

Brokerage in SME networks

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ABSTRACT

This study focuses on SME networks of design and high-tech companies in Southeast Netherland. By highlighting the personal networks of members across design and high-tech industries, the study attempts to identify the main brokers in this dynamic environment. In addition, we investigate whether specific characteristics are associated with these brokers. The main contribution of the paper lies in the fact that, in contrast to most other work, it is quantitative and that it focuses on brokers identified in an actual network (based on both suppliers and users of the knowledge infrastructure). Studying the phenomenon of brokerage provides us with clear insights into the concept of brokerage regarding SME networks in different fields. In particular we highlight how third parties contribute to the transfer and development of knowledge. Empirical results show, among others that the most influential brokers are found in the nonprofit and science sector and have a long track record in their branch.

KEYWORDS

Innovation, Networks, Intermediaries, Creative Industries

1. INTRODUCTION

Firms are increasingly facing their own limitations in today's complex and demanding environment (Das and Teng, 2000; Eisenhardt and Schoonhoven, 1996; Duysters and de Man, 2003). The need for cooperation is evident in an environment characterized by uncertainty, complexity and rapid technological progress. (Acs, Carlsson and Thurik, 1996). Especially small and medium-sized enterprises are faced with a dilemma. On the one hand SMEs feel the urge to cooperate with others in order to acquire knowledge and other competencies; on the other hand they often face difficulties in finding partners and often they lack the knowledge base to be able to absorb the required knowledge. This dilemma clearly points to a need for intermediaries in order to deal effectively with the complex environment. Bridging organizations are needed to compensate for weaknesses in the local innovation system (Sapsed et al., 2007). Since intermediaries become more and more important the need arises to provide SMEs insight into what makes them so valuable. This information enables them to decide with what kind of intermediary they should cooperate.

Bridging organizations are gradually gaining attention in SME literature, but there is a clear lack of understanding regarding intermediaries operating within SME networking structures (Klerkx and Leeuwis, 2008). The subject of most network literature is related to the discussion on social capital versus structural holes. New in network literature is the idea of intermediaries whose commercial goal is

to bring heterogeneous parties together and co-develop innovations, and not just exploit the knowledge (Obstfeld, 2005). The few existing studies in this area are based on research focusing on large enterprises. Almost no research has been done within SME networks (Hanna and Walsh, 2002; Pittaway et al., 2004; Shaw, 2006). Although SMEs are believed to provide vital energy and stimulate growth (Schumpeter 1934; Heilbroner, 1984) and recently regain popularity as an important topic in literature and policy-making programs (Shane and Venkataraman, 2000; OECD, 2000; Audretsch and Thurik, 2001; Corbetta et al., 2004), quantitative research on networks in entrepreneurship has been limited to the most rudimentary of network data (Burt, in Sutton and Staw, 2000). In addition the support instruments in programs unfortunately do not increase the interaction between SMEs and knowledge providers from outside the business sector (Kaufmann and Tödtling, 2002). It is unclear how an intermediary successful can bridge gaps or how specific characteristics influence the capacity of brokers.

The main focus of this study is on the SME network of design and high-tech companies in Southeast Netherland. Design is seen as increasingly important in product development and there is an increase in efforts to establish co-operations between design and high-tech organizations. The design sector is a dynamic but highly fragmented industry. By highlighting the personal networks of members across design and high-tech industries, the study attempts to identify the main brokers in this dynamic environment. In addition, we investigate

whether specific characteristics are associated with these brokers. The main contribution of the paper lies in the fact that, in contrast to most other work, it is quantitative and that it focuses on brokers identified in an actual network (based on both suppliers and users of the knowledge infrastructure). Studying the phenomenon of brokerage will provide more insights into the concept of brokerage regarding SME networks in different fields. In particular it will highlight *how* third parties contribute to the transfer and development of knowledge.

The remainder of this paper is structured as follows. In the literature review section we provide a brief overview of the theory and the empirical field in which the research takes place. The main research question will be answered by using sub-questions. These are addressed in section 3 and 4. Next, the methodology used to explore the SME network is described. We will end with the main conclusions and a discussion of the findings.

