

Mechanisms for coordination and knowledge sharing in the networks of internationalising biotech SMEs

Angelika Löfgren
Department of Marketing and Strategy
Stockholm School of Economics
P.O. Box 6501
S-113 83 Stockholm, SWEDEN
Voice:+46 8 736 9538
Fax:+46 8 33 43 22
Email: angelika.lofgren@hhs.se

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Abstract

A biotechnology SME manager's ability to coordinate network partners that possess complementary knowledge bases is suggested to affect the organizational learning and international growth of the firm. This multiple-case study reveals that the networks of international biotechnology SMEs contain mechanisms that enable or enhance network coordination by (i) the education of network partners, (ii) joint decision-making with network partners, and (iii) direct interaction between network partners. These activities result in increased knowledge flows in the biotechnology SMEs' international networks. Knowledge sharing is a prerequisite for organizational learning by combining of network partners' complementary knowledge bases. This study thus contributes to our understanding of how certain biotechnology SMEs are able develop sufficient knowledge to compete on knowledge-intensive markets and grow internationally despite limited internal resources.

Introduction

International entrepreneurship research is concerned with innovative, proactive, and risk-seeking firms with activities that cross international borders (Jones and Coivello, 2005; McDougall and Oviatt, 2000). The present paper analyses findings from a multiple-case study of eight internationalising biotechnology SMEs to build our understanding of how the business environment can influence the strategic management and organizational learning of international entrepreneurial firms. I particularly emphasize the ability of biotech SMEs to coordinate network partners for organizational learning purposes.

Researchers have noted that certain SMEs have an extraordinary ability to develop both the technical and the 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 such firms' extraordinary abilities to gain knowledge and grow internationally stem from their ability to amass resources, in particular knowledge, from their business network partners (Jones, 1999; Coivello and Munro, 1997). Accordingly, several researchers 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 crucial (Crick and Jones, 2000), and there is a need for further study of the interaction between managerial intentionality and knowledge accumulation in internationalising firms (Hutzschenreuter et al., 2007).

The internationalising entrepreneurial firms that appear to have the most sustainable competitive advantage derive significant benefits from their capability to perform extensive coordination of multiple organizational activities across national borders. Managing such internationalising firms, however, may be challenging, as it requires extensive international coordination skills (Oviatt and McDougall, 1994, 2005). In the present paper, coordination refers to the organizing of two or more groups so that they know what the others are doing, to facilitate cooperation and increase work efficiency. Coordination thus entails a certain amount 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, to improve cooperation and work efficiency. In this paper, management capability to coordinate the activities of the focal

firm's customers and suppliers is referred to as "network coordination capability", defined as the coordination of network partners within and across dyadic business relationships for the purpose of knowledge combining and organizational learning.

The present study takes the stance that the exceptional internationalization ability of some successfully internationalising high-technology entrepreneurial firms can result from factors such as their ability to build knowledge by coordinating network partners that possess complementary knowledge bases. Although each firm is assumed to have a certain network coordination *capability*, it is expected that the manager's actual *ability* to coordinate the network will depend on environmental factors. In entrepreneurship research there is a need for further exploration of the role of environmental factors (Zahra and George, 2002; Fernhaber et al., 2007). It has also been recognized that certain internationalising firms differ from traditional firms in their extent of learning, though the sources of this variation are not well defined and future studies need to examine how these firms learn (Zahra, 2005). To fill this gap in the literature, the present study aims to shed light on how the business environment can enhance the ability of internationalising biotech SMEs 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 enhance the ability of internationalising biotechnology SMEs to coordinate network partners for the purpose of organizational learning and international growth, and how?

The study contributes to existing literature by adding a business environment perspective to research into strategic management in international entrepreneurship, in seeking to explain how certain SMEs develop sufficient knowledge to compete on technically advanced, knowledge-intensive, and internationally dispersed markets despite limited internal resources. Moreover, the study highlights managers' role as network coordinators and shows how strategic management of network partners can facilitate knowledge flows and, as a result, organizational learning and in the international networks of biotech SMEs.

Theoretical Foundation

International entrepreneurship

International entrepreneurship researchers study innovative, proactive, risk-seeking firms with 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; Johanson and Wiedersheim-Paul, 1975) and network theories (Håkansson, 1987) in studying internationalising high-technology SMEs that must cope with dynamic knowledge 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 experience on a foreign market, can reduce the firm's uncertainty and promote the further commitment of resources to that market (Penrose, 1959; Johansson and Vahlne, 1977). However, in their widely recognized paper on international entrepreneurship, Oviatt and McDougall (1994) suggested that certain firms can bypass several stages in the internationalization process. Other studies claim that some high-technology firms can proceed through the internationalization stages more rapidly by creating opportunities together with network partners (Coivello and Munro, 1995).

