
Air	Seminars Support Conference		Market Product	Product Research	Academia Seminars Conference	Product	
Beat	Support		Product		Conference Academia		
Cell	Support Seminars Courses Conference	Research	Research Product	Research	Seminars Conference Courses		
Digit	Support Courses				Conference Courses		
Exhale	Support Conference		Product		Conference		
Flow	Product Market Support	Product	Product Standards	Product	Conference Standards		Business
Gene	Product Research	Research	Product	Research	Conference	Research Academia	
Heal	Courses Support		Product	Research	Courses Academia Conference		

Figure 2: Mechanisms for network coordination within the biotechnology SMEs

Empirical Analysis

The empirical findings demonstrated that in the networks of internationalising biotech SMEs there are a number of mechanisms for network coordination by means of (i) education of network partners; (ii) joint decisions with network partners and; (iii) direct interaction between network partners. The empirical analysis elaborates on the function of the mechanisms for the knowledge flow within the network because knowledge sharing is considered central for knowledge combining, organizational learning and international growth of biotechnology SMEs.

Education of network partners

Network coordination capability can be manifested by the focal firm's efforts to educate its network partners. The data shows that courses, seminars, conferences, customer aimed support, local market decisions, product development processes and research processes serve as mechanisms for education of network partners.

Courses and Seminars

Among the sample firms education of network partners, especially customers and customers of customers is evident. Education of customers by means of courses or workshops arranged by the focal firm alone or together with a partner firm can be observed in three of the sample firms; Cell, Digit, and Heal. Customers aimed courses takes place in various ways, for example by inviting members of the customer firm to the head office on courses that spans over a few days. Some courses take the form of laboratory courses aimed at researchers where the customer's representative is invited to the focal firm's head office for a few days. In other cases the firms arrange workshops for customers at foreign universities. The content of the courses include both directly product related issues and more general science subjects such as biomedicine.

Customer support and backup

The sample firms Air, Beat, Cell, Digit, exhale, Flow and Heal demonstrate that customer support can go beyond mere product maintenance and delivery issues and rather function as a mean for customer education by helping the customers to implement and use the products in for example complex research projects. The sample SMEs all have technically advanced products that may be difficult to use correctly, even by highly qualified professionals which make competent customer support vital as is demonstrated by Cell: "Our product is, after all, quite complicated. We try to

follow up on our customers to ensure that they use it correctly. We feel responsible as the customers' research projects are time- and resource demanding. It is important that our testing-device functions optimally"(CEO, Cell). One example of a less demanding education by customer support is illustrated by the sample firm Heal where the CEO explains that they call their customers to support them in the use of the firm's products. An example of a more resource demanding customers support is demonstrated by the sample firm Gene where their researchers regularly join customers' product development team in order to support the customer with knowledge so as to adapt and finalize the basic product generated at Gene. Customer support does not necessarily need to be product related as demonstrated by Flow which supports its customers in local market, regulative issues as the firm has an expert working in a local foreign office.

International conferences, management forums and fairs

Another form of customer education takes place during lectures and presentations at international management forums and international industrial fairs. International fairs within the focal firms' specific industry or research area gives the sample firms an opportunity to meet, inform and educate their customers, customers of customers and potential customers by means of lectures, product presentations etc. The data shows that the firms may meet several customers at once, as when they hold presentations, but they can also meet them one by one. Education of customers at international fairs, conferences and forums is demonstrated by three of the HTSMEs in the sample, Air, Cell and Exhale. Cell, for example, explains that they participate in industrial fairs abroad together with their local distributor on that market and uses this as an opportunity to educate the end-customers: "We also hold presentations and lectures for the end customers." Similarly, managers from the firm Flow attend international management forums where they interact with managers from their customer firms and update them on their technology and product developments.