2. THEORETICAL BACKGROUND

In a world of rapid economic and technological change, organizations increasingly interact with each other (Eisenhardt and Schoonhoven, 1996; Das and Teng, 2000; Hagedoorn, 2002). A complex environment especially affects small innovative firms, because they tend to rely more heavily on technological

developments outside the firm than large firms to obtain new knowledge (Porter, 2000; Hicks and Hedge, 2005). In their effort to survive and overcome resource scarcities SMEs are increasingly looking for competent partners that provide them with complementary assets and resources (Almeida and Kogut, 1997; McEvily and Zaheer, 1999; Hite and Hesterly, 2001; Narula, 2004). However, the complex environment and the limited resources and scanning abilities make it difficult for SMEs to find competent partners.

Another complication is the increasing drive towards specialization. Increased global competition between global alliance blocks leads to an increase in specialization; uncertainty and market fragmentation forces organizations, especially SMEs, to enhance flexibility and search for new ways to differentiate (Acs, Carlsson and Thurik, 1996). Many organizations are forced to specialize in order to make sense of the overload of complex information nowadays. As a result, organizations increasingly have fewer knowledge bases in common and therefore lack a basis on which they can communicate with each other. Due to their technological know-how and cognitive distance (Nooteboom et al., 2007) it becomes more difficult to communicate with companies outside the own industry (Nooteboom, 2000). Again SMEs are affected by this problem in particular. They have more limited time and resources to spend on learning to acquire knowledge (Powell et al., 1996; Syntens, 2000; Narula, 2004; MacGregor, 2004; Lavie and Rosenkopf, 2006). As a reaction, intermediaries have emerged that assist

entrepreneurs in coping with these challenges. However, the question remains: What makes a broker so valuable?

Finding a partner is often associated with uncertainty about both the skills of the potential partner and his reliability (Powell, 1990). Intermediaries claim to reduce this uncertainty by connecting heterogeneous partners in a prosperous way for all parties (Howells, 2006). In the case of the Children's Television Network (CTW), CTW tried to actively link parties in its network. This was done by providing resources where needed, and by facilitating interaction and trust building between the parties (Honig and Lampel, 2000). In the Sectoral Systems of Innovation literature bridging organizations are regarded as organizations that compensate for weaknesses, such as the absence of domestic suppliers of key technologies, in the local innovation system (Sapsed et al. 2007). This literature points to the need for a better understanding of the structures and boundaries of the sector i.e. the agents and their interactions (Malerba, 2002).

In network literature opinions regarding intermediaries stem from the concept of social capital¹ which includes two arguments: closure (Coleman, 1988; Walker et al., 1997) and structural holes (Burt, 1992; Walker et al., 1997). Structural holes are gaps of value in the social structure between groups of people or organizations (Burt, 2005). Brokers span these holes and consequently are able to improve information flows between actors. Closure emphasizes in-depth

¹ Social capital is seen as the value that arises from the way a person is tied to others.

exchange of information within a group of highly connected people. In the past the debate was about what form of social capital should be emphasized in network design. However research of Ahuja (2000) illustrates that actors' strategic goals play an important factor in determining what type of social capital is most favorable. Related research suggests that both forms of social capital have to be present within networks, because firms want to efficiently absorb knowledge as well as create novelty (Gilsing et al., 2008; March 1991). Closure is needed in order to fully grasp the value created by brokering activities (Burt, 2005). The *tertius iungens* (those who unite) orientation described by Obstfeld (2005) is a network theory that is in line with the idea that bridging and bonding activities are entangled. This approach discusses the role of companies that join alliances with the intention to co-develop expected network opportunities. They connect individuals in one's social network by either introducing disconnected people or by facilitating new coordination between connected individuals. Those companies purposely search for a role as integrator (Winch and Courtney, 2007). The *tertius iungens* orientation emphasizes that being a broker is not about either spanning the structural holes or being highly connected, but about building bridges and being highly involved in the cooperation initiated.

The discussion regarding brokers has changed from whether or not brokerage is (more) valuable to *how* structural holes are being spanned. A quote from Hargadon and Sutton (1997: 745) describes clearly the contribution of such research to network theory:

“The network perspective treats network actors largely as conduits that pass along unchanged ideas and resources to others. Little attention is devoted to how or why those ideas and resources are transformed and combined into new solutions for other actors and subgroups.”