Regardless of whether firms bypass stages in the internationalization process or proceed through the stages more rapidly, certain firms clearly have an extraordinary ability to develop both the technical and the local market knowledge they need to internationalize. It has been suggested that these firms' extraordinary abilities to gain knowledge and grow internationally stem from their ability to gain resources, 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 gained from business network partners such as customers and suppliers. In line with process theories of internationalization, this study views experiential knowledge as a driver of the internationalization process and, in line with network theories, recognizes that

knowledge can be accessed from network partners.

Strategic management in the networks of internationalising high-technology SMEs

International entrepreneurship research needs to apply a strategic management perspective to build our understanding of how high-technology SMEs amass a combination of 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 and Grant, 1996; Cohen and Levinthal, 1990) states that, more than anything else, knowledge determines a firm's success. However, organizations that need to cope with dynamic markets not only must process existing knowledge efficiently, but also must create new knowledge to adapt to the changing circumstances (Oviatt and McDougall, 2005; Nonaka, 1994). A firm's survival depends on whether it can manage the organizational knowledge evolution necessitated by environmental change (Leonard-Barton, 1992). Moreover, both internal and external resources are vital for the international growth of entrepreneurial firms (Oviatt and McDougall, 1994; Bell, 1995; Coivello and Munro, 1997), which shifts the focus from the resources firms possess to how they access resources, knowledge in particular, from their business networks. The limited internal resources of internationalising high-technology SMEs (HTSMEs) in combination with their need for both technical progress and foreign market knowledge development (Yli-Renko et al., 2001) favours the establishment of international networks of firms covering complementary technologies. This lets the firm spread its costs while retaining some control over the new technologies that they develop in the network (Buckley and Casson, 1998). However, a firm that relies on its business network depends on its ability to manage not only the firm but also, as far as 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 of organizational learning (Teece et al., 1997; Doz and Shuen, 1990). Moreover, successfully 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). Research indicates that the network coordination of interdependent firms in a business network is a management capability that can enhance a firm's organizational learning and international performance. Van den Bosch et al. (1999) claim that coordination capability is a type of combinative capability (Kogut and Zander,

1992) that enhances organizational learning in a firm, while Ritter (1999) argues that network relationship management can enhance firm performance. Researchers recognize that network management 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 den Bosch et al., 1999). Furthermore, research has demonstrated that the international entrepreneurial firms that appear to have the most sustainable competitive advantage derive significant benefits from their capability to perform the extensive coordination of multiple organizational activities across national borders (Oviatt and McDougall, 1994, 2005). The present study refers to this management capability as "network coordination capability", defined as "experiential knowledge of how to coordinate the activities of business network partners within and across dyadic business relationships for the purpose of knowledge combining". The study holds that the exceptional internationalisation ability of some successfully internationalising high-technology entrepreneurial firms may result from factors such as their ability to build knowledge by coordinating the activities of network partners that possess complementary knowledge bases.

Manifestations of network coordination capability in the networks of internationalising biotechnology SMEs

We assume that, while each firm has a certain network coordination *capability*, the actual *ability* of management to coordinate the firm's network is expected to depend on the business environment. In the entrepreneurship research field, there is a need for further exploration of the role of environmental factors (Zahra and George, 2002; Fernhaber et al., 2007), so it may be rewarding to study how network coordination capability can be manifested in biotechnology SMEs' customer and supplier networks. Although the literature on network level coordination is limited, research into related areas does offer some direction for research.

Education of network partners

Training and education enhance a firm's coordination capability and organizational learning; these activities indirectly discharge the same functions as do rules and procedures, since they facilitate control, coordination, and knowledge absorption (Van den Bosch et al. 1999). Adding a network management perspective (Ritter, 1999) to this line of reasoning suggests that network coordination capability can be manifested in measures for *(i) the education of network partners*.

In this study, the education of network partners is defined as a focal firm's efforts to educate its customers, customers of customers, and suppliers in areas in which the focal firm is knowledgeable.

Joint decision-making with network partners

The participation of subordinates in decision-making increases knowledge sharing and the absorptive capacity of the firm; similarly, liaison devices regulate mutual adjustments between individuals or units, giving rise to lateral communication and joint decision-making that increase the capacity to process and absorb information (Van den Bosch et al., 1999). This study assumes a network perspective and focuses on relationships between firms, so it may not always be clear what firm in a network assumes the "subordinate" role and whether a relationship is lateral or vertical. Liaison devices and joint decision-making are consequently studied as comprising one factor, and it is suggested that a firm can manifest its network coordination capability through *(ii) joint decision-making with network partners*. In this study, joint decision-making with network partners is limited to decision-making of significance to the focal firm and that relies on input from the firm's network partner(s) to some extent.