Education of Suppliers

In the data there is less evidence of focal HTSMEs' education of suppliers. The sample firms Cell and Gene collaborate with research institutes that serve as suppliers of basic research ideas in their product development processes and as a part of these arrangements the firms support the research and education of the suppliers' PhD students and Post Doctors and the firms and research groups learn from each other. This is well described by the firm Gene: "We have this

Post Doc thing. It is a method to get contacts. [...] We also have this PhD student program- the research school, [...] we support their work...” (CEO, Gene).

The knowledge flow by means of education of network partners

All of the sample firms educate their customers and there are a number of settings and processes that serve as mechanisms for customer education in the international biotechnology networks. However, as displayed by merely three of the firms, only product development processes and research processes serve as mechanisms for supplier education. The networks of internationalising biotechnology SMEs thus predominantly have mechanisms that enable or facilitate education of customers. This indicates that network management efforts in the form of network coordination by means of educational efforts primarily enhance the upstream flow of knowledge, from the focal SMEs’ to their customers. Knowledge sharing is a prerequisite for knowledge combining, which in turn renders new knowledge. The educational efforts of biotechnology SMEs are thus suggested to increase the organizational learning mainly within in the SMEs’ customer relationships. The knowledge flows attributable to educational efforts in the international biotechnology networks is illustrated by figure 3.

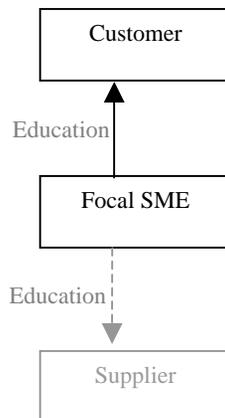


Figure 3: Knowledge flows attributable to education of network partners

Joint Decision Processes

The theoretical line of argument suggests that network coordination capability can be manifested through joint decision processes with network partners. The data shows that product development processes, research processes, local market decision processes and industry standardization committees, serve as mechanisms for joint decisions processes.

Research and product development processes

In this study it is assumed that joint product development processes and research development processes incorporates joint decision processes to some degree. Joint product development is apparent in all of the sample firms except Digit. Network partners can serve as a source of product ideas as well as a forum to test products during the product development process. For example Gene states that decisions regarding which products ideas to develop further are made in collaboration with customers and Beat explains that their product was: "...developed in close collaboration with cardiologists, nursing staff...(CEO, Beat). Input from network partners is valued in various stages of the processes:"In an early stage of the project we will test the concept and receive feedback so that we can make modifications then when we enter [...] the last phase before serial production we do beta tests and the machines are placed in clinics for a few weeks and that we do in a number of different countries and environments in order to see how it functions (CEO, Air). The sample firms Cell and Gene demonstrate that close interactions with research institutes that serve as suppliers is important for some firms:" These contacts [with research institutes] are reliable and convenient when we need someone to evaluate the product so that we can discuss it with somebody" (Cell). A product development process can involve joint decisions with different network partners at different stages of the process as is evident in Gene: "We develop an idea... often together with our collaborating academic researchers... then we study their research findings from a more commercial point of view..." (CEO, Gene). In order to make sure that the product can be practically useful for the end customers Gene needs to adapt the scientific research ideas to the markets and therefore they need a different type of input: "...then we work together with the medical [customer] firms for some time" (Gene).

Standardization work

Another example of joint decision processes is demonstrated in Flow where a member of the firm is a member of an international standardization committee for their particular business- and research area. The work within this committee incorporates joint decision processes regarding

new standards and regulations for their field of expertise. This work is deemed influential for the industry as it sets up guidelines and polices for all research within this particular industry and research discipline.

Local market related decisions

A further example of joint decision processes is illustrated by Air where they take information from customers into account in their local market related decision processes: “If we find an interesting market we try to collect as much input as possible. [...] One might go to a local congress [...]. We try to talk to medical doctors in these countries, they possess very much information- which distributors are competent and who we should stay away from.”(CEO, Air). Hence, it is evident from the data that customers also can join a focal firm’s decision processes regarding market issues.