In the context of SMEs, the importance of third parties in building interfaces and developing knowledge is acknowledged in innovation and SME literature (Major and Cordey-Hayes, 2000; Kaufmann and Tödtling, 2002; Sapsed et al. 2007). However, almost no research has been done within SME networks (Burt, in Sutton and Staw, 2000; Hanna and Walsh, 2002; Pittaway et al., 2004; Shaw, 2006; Klerkx and Leeuwis, 2008). It is well known that the few resources of SMEs make it necessary to work with others. Network partners have proved to be a main source of information about potential partners (Duysters and de Man, 2003; Hoang and Antoncic, 2003). Research on SMEs has come to the conclusion that the above described perspectives are not mutually exclusive. However, there are mixed results on how to reach a balance between the two forms of social capital (Hoang and Antoncic, 2003). Very little network research examines the role of third parties. How brokerage activities are successfully put into practice clearly needs further investigation.

Can the ways be described in which brokers span structural holes? According to Howells (2006) brokering is more than information gathering, exchange and linking functions. Intermediaries can provide a much wider, more varied and holistic role for their clients in the innovation process than has generally been acknowledged. The way brokerage activities are put into practice is likely to be

dependent on what actors seek to enable (just like the form taken by social capital is dependent on what actors seek). The personal goals and interests of brokers influence brokerage behavior (Gould and Fernandez, 1989; Täube, 2004). These goals & interests seem in turn to be based on actors' structural environment, kinds of relations, kind of information and personal characteristics (Burt, 2005).

2.1 Concepts of brokers

A number of authors have described brokers or intermediaries, however only two concepts have been operationalized in more detail. Burt's structural holes theory (1992) argues that people exchange information at the dyad, triad and cluster level in networks. Depending on the point of view, structural holes can be found in almost every task and thus every actor faces brokerage opportunities in some way. Many studies have looked at the centrality of an actor in a network.

However fulfilling a central position does not provide information about how a broker behaves. The concept of Gould and Fernandez (1989) generates more insight into brokerage behavior. Their concept of brokerage roles describes brokerage behavior as the facilitation of information flows whether or not a direct reward is involved. They argue that the various interests of actors will affect the way they seize the brokerage opportunities. For example, different knowledge will flow between people of the same department than between people of different departments. Accordingly people will behave differently. They argue that

“Actors in a social structure are differentiated with regard to activities or interests, so that exchanges between some actors differ in meaning from exchanges between other actors.” Gould and Fernandez (1989) have formalized the concept regarding brokerage behavior and operationalized it. Their theory recognizes five different types of brokers.

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- Coordinator: enhances interaction between members of the group he belongs to
 - Gatekeeper: absorbs knowledge from a group and passes it to the group he belongs to
 - Representative: diffuses knowledge of the own group to another group
 - Cosmopolitan (Itinerant): mediates as an outsider between members of the same group
 - Liaison: enhances as an outsider interaction between different groups

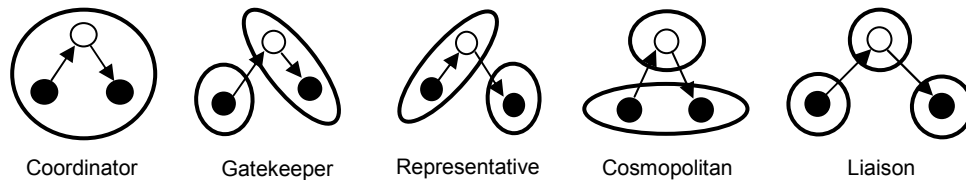


Figure 1 Graphic presentation of the five types of brokerage. Open points represent the brokers

An actor in a network can perform several of these roles. On the one hand the actor can be a gatekeeper for the group he belongs to; on the other hand the actor can function as a liaison that passes along information to a cluster of people he does not belong to. This concept points to brokers in networks and

also describes what types of brokers are present in a network. It provides information about the mixture of relations in a network. A lack of certain roles in a network tells us something about the flow and transformation of knowledge in the field.

2.2 Characteristics of Brokers

Being a broker will not appeal to everyone. Seeing and creating brokerage opportunities successfully seems to be depended on characteristics of people and their surroundings; affiliation, kinds of relations and kinds of information they receive (Gould and Fernandez, 1989; Brüderl, Preisendörfer, Ziegler, 1992; Ritter and Gemünden, 2003; Burt, 2005)². To what extend do these characteristics relate to brokers' capacity?