Direct interaction between network partners

Hierarchical lines may provide a sufficient means of coordinating external relationships in firms with only limited external cooperation, but hierarchical structure will prove ineffective when external cooperation is more extensive (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 demonstrated that the direct interaction of external parties facilitates coordination (Hillebrand and Biemans, 2003). Network coordination ensures that a firm's network partners know what the other partners are doing. A focal firm's awareness of its network partners' direct connections should increase its ability to draw on these connections for network coordination purposes. From a network management perspective, it is suggested that a firm can manifest its network coordination capability by awareness of *(iii) direct contact between the firm's network partners*. In this study, direct contact between network partners refers to situations in which the focal firm's customers, customers of customers, and suppliers interact and

share knowledge and information without the focal firm acting as an intermediary.

Condensed theoretical line of reasoning

The theoretical reasoning indicates that internationalising HTSMEs depend on their network coordination capability to develop sufficient knowledge to handle a combination of technical challenges and new foreign market adaptations. Moreover, I argue that their network coordination capability can be manifested by:

- (i) Education of network partners
- (ii) Joint decision-making with network partners
- (iii) Awareness of direct contact between network partners

Furthermore, it is expected that the ability of a focal biotechnology SME to coordinate its network partners will be affected by the international biotechnology environment. It may be thus rewarding to empirically investigate the mechanisms in international biotechnology networks that enable or facilitate network coordination by the education of network partners, joint decision-making with network partners, and direct contact between network partners.

Methodology

This paper takes on a multiple-case study approach to investigate how various mechanisms can enable or facilitate network coordination and organizational learning in the networks of biotechnology SMEs. This approach was chosen as I empirically identified a phenomenon for which I found no explanations in the existing literature and therefore saw a need to expand existing theory. Furthermore, I consider it advantageous that multiple-case studies are more deeply grounded in varied empirical evidence (Eisenhardt and Graebner, 2007). Multiple-case studies, moreover, provide a more robust basis for theory building (Yin, 1994) and can yield more generalizable and testable theories than can single-case studies (Eisenhardt and Graebner, 2007).

Case selection

The phenomenon of interest in this study is biotechnology SMEs possessing the seemingly impossible combination of resource-intensive product development and successful internationalization despite limited internal resources. The case firms were chosen to provide strong examples of the phenomenon of interest. In other words, a replication logic rather than a sampling logic (Eisenhardt and Graebner, 2007) guided case selection. In multiple-case studies, it is strongly recommended that cases not be chosen randomly to represent a larger universe; on the contrary, cases should be chosen precisely because similar results are expected from them, so that the cases can provide clear examples of the phenomenon of interest (Eisenhardt and Graebner, 2007). Data on eight firms from an initial sample of 12 were included because little new insight into the studied phenomenon was yielded by the data on the remaining firms, which resembled the data from the other firms. In other words, the saturation point had been reached (Eisenhardt, 1989). All the studied firms are situated in the Stockholm area in Sweden, a location chosen for reasons of proximity and its high concentration of biotechnology firms.

Data collection and analysis

To collect data, semi-structured interviews approximately 60–90 minutes long were conducted at the sampled firms' head offices. Informants included CEOs and managers. Two interviewers, including the present author, were present during the interviews, strengthening the reliability and enhancing confidence in the data (Eisenhardt, 1989). The interviews were recorded, transcribed into text, and thereafter analysed in several iterations. Databases, printed information, and

information from the firms' websites were also collected. In subsequent analysis, I alternated between consulting existing theory and the empirical material. Eventually this led to a stage at which I screened the empirical material for signs of network coordination capability via i) the education of network partners, ii) joint decision-making with network partners, and iii) awareness of direct interactions between network partners. Interview passages and other material capturing this were translated from Swedish to English and entered into a comprehensive table for each firm. These tables formed the basis for the empirical presentation and analysis of the study. Throughout the analysis, I repeatedly alternated between the original data transcriptions, the data tables, and theory.