The Knowledge flow caused by joint decisions with network partners

All of the sample firms except one incorporate input from their customers in various decisions processes while the suppliers appear less influential. Thus there appears to be mechanisms that serve to enable or facilitate joint decisions with primarily customers in the international networks of biotechnology SMEs. This indicates that that network management efforts in the form of network coordination by means of joint decision processes mainly enhance the downstream flow of knowledge, from the customers to the focal SMEs. Knowledge sharing is a prerequisite for knowledge combining, which in turn renders new knowledge. Network coordination in the form of joint decision processes thus appears to increase the organizational learning mostly within in the biotechnology SMEs' customer relationships. The knowledge flow attributable to joint decision processes in the international biotechnology networks is illustrated by figure 4.

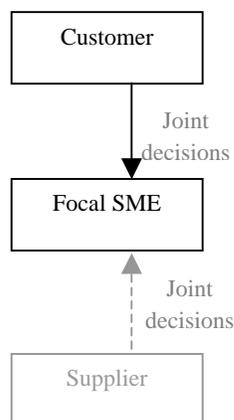


Figure 4: Knowledge flows attributable to joint decision processes with network partners

Direct Interaction between Network Partners

The theoretical line of argument suggests that a firm's network coordination capability can be manifested by an awareness of network partners' connections with each other (without the focal firm as a mediator). According to the sample firms, educational events such as customer aimed courses, conferences, seminars and workshops as well as academic settings and standardization committees serve as mechanisms for direct interaction between the focal firms' network partners.

Courses, work-shops and seminars

One example of a mechanism for direct interaction between customers is the courses which three of the sample firms, Cell, Digit and Heal arrange for their customers. A course arranged by a focal HTSME at the focal firms' location, where customers from various countries are invited to learn about the firm's products for a number of days, naturally need to involve some interaction between the customer representatives who attend. Hence, these courses that are arranged for the customers serve as mechanisms for direct contact between customers of that firm. For example, the respondent at Heal explains that: "We hold plenty of courses for customers, several times a year. On those occasions a Korean customer, an American customer and a Norwegian customer will sit next to each other...(CEO, Heal)". Courses and seminars may also be arranged outside the focal firm as in Cell: "We arrange seminars at universities and invite 10-12 customer representatives at a time. We hold a presentation and they discuss with each other (Cell)".

Academia, Conferences and Standardization committees

Due to the high tech nature of the sample firms, their suppliers, customers and customers of customers include researchers, medical doctors and other highly qualified professionals. The interviewees describe various mechanisms for everyday interaction between professionals within their area of expertise. For example, medical doctors work at hospitals and researchers may participate in international research projects where they can interact with each other. For example, the CEO at Cell explains that their end-customers, mainly researchers at universities, have a network of their own and that they often communicate through various research projects. Moreover, researchers and other members of these professional groups often interact at academic conferences, management forums, and medical symposiums. The conferences can be small and specialized as described by Exhale: "...these [conferences] are quite focused on perhaps one group, a medical specialty so to say, there customers will attend."(Exhale). Other conferences are

more general and involve a large number of specialists: “One of the larger ones [...] incorporates all European medical doctors within the [field] and then they will gather about 15000 medical doctors...”(Air). Another mechanism for direct contact between customers is international standardization project groups where new industrial standards are developed by specialists in their industry: “...practically all our existing and potential customers are represented there”(Flow).

Direct interaction between suppliers and between customers and suppliers

Gene describes how research settings and academia can serve as a mechanism for direct interaction between their suppliers that are researchers:”...they go to a university in Germany and rent time in their laboratory. There are a few [laboratories] with that capacity in the world. It is a way for them to have a network and the biologists have a lot of networks...”(CEO, Gene). The only example of a mechanism for direct interaction between the focal firms’ customers and their suppliers was found in the firm Flow where they have suppliers in common with some customers. In other words Flow’s customer interacts with Flow’s supplier in order to do business.