2.2.1 Affiliation

The affiliation of people can affect a person's interests. Origins in profit, non-profit and science organizations will influence behavior of people and consequently their personal network. Different kinds of people build different kinds of networks (Powell et al., 2005). The sector in which an actor is operating can influence the broker opportunity they face (Sapsed et al., 2007). It would be interesting to investigate whether individuals in the so called triple helix spheres (Etzkowitz and Leydesdorff, 2000) indeed face other broker opportunities, since the business

² Personal characteristics can also be of influence on broker opportunity (Brüderl et al., 1992; Kakati, 2003). However this is not an issue in this paper.

community, knowledge institutions and government are a focal point of EU and national knowledge stimulation programs (EC, 2006).

Nonprofit organizations provide collective support services to firms in the region. As intermediaries, regional (semi-)government agencies and nonprofit discussion platforms facilitate the acquisition of competitive capabilities by compiling and disseminating knowledge and by reducing search costs (McEvily and Zaheer, 1999). Research of Van der Meulen and Rip (1998) shows that especially in The Netherlands there is a dense intermediary layer of network linkages between the institutions, committees, councils and programming bodies at the strategic research level which focuses on advising on science policy and also on the implementation of new initiatives in order to obtain 'relevant science'. The government has moved to a role of enabling and stimulating contacts, instead of also executing science.

Universities and research institutes are more focused on executing science. However despite pressures put on them by other sectors to be relevant, they are still often guided by their own interests (Van der Meulen and Rip, 1998). They are important entities that can play a crucial role in innovation in increasingly knowledge-based societies (Etzkowitz and Leydesdorff, 2000). They indirectly transfer knowledge via the publication of research results, graduates or technology transfer offices, especially to SMEs in the high-tech sector (Drejer and Jørgensen, 2005, Hoppe and Ozdenoren, 2005; de Jong, 2006).

Furthermore they can function as a neutral and trustworthy partner to profit organizations (Boulding et al., 1997; Winch and Courtney, 2007).

The third grouping of the triple helix is the profit sector. SMEs are used to work with various partners. Maybe they work unconsciously as brokers? Research regarding public-private collaboration (Drejer and Jørgensen, 2005; Medda et al., 2006; de Jong, 2006) shows that information from universities or government laboratories are not seen to be decisive for the innovation process. On the contrary suppliers of materials and components are assessed to be at least moderately significant sources of information. Thus, although the non-profit organizations and universities research institutions do play a role in the knowledge development processes in innovative firms; this role is not as significant as those played by e.g. supplier firms, customers and even competitors. It is in line with the idea that exploiting inventions takes place in more closely related, homogenous groups (March, 1991). Assumed is that public-private collaborations become more critical when there is high uncertainty regarding new technology. However this is not true for collaborations in the biotechnology industry. Actors prefer to have various connections to diverse partners (Powell et al., 2005; Baum, Calabrese and Silverman, 2000).

2.2.2. Kind of Partner

Not only do different kinds of people build different kind of networks, the kind of relations people have with others can also influence their network. A wide range

of studies have highlighted potential contributions of partners to a company's innovation efforts and the positive impact of technological interweavement on a firm's innovation success (Powell et al., 1996; Keizer et al., 2002; Hagedoorn, 2002; de Man and Duysters, 2005). Customers, consultants, co-suppliers, administration, suppliers, researchers & trainers, competitors and distributors, all contribute in different ways to their partners (Gemünden et al., 1996). An organization can fulfill many of these partner roles; they can be a supplier to a company, but also a customer to another. Do brokers have specific preference regarding partners? The partner's role may affect the broker opportunities they face. The relations with researchers and administrators seem to be more enabling regarding innovation efforts (Keizer et al., 2002). Customers (and co-suppliers) are seen as closely related partners with whom knowledge is mainly exploited. In addition to more formal business relations, people in organizations also have important informal, personal partners with whom they exchange work-related information. A former boss or a colleague of another company can provide relevant information (Cross, Borgatti and Parker, 2002). Personal relations in business are difficult to separate from formal relations. The two are clearly intertwined. Not much research makes a distinction among these different kinds of relations, but it provides an interesting venue to explore in network analysis (Burt, 2005 pg. 50).