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

The study was conducted from the perspective of a focal internationalising biotechnology SME. Both the firms and their surrounding network environments were studied from the firm perspective. A disadvantage of such an approach is that one cannot know whether the viewpoint of the studied firms corresponds to that of the network partners. However, an advantage of this approach is that it uses the perspective that likely corresponds to that of management and is therefore the most relevant perspective for managers of internationalising SMEs. Finally, one must also recognize the limitations of viewing the focal SME as a network coordinating node: this view implies that the firm is in control when, in reality, only a limited number of the activities and knowledge-sharing processes can be controlled by one firm. Firms exist in changing environments that cannot be fully controlled. Moreover, knowledge-sharing processes are generally reciprocal and based on "give and take" relationships that cannot be fully controlled by any one partner. However, this study assumes that most firms have *some* power to influence and coordinate their networks.

Empirical Findings

Though each firm is assumed to have a certain network coordination *capability*, it is expected that a firm's actual *ability* to coordinate its network is dependent on environmental factors. The empirical findings indicate that several situations, settings, and processes can serve as network coordination mechanisms by enabling or facilitating the education of network partners, joint decision-making with network partners, and direct interaction with network partners. All the sample firms describe such mechanisms within the biotechnology sector that they may draw on for the purpose of network coordination. Figure 1 outline the network coordination mechanisms identified in the networks of the internationalising biotechnology SMEs in this study. Each mechanism is shortly described and linked to one or several of the three manifestations of network coordination capability. The mechanisms were identified from a large number of quotations from the data, and a few examples of these quotations are presented in the Appendix.

Figure 1 Mechanisms for education, joint decision-making and direct interaction with network partners

Mechanism	Description	Manifestations
Conferences	<i>Conferences, management forums, and industrial fairs aimed at the scientific community</i>	<i>Education Direct contact</i>
Seminars	<i>Customer-aimed seminars, presentations, and lectures with scientific and/or product-oriented content</i>	<i>Education Direct contact</i>
Courses	<i>Customer-aimed courses or workshops arranged by the firm alone or together with a collaborating firm at the head office location or externally: such courses typically last a few days and cover advanced technical and science-related subjects as well as practical training on how to use the product</i>	<i>Education Direct contact</i>
Standards	<i>International committees that set standards and rules for each specific industry</i>	<i>Joint decision making Direct contact</i>
Business	<i>A focal firm's network partners' business connections with each other: for example, a focal firm's supplier may also supply one of the focal firm's customers</i>	<i>Direct contact</i>
Research	<i>Basic research projects in various scientific areas, including medicine, biochemistry, and neuroscience; not directly, though often indirectly, product related</i>	<i>Education Joint decision making Direct contact</i>
Support	<i>Customer-aimed support: either more resource intensive (e.g., when a firm member travels abroad to the customers' location to join a product team for a few weeks) or less resource intensive (e.g., when researchers answer research-related questions by phone or email)</i>	<i>Education</i>
Product	<i>Product development processes aimed at either developing an entirely new product or improving an existing one</i>	<i>Education Joint decision making</i>
Market	<i>Local market-related decision processes, including decisions about legal protection issues and choosing a competent local distributor</i>	<i>Joint decision making</i>
Academia	<i>Universities, research institutions, university hospitals, or other settings where academic professionals meet and collaborate</i>	<i>Direct contact</i>

Several mechanisms for education of customers are apparent in the networks of the sample firms while mechanisms for education of suppliers were few and only were visible in the networks of three of the firms, Cell, Flow and Gene. Mechanisms that render joint decision-making with customers were found in all of the firms' networks except for Digit's network. Most of the mechanisms related to joint decision-making with customers were product-related. Evidence of mechanisms for joint decision-making with suppliers was found in five of the firms and notably four of these explained that they were involved in joint *research processes* with suppliers. All of the sample firms are aware of situations where their customers can have direct contact with each other and in particular, all of the sample firms refer to *conferences* as settings for direct contact between their customers. Only two of the firms are aware of settings where their suppliers can interact and only one of the sample firms, Flow, mention a mechanism for direct contact between one of the firms customers and one of the firms suppliers. Figure 2 shows the mechanisms on which each of the sample firms rely on for manifesting their network coordination capability in the relationships with customers and suppliers.