The Knowledge flow caused by direct interaction between network partners

It is evident from the data that all of the sample firms are aware of various situations where their customers or customers of customers interact but only limited evidence of an awareness of interaction between suppliers and direct contact between the firms’ suppliers and customers has been found. This could be because it is uncommon but it could also be because these types of relationships are less visible to the interviewed sample firms. Nevertheless, based on the empirical data, there appears to be mostly mechanisms for direct interaction between customers in the networks of biotechnology SMEs. The fact that the customers appear to have contact with each other may be partially due to the high technology nature of the sample firms’ business areas as the mechanisms include educational events such as courses and seminars as well as business- and job related settings such as research projects and hospitals. However, it is also clear that the sample firms facilitate direct contact between their customers by arranging or contributing to various activities where direct contact between network partners is a natural and necessary aspect such as courses, conferences and seminars. Coordination means that the activities of two or more groups are organized so that they know what the others are doing. If the focal SME is aware of which customers that interacts with which other customers they are more likely to be able to draw on this for network coordination purposes. The data illustrates that all of the sample firms have an

awareness of situations where their network partners interact. This awareness can be seen as a prerequisite for network management efforts in the form of network coordination where the focal firm draw on the fact that they know which of their network partners that can interact and share information and knowledge. In summary, the biotechnology SMEs appear to act in environments that enable or facilitate direct interaction between mainly their customers. Direct interactions between the focal SME's customers enhance the focal SME' ability to coordinate their customers as it enables or enhances the flow of knowledge in between customers. Knowledge sharing is a prerequisite for knowledge combining, which in turn renders new knowledge. Network coordination opportunities stemming from the direct interaction of network partners in the biotechnology setting thus mainly appears to increase the organizational learning in the customers' relationships with each other. The knowledge flow attributable to direct interaction between network partners of the international biotechnology SMEs is illustrated by figure 5.

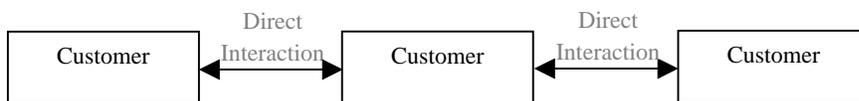


Figure 5: Knowledge flows attributable to direct interaction between network partners

The Knowledge Flow in the networks of international biotechnology SMEs

The multiple case study of biotechnology SMEs indicates that network coordination by means of education mainly results in a knowledge flow from the focal firms to their customer networks. Network coordination manifested by joint decision processes with network partners, on the other hand, renders a knowledge flow in the other direction; from the customers to the focal firms. Finally, direct interaction between the customers may allow the knowledge to be transferred between the various customers. The knowledge flows to and from the suppliers is less visible and the role of the suppliers for knowledge combining within the biotechnology networks appears to be secondary. Altogether the study points towards a continuous pattern of knowledge flows from the focal firm to its customers, in-between the customers and then back to the focal firm. Figure 6 illustrates how knowledge generated from knowledge combining in one business relationship may be transferred to- and combined with knowledge in another business relationship, thereby generating further organizational learning in the network.

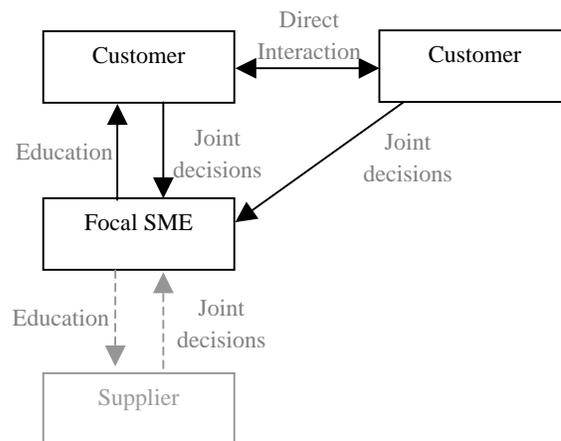


Figure 6: Knowledge flows attributable to network coordination in the networks of internationalising biotechnology SMEs

This study shows that there are mechanisms within the international biotechnology network that can enable and facilitate network coordination by means of education of network partners, joint decisions with network partners and direct interaction between network partners. These activities results in knowledge flows mainly within the biotechnology SMEs' network of customers.