Again several kinds of relations can relate positively to broker opportunity depending on what is considered important by the respondent. This is in line with

the opinion that brokers can full their brokerage role in many ways (Gould and Fernandez, 1989; Howells, 2006).

2.2.3. Kind of Information

People that broker connections between others tend to possess certain kind of knowledge to fulfill this position successfully. What exactly is being brokered, the characteristic of the information itself can also be a factor of influence which distinguishes a broker from a non-broker. Even though a broker may be situated within certain sector and interacts with certain partners, the kind of information they exchange with others may not always be the same. Do brokers merely focus on coordinating information, or is there room for exchange of in-depth knowledge? As described above, besides being coordinators of spanning activities, brokers can also be the producers of extra value (Howells, 2006; Obstfeld, 2005). Several studies have identified criteria that relate to entrepreneurship and successful business in a high-tech environment (Chen et al., 1998; Kakati, 2003; Ritter and Gemünden, 2003; de Jong, 2006; Zahra et al., 2007; Sawers, 2008). Marketing, innovation, management and finance are areas in which entrepreneurial persons need to have skills. Knowledge of these areas is a precondition to succeed in business. If any of these areas are not developed enough, the gap can be covered by a broker (Papagiannidis and Li, 2005).

Besides the more resource-based information, entrepreneurial persons also need to manage network relationships. Initiation information, operational information, personal information and relationship-specific expertise are needed in order to

manage a single relationship (Ritter and Gemünden, 2003). It is unclear what kind of knowledge is valued most in relations with brokers.

Empirical research will enhance our current knowledge about the existence and types of brokers present in various fields of industries. The investigation of brokers requires foremost insights into connectivity of an actual network. A construction of an actual network provides information about who has brokerage opportunities and thus who can be identified as the most successful broker. Detailed information about broker characteristics in relation to broker opportunities will provide insights into the involvement of brokers in building social capital in a network. Ambiguity about how brokerage activities are successfully put into practice can be diminished.

3 RESEARCH DESIGN

3.1 Research setting

This paper will study a network of SMEs in the design and high-tech industry³.

We will look into inter-firm relations of so-called transitory alliances; direct relations between two and three actors. We define a transitory alliance as a

³ High-tech industries in the Southeast Netherlands consist of medical technology, high tech systems, automotive, nano & microsystems, ICT and the field of design & technology and new materials. The area is an important driver for the Dutch economy, contributing 15% of gross domestic product, 30% of industrial employment and almost 40% of the added value of total Dutch manufacturing industry (Sisttermans, 2005).

particularly short-lived non-equity alliance that focuses on completing narrowly defined tasks in a very short time frame. These kinds of inter-firm relations are established in dynamic industries because equity-based alliances do not deal effectively with turbulent environments (Duysters and de Man, 2003).

The design and high-tech industries are particularly dynamic environments. These sectors also become more and more important in modern economy (Jacobs, 2005). Recent government studies in the Netherlands and Great Britain emphasize the importance of the creative industries⁴ of which the design sector is a part. It is a sector which shows the necessity to cooperate in order to develop meaningful products. The creative industry is known for its short product cycles, risky projects and fast changes in production processes. Its social network is built on the principles of collaboration, participation, exploration and exploitation (Hartley, 2005). Actors are found to function as knowledge or technology brokers (Vanchan and MacPherson, 2008). Furthermore it is a sector which mainly consists of SMEs.

Over the past years design has become increasingly important for high-tech products. The Southeast Netherlands is a top technology region in Europe which also shows a concentration of design firms. Design is increasingly seen as

⁴ The creative industries are a wide-ranging industry including:

- Art & heritage sector: plastic arts, stage arts, museums, cultural festivals
- Media and entertainment: television, radio, publishing, film, music industry, popular festivals
- Creative business services: fashion, design, games, architecture, advertising.

Creative activities are defined as innovative activities that create value by adding a meaning, identity or experience to products or services (Innovatieplatform, 2005; DCMS, 2001).

'business creator'; involved in developing and exploiting new ideas. Designers in this region are often asked to join firms at a very early stage of the innovation process (TNO, 2005).