Figure 2 Mechanisms for network coordination in biotech SMEs relationships with customers and suppliers

Firm	Education of		Joint decision-making with		Direct contact between		
	Customers	Suppliers	Customers	Suppliers	Customers	Suppliers	Customers and suppliers
Air	Seminars Support Conferences		Market Product	Product Research	Academia Seminars Conferences	Product	
Beat	Support		Product		Conferences Academia		
Cell	Support Seminars Courses Conferences	Research	Research Product	Research	Seminars Conferences Courses		
Digit	Support Courses				Conferences Courses		
Exhale	Support Conferences		Product		Conferences		
Flow	Product Market Support	Product	Product Standards	Product	Conferences Standards		Business
Gene	Product Research	Research	Product	Research	Conferences	Research Academia	
Heal	Courses Support		Product	Research	Courses Academia Conferences		

Empirical Analysis

The empirical findings indicate that the networks of internationalising biotech SMEs incorporate several mechanisms for network coordination by (i) the education of network partners, (ii) joint decision-making with network partners, and (iii) direct interaction between network partners. The empirical analysis elaborates on the function of these mechanisms for the knowledge flow in the network, because knowledge sharing is considered central to knowledge combining, organizational learning, and the international growth of biotechnology SMEs.

Education of network partners

Training and education enhance a firm's coordination capability and organizational learning as it facilitates control, coordination, and knowledge absorption (Van den Bosch et al. 1999). Thus, 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

The sampled firms engaged in educating their network partners, especially customers and their customers. Three sampled firms – Cell, Digit, and Heal – educate customers via courses or workshops arranged by the focal firm, either alone or with a partner firm. Customer-aimed courses are offered in various ways, for example, by inviting members of the customer firm to the head office for courses lasting several days. Some courses take the form of laboratory courses for researchers in which the customer representative is invited to the focal firm's head office for several days. In other cases, the firms arrange workshops for customers at foreign universities. The course content includes both directly product-related issues and more general scientific subjects such as biomedicine.

Customer support and backup

The sampled firms – Air, Beat, Cell, Digit, Exhale, Flow, and Heal – all provide customer support that can go beyond product maintenance and delivery, additionally functioning as a means of customer education by helping customers implement and use the products, for example, in complex research projects. The sampled SMEs all provide technically advanced products that

may be difficult to use correctly, even by highly qualified professionals, making competent customer support vital, as explained by the Cell CEO: “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 intensive. It is important that our testing-device function optimally”. One example of less demanding education via customer support was provided by Heal, whose CEO explained that they call their customers to support them in using the firm’s products. An example of more resource-intensive customer support is that of Gene, whose researchers regularly join the customers’ product development teams to support the customers with knowledge, to help them adapt and finalize the basic product developed at Gene. Customer support need not necessarily be product related, as demonstrated by Flow, which supports its customers in local market regulatory 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 trade fairs. International trade fairs in the focal firm’s specific industry or research area give the sampled firms an opportunity to meet, inform, and educate their customers, customers of customers, and potential customers via lectures, product presentations, etc. The data indicate that the firms may meet several customers simultaneously (e.g., when they hold presentations) or one by one. Educating customers at international fairs, conferences, and forums was done by Air, Cell, and Exhale. A manager at Cell CEO, for example, explains that Cell participates in industrial fairs abroad, together with its local distributor on that market, and uses them as opportunities to educate end customers: “We also hold presentations and lectures for end customers”. Similarly, managers from Flow attend international management forums where they interact with managers from customer firms and update them on technology and product developments.

Education of suppliers

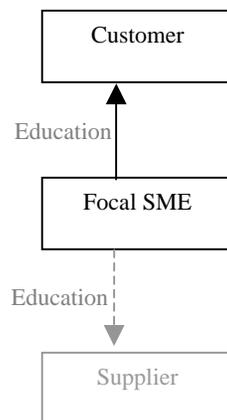
The data provide less evidence that focal HTSMEs educate their suppliers. Cell and Gene collaborate with research institutions that serve as suppliers of basic research ideas in their product development processes. As a part of these arrangements, the firms support the research and education of PhD students and post-doctoral fellows posted at the suppliers, and the firms and research groups learn from each other. This is well described by the Gene CEO: “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 ...”.

Knowledge flow by educating network partners

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

Figure 3 Knowledge flows attributable to the education of network partners



Joint Decision-Making

Participation in decision-making increases knowledge sharing regulate mutual adjustments and facilitate coordination between individuals or units and joint decision-making also increase the capacity to process and absorb information (Van den Bosch et al., 1999). The theoretical reasoning thus suggests that network coordination capability can be manifested through joint decision-making with network partners. The data indicate that product development processes, research processes, local market decision-making, and industry standardization committees all serve as mechanisms for joint decision-making.