Knowledge sharing within the network is necessary for knowledge combining of complementary knowledge bases of the network partners. This can in turn generate new knowledge which serves as a driver of the internationalization process. A biotechnology SME's ability to draw on mechanisms in the business environment to coordinate network partners with complementary knowledge bases is thus suggested to affect the organizational learning and international growth of the firm and its network of primarily customers.

Conclusions, managerial implications and suggestions for future studies

The aim of this study was to shed light on how various mechanisms in the business environment can enhance internationalising biotech SMEs ability to coordinate their network partners for the purpose of knowledge combining and organizational learning in the internationalization process. The study reveals that in the international biotechnology networks there are settings, processes and situations that serve as mechanisms for network coordination by means of education of network partners, joint decisions with network partners and direct interaction between network partners. These activities enable and facilitate the knowledge flow within the international biotechnology networks of primarily the focal firms' customers. Knowledge sharing is a prerequisite for organizational learning by means of knowledge combining and therefore this may explain how certain successfully internationalising biotechnology SMEs are able to develop sufficient knowledge to compete on international and knowledge demanding markets despite limited internal resources. Managers can benefit from this study as it puts light on the managers' role as proactive network coordinators and illustrates how the business environment can enhance the managers' ability to coordinate network partners. In the future it would be interesting to test the findings of this article on a larger sample and to further investigate why the customer relationships appear more central than the supplier relationships for organizational learning in the international biotechnology networks.

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Appendixes

Appendix 1: Citations- some examples from the data

This study investigates for mechanisms that can enhance internationalising biotechnology SMEs' ability coordinate network partners for organizational learning purposes. The empirical findings reveal that there are a number of settings, situations and processes that serve as mechanisms for network coordination in the international biotechnology networks as they enable or facilitate education of network partners, joint decisions with network partners and interaction between network partners. In this paper, the word "mechanisms" is used to capture various structural components, processes, situations and settings in the networks of biotechnology SMEs. The table include the mechanisms found in the data and citations from the interviews that are meant to serve as illustrative examples of how the data was interpreted.

Education of customers

Mechanism	Citation
Conferences	<i>...and as soon as we have any new research findings we go to these conferences and [...] inform and talk on seminars. (Cell)</i>
Seminars and presentations	<i>...offers various educational activities and seminars on [...] arranged either by ourselves or together with partners. (Air)</i>
Courses and workshops	<i>...we prefer to sell directly [to the end customer] and invite the customer here for a course. Then we know that he can [use it]. Otherwise [...] the poor customer will have no use of the product as he does not know how to use it.(Heal)</i> <i>Courses [include] technical training on [...] medical technology. [...] Our training is especially formed for medical technical Engineers ... (Digit)</i>
Research process	<i>...and at the same time they know that we have competence within an area that they are not really knowledgeable in. And there is an exchange around that. [...] It has resulted in that they started a spin off firm [...] It is based on our technology (Cell)</i>
Customer aimed support	<i>[we tell the customers] 'Call, as soon as there is an issue, call' and then they [the technicians] go to them in order to support them. (Exhale)</i>
Product development processes	<i>The customer is not always as knowledgeable as one might think within areas such as mechanics, electronics- on the other hand [they are knowledgeable] of biochemistry and the meaning of molecules and how it works within the human body and things like that, that they know very well, but how it interacts with the [humans], Yes, man-machine interface and all that [they] do not know a thing most of the time. (Flow)</i>
Local market decision	<i>... what we offer our customers is the backup, that support,..., they can use this person in their strategy work in order to make a rational approach to</i>

Processes	<i>regulatory issues [...] and this person can participate in their project, administer that part. (Flow)</i>
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Education of suppliers