Research and product development processes

This study assumes that joint product development and research development processes incorporate joint decision-making to some degree. Joint product development is evident in all sampled firms except Digit. Network partners can serve as a source of product ideas as well as a product-testing forum during product development. For example, Gene states that decisions regarding what product ideas to develop further are made in collaboration with customers, while the Beat CEO explains that their product was: "... developed in close collaboration with cardiologists, nursing staff ...". Input from network partners is valued in various stages of the processes: "In an early stage of the project, we test the concept and obtain feedback so 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 we do that in several different countries and environments to see how they function" (CEO, Air). Cell and Gene exemplify how close interactions with research institutions serving as suppliers are important to some firms: "These contacts [with research institutions] are reliable and convenient when we need someone to evaluate the product so we can discuss it with somebody" (CEO, Cell). Product development can involve joint decision-making with different network partners at different stages of the process, as 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). To ensure the product can be practically useful for end customers, Gene needs to adapt scientific research ideas to the market, and therefore needs a different type of input: "... then we work together with the medical [customer] firms for some time" (CEO, Gene).

Standardization work

Another example of joint decision-making is provided by Flow, where a firm member serves on

an international standardization committee whose work involves joint decision-making regarding new standards and regulations in Flow's business and research area. This committee is deemed influential for the industry, as it sets guidelines and policies for all research in this particular industry and research discipline.

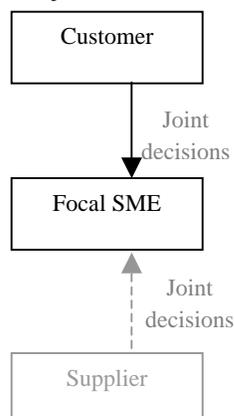
Local market-related decisions

A further example of joint decision-making is provided by Air, which takes information from customers into account in local market-related decision-making: "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 considerable information – which distributors are competent and who we should stay away from" (CEO, Air). The data thus indicate that customers can also become involved in a focal firm's decision-making regarding market issues.

Knowledge flow arising from joint decision-making with network partners

All but one of the sampled firms incorporate customer input in various decision-making processes; the suppliers, however, appear less influential. There appear to be mechanisms that enable or facilitate joint decision-making, primarily with customers in the international networks of biotechnology SMEs. This indicates that network management efforts in the form of network coordination via joint decision-making mainly enhance the downstream flow of knowledge from customers to focal SMEs. Knowledge sharing is a prerequisite for knowledge combining, which in turn renders new knowledge. Network coordination via joint decision-making appears to increase organizational learning, mostly in a biotechnology SME's customer relationships. The knowledge flow attributable to joint decision-making in international biotechnology networks is illustrated in Figure 4.

Figure 4 Knowledge flows attributable to joint decision-making with network partners



Direct Interaction between Network Partners

Network coordination is a management activity performed so as to ensure that a firm's network partners know what the other partners are doing. However, traditional configurations such as hierarchical structures 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 formal structures is direct contact between network partners, as it has been demonstrated that the direct interaction of external parties facilitates coordination (Hillebrand and Biemans, 2003). This study takes a stance in that a focal firm's awareness of its network partners' direct connections should increase the firm's ability to draw on these connections for network coordination purposes. Thus, the theoretical reasoning suggests that a firm's network coordination capability can be manifested by awareness of network partners' connections with each other (without the focal firm as a required mediator). According to the sampled firms, educational events such as courses, conferences, seminars, and workshops as well as academic activities and standardization committees serve as mechanisms for direct interaction between the focal firms' network partners.

Courses, workshops, and seminars

One mechanism for direct interaction between customers is the courses that Cell, Digit, and Heal arrange for their customers. A course arranged by a focal HTSME at its location, where customers from various countries are invited to learn about the firm's products for several days, naturally entails interaction between the customer representatives who attend. Hence, the courses arranged for the customers serve as mechanisms for direct contact between customers of the firm. For example, the respondent at Heal explains: "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 hold discussions with each other" (CEO, Cell).

Academia, Conferences, and Standardization committees

Due to the high-tech nature of the sampled 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 in their areas of expertise; for example, medical doctors work at hospitals and researchers participate in international research projects in which they can interact with each other. Cell's CEO explains that their end customers, mainly researchers at universities, have networks 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. These conferences can be small and specialized, as described by the CEO of Exhale: "... these [conferences] are quite focused on perhaps one group, a medical specialty for example, and several of our customers go there. Other conferences are more general and involve a great many specialists: "One of the larger ones ... incorporates all European medical doctors in the [field], and then they will gather about 15,000 medical doctors ..." (CEO, Air). Another mechanism for direct contact between customers is international standardization project groups in which new industrial standards are developed by specialists in their industry: "... practically all our existing and potential customers are represented there" (CEO, Flow).

Direct interaction between suppliers and between customers and suppliers

The CEO of Gene describes how research settings and academia can provide a mechanism for direct interaction between suppliers who are researchers: "... they go to a university in Germany and rent time in their laboratory. There are few [laboratories] in the world with that capacity. It is a way for them to have a network, and biologists have a lot of networks ...". The only example of a mechanism for direct interaction between the focal firms' customers and their suppliers was found in Flow, which shares suppliers with some customers. In other words, Flow's customers must interact with Flow's suppliers to do business.

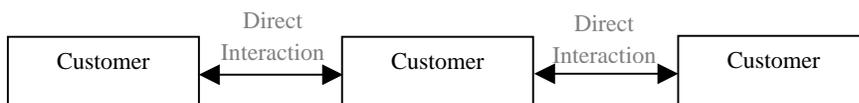
The knowledge flow caused by direct interaction between network partners

It is evident from the data that all sampled firms are aware of various situations in which their customers or customers of customers interact. However, there is only limited evidence of awareness of interaction between *suppliers* and of direct contact between the firms' suppliers and customers. This could be because such relationships are uncommon, or because they are less visible to the interviewed sampled firms. Nevertheless, based on the empirical data, there mostly appear to be mechanisms for direct interaction between customers in the networks of biotechnology SMEs. The fact that customers appear to have contact with each other may be

partially due to the high-technology nature of the sampled firms' business areas, as the mechanisms include educational events (e.g., courses and seminars) and activities in business- and job-related settings (e.g., research projects and hospitals). However, it is also clear that the sampled firms facilitate direct contact between their customers by arranging or contributing to various activities where direct contact between network partners is natural and necessary, 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 are interacting with which other customers, it is more likely to be able to draw on this for network coordination purposes.

The data indicate that all the sampled firms are aware of situations in which their network partners interact. This awareness can be seen as a prerequisite for network management efforts via network coordination in which the focal firm draws on its knowledge of which network partners can interact and share information and knowledge. Thus, the studied biotechnology SMEs appear to act in environments that enable or facilitate direct interaction, mainly between their customers as opposed to their suppliers. Direct interactions between the focal SME's customers enhance the focal SME's ability to coordinate its customers, as it enables or enhances the flow of knowledge between customers. Knowledge sharing is a prerequisite for knowledge combining, which in turn renders new knowledge. Network coordination opportunities stemming from direct interaction between network partners in the biotechnology setting thus mainly appears to increase organizational learning in customers' relationships with each other. The knowledge flows attributable to direct interaction between the network partners of the international biotechnology SMEs is illustrated in Figure 5.

Figure 5 Knowledge flows attributable to direct interaction between network partners

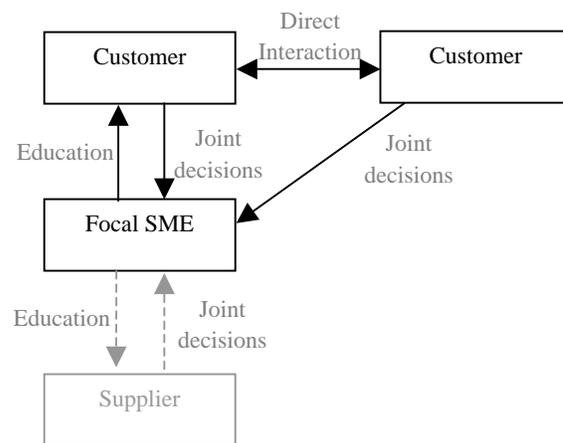


The knowledge flows in the networks of international biotechnology SMEs

The multiple-case study of biotechnology SMEs indicates that network coordination by means of education mainly results in knowledge flow from the focal firms to their customer networks.

Network coordination manifested by joint decision-making 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 customers may allow knowledge to be transferred between them. The knowledge flows to and from suppliers are less visible, and the role of suppliers in knowledge combining in biotechnology networks appears to be secondary. The study identifies a continuous pattern of knowledge flows from the focal firm to its customers, 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 internationalizing biotechnology SMEs



This study demonstrates that there are mechanisms in international biotechnology networks that can enable and facilitate network coordination by means of the education of network partners, joint decision-making with network partners, and direct interaction between network partners. These activities result in knowledge flows mainly in the biotechnology SME's customer network. Knowledge sharing in the network is necessary not only for network coordination but also for knowledge combining of the complementary knowledge bases of network partners. Combining complementary knowledge bases can in turn generate new knowledge which serves as a driver of

the internationalization process. This study thus suggest that a biotechnology SME's ability to draw on mechanisms in the business environment to coordinate network partners that possess complementary knowledge bases affects the organizational learning and international growth of the focal firm and its network partners.