Mechanism	Citation
Research process	<i>We have this Post Doc thing. It is a method to get contacts. Well, most are competent but if they are especially competent we might hire them. [...] We also have this PhD student program- the research school, [...] we support their work... (Cell)</i>
Product development process	<i>Then the engineer travel to [the suppliers country] and stay there for a few weeks and he is present when [the first] products [i.e. prototypes] arrives [from the local production process machines] and they simply work together with the local product technicians that work there. [...]...until the first working parts are delivered, then they [the engineers] are present and then there is often a number of modification-loops and then they might have to go there again a number of times, until it [the production] start rolling (Flow)</i>

Joint decisions with customers

Mechanism	Citation
Standardization committees	<i>...there are international projects, for example the standardization work being carried out. When they are to develop a new standard, for example for inhalators where we participate, worldwide, and there are all kinds of customers, if we have such an project, participate [in it] then it is somebody who knows a lot, have plenty of influence/power, a gentleman who can bring forward our requests. ..they meet regularly... (Flow)</i>
Local market issues	<i>Sometimes there are requests from customers/partners about which countries about which countries we should apply for patents rights in. (Air)</i>
Research process	<i>...from one point of view they are customers of our research time, from another point of view we actually work together. (Gene)</i>
Product development process	<i>[the product] needs to be human- or practically applicable, not abnormally big or anything like that. [...] There are many aspects like that and then we work on making it into a well functioning [product] but then we work together with the [customer] firm. (Gene)</i>
Local market issues	<i>[What type of information do you search for?] Trends in certain countries, what's going on [...] If we find an interesting market we try to collect as much input as possible. [...] One might go to a local congress [...]. We try to talk to medical doctors in these countries, they possess very much information- which distributors are competent and who we should stay away from." (Air)</i>

Joint decisions with suppliers

Mechanism	Citation
Research process	<i>We develop an idea behind a [product] and that we often do in collaboration with academics, collaborating partners that come up with ideas based on applied basic research where we can take part in their findings and study it from a more commercial point of view. (Gene)</i>
Product development process	<i>The product specification stage focus on function and what we want to produce, then we test this [idea] on customers and opinion leaders. And the same procedure when it is time for production. Different construction stages are tested on the suppliers, that is why the suppliers need to be part of the project so that they can tell us that 'this we can produce and this we cannot produce'. (Air)</i>

Direct contact between customers

Mechanism	Citation
Conferences	<i>"...the main contact platform is [...] which is that conference [...] during those four days [...] I meet our distributors, not only German but also French, Dutch and everything... (Beat).</i>
Seminars and presentations	<i>Then we participated in a small fair [...] we arranged a seminar and four medical doctors did presentations...(Exhale)</i>
Courses and workshops	<i>We have plenty of courses for customers. Maybe eight times a year, when we bring customers from all over the world. Then a Korean, a Norwegian, an American will sit next to each other... (Heal)</i>
Standardization committees	<i>...there are international projects, for example the standardization work being carried out. [...] and there are all kinds of customers [...] they meet regularly...(Flow)</i>
Business	<i>[how do you know which customers to approach?] Suppliers we have in common [with customers]... (Flow)</i>

Direct contact between suppliers

Mechanism	Citation
Research process	<i>...they go to a university in Germany and rent time in their laboratory. There are a few [laboratories] with that capacity in the world. It is a way for them to have a network and the biologists have a lot of networks especially when it comes to pharmacology. (Gene)</i>
Product development process	<i>If different [external] specialists need to talk to each other then they will do that even if they belong to different firms. Then they do not have to go through [us] (Air).</i>
Academia, hospitals,	<i>...they go to a university in Germany and rent time in their laboratory. There are a few [laboratories] with that capacity in the world. It is a way</i>

universities and research institutes	<i>for them to have a network and the biologists have a lot of networks... (Gene)</i>
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Direct contact between customers and suppliers

Mechanism	Citation
Business	<i>[How do you know which customers to approach?] [through] suppliers we have in common [with customers]... (Flow)</i>