Conclusions, managerial implications, and suggestions for future studies

This study aimed to shed light on how various mechanisms in the business environment can enhance the ability of internationalizing biotech SMEs to coordinate their network partners for the purpose of knowledge combining and organizational learning in the internationalization process. The study reveals that international biotechnology networks include settings, processes, and situations that serve as mechanisms for network coordination by means of the education of network partners, joint decision-making with network partners, and direct interaction between network partners. These activities enable and facilitate knowledge flow in international biotechnology networks mainly comprising the focal firm's customers. Knowledge sharing is a prerequisite for organizational learning by means of knowledge combining and may therefore explain how certain successfully internationalising biotechnology SMEs develop sufficient knowledge to compete on international and knowledge-intensive markets despite limited internal resources.

Managers can benefit from this study as it sheds light on their role as proactive network coordinators and illustrates how the business environment can enhance their ability to coordinate network partners. In the future, it would be interesting to test the present findings on a larger sample and investigate further why customer relationships appear more central than do supplier relationships to organizational learning in international biotechnology networks.

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Appendix: Quotations – some examples from the data

This study investigates mechanisms that can enhance the ability of internationalising biotechnology SMEs' to coordinate network partners for organizational learning purposes. The empirical findings indicate that there are several settings, situations, and processes that serve as network coordination mechanisms in international biotechnology networks, as they enable or facilitate the education of network partners, joint decision-making with network partners, and interaction between network partners. In this paper, the word “mechanisms” is used to refer to various structural components, processes, situations, and settings in the networks of biotechnology SMEs. The following tables present the mechanisms identified in the data and quotations from the interviews that exemplify how the data were interpreted.

Education of customers

Mechanism	Quotation
Conferences	<i>... and as soon as we have any new research findings, we go to these conferences and ... share these findings [with the participants] and talk in seminars. (Cell)</i>
Seminars and presentations	<i>... offers various educational activities and seminars ... 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 for the product, as he will not know how to use it. (Heal)</i> <i>Courses [include] technical training on ... medical technology. ... Our training is especially formulated for medical technical engineers ... (Digit)</i>
Research process	<i>... and at the same time they know that we have competence in an area in which they are not really knowledgeable. And there is an exchange around that. ... It has resulted in their starting 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 to support them. (Exhale)</i>
Product development processes	<i>The customer is not always as knowledgeable as one might think in areas such as mechanics, electronics. On the other hand, about biochemistry and the meaning of molecules and how they work in the human body and things like that, that they know very well, but about how it [i.e., the equipment] interacts with [people] – yes, the man–machine interface and all that – [they] do not know anything most of the time. (Flow)</i>
Local market	<i>... what we offer our customers is the backup, the support ... they can use</i>

decision-making processes	<i>this person in their strategy work in order to take a rational approach to regulatory issues ... and this person can participate in their project, administer that part. (Flow)</i>
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Education of suppliers

Mechanism	Quotation
Research process	<i>We have this “post doc thing”. It is a way 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 travels [to the supplier’s country] and stays there for a few weeks. And he is present when [the first] products [i.e., prototypes] arrive [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 are often several modification loops and then they might have to go there again several times, until it [the production] starts rolling. (Flow)</i>

Joint decision-making with customers

Mechanism	Quotation
Standardization committees	<i>... there are international projects, for example, standardization work, being carried out. When they develop a new worldwide standard, for example for inhalators,... they meet regularly ... (Flow)</i>
Local market issues	<i>Sometimes there are requests from customers/partners about the countries in which we should apply for patent rights. (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 considerable information – which distributors are competent and who we should stay away from.” (Air)</i>

Joint decision-making with suppliers

Mechanism	Quotation
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Research process	<i>We develop the idea behind a [product] and we often do this in collaboration with academics, collaboration partners who come up with ideas based on applied basic research where we can take part in their findings and study them from a more commercial point of view. (Gene)</i>
Product development process	<i>The product specification stage focuses 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, which is why the suppliers need to be part of the project so that they can tell us “This we can produce and this we cannot produce”. (Air)</i>

Direct contact between customers

Mechanism	Quotation
Conferences	<i>... the main contact platform is ... which is that conference ... on 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 gave presentations ... (Exhale)</i>
Courses and workshops	<i>“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)</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 what customers to approach?] [Through] suppliers we share [with customers]... (Flow)</i>

Direct contact between suppliers

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

Direct contact between customers and suppliers

Mechanism	Quotation
Business	<i>[How do you know what customers to approach?] [Through] suppliers we share [with customers]... (Flow)</i>