The region itself has a high concentration of elite knowledge and cooperation between wide varieties of organizations: SMEs, Educational institutions, University research institutes, large-scale industry and other knowledge institutions (Sisternans, 2005). The Southeast Netherlands will therefore be the starting point of our research.

3.2 Methodology

To get a closer insight into brokers and their characteristics an empirical study was conducted. A questionnaire was constructed to map the most important work relations between people who are active in the fields of design and/or technology. Respondents were asked to mention the names and organizations of at most ten of their Dutch business partners who had an important (qualitative) influence on their business performance over the last five year. Partners who were most important to their business results during the last five years had to be put at the top of the listing. The limitation of five years was added to get insights in the present state of affairs since the industries are dynamic environments. Only Dutch partners are considered because the network would get too wide

spread and fragmented. Besides the study's interest primarily focused on the area of Southeast Netherlands.

The respondents had to specify the role of the partner and the kind of influence of the partner on their business performance. In order to take into account the full richness of relations in the network the respondent had to identify who was important to them in what way. It was not possible to identify upfront who is involved in what way in the network. Also by limiting respondents we may have excluded important relations. Network analysts work around definitions by asking people to define their own relationships (Burt, 2005 pg. 25)⁵. By taking this approach we pinpoint what the actors in the field consider important. The information enables us to construct our dependent variable *brokerage*. The extra information about organization names and the content of relations enabled us to construct independent variables concerning broker characteristics. The independent variable sector was constructed by considering the organizations in which actors work. The answers of respondents regarding the role (Gemünden et al., 1996) and influence of partners (Chen et al., 1998; Ritter and Gemünden, 2003; Papagiannidis and Li, 2005) were categorized by using an expert panel. We extended the model of Gemünden et al. (1996) by making an additional category, that of informal discussion partner. Control variables are gender,

⁵ Analyst's distinctions of relations can differ from distinctions in the study populations (Burt, 2005).

education level and working years in branch⁶. Table 1 lists and describes all variables.

Table 1 Description of the Variables

Type	Variable	Description
Dependent (count variable)	brokerage	Brokerage roles; Times a brokerage position is occupied
control	gender	Male or Female
control	education	Professional education (MBO, Applied Science University) or (Post-) University
control (dummy variables)	years branch 1	0 - 10 year
	years branch 2	10 - 20 year
	years branch 3	more than 20 years
independent (dummy variables)	nonprofit	Public institutions, committees, councils and programming bodies, public research institutes
	science	Universities, applied science universities
	profit	Profit-oriented organizations
independent (count variables)	customer	Defining new requirement, solving problems of implementation and market acceptance, reference function
	consultant	Advise regarding the product development process, innovative concepts
	co-supplier	Co-producer at strategic en/or operational level. Supplier of complementary knowledge
	non-profit consultant	Administration; advise regarding subsidies, regulations, political support
	supplier	Producer of means of production
	knowledge supplier	Research and training institutes

⁶ Age was left out as control variable. It showed a high correlation with the variable branch years.

	competitor	Joint basic research, establishing standards, getting subsidies
	distributor	Dealers; Market en competitor information
	informal	Informal discussion partner, informal contacts, producers of network information, reference function
independent (count variables)	innovation	In-depth product-related knowledge
	finance	Information on finance-related issues
	marketing	Information on market dynamics, customers and marketing
	management	Information on strategy, structure and culture
	network	Initiation information, network contact knowledge in order to be able to start relations
	operation	Coordination information in order to tune with each other
	person	Personal needs, requirements and preferences to establish social bonds

The survey was initially sent to a selected group of people involved in design as well as in technology; owner/managers of small profit firms. The respondents were asked to provide the names of business partners with whom they have the aforementioned relationship. E-mail addresses of people listed or organization names were asked for. In the case e-mail addresses were missing, a search for e-mail addresses was performed on the internet or inquiries were made. Everybody who was listed in the response also received an invitation to fill in the survey. Several waves have been set in motion to collect data. This snow ball technique⁷ is developed to identify hidden members and relation patterns (Hanneman and Riddle, 2005). In case of the design and high-tech industries,

⁷ The snowballing technique is developed to identify hidden members and relation patterns (Hanneman and Riddle, 2005). Especially designers are a rather hidden population. Some work in firms, some work as part-time freelancer, some have their own firms.

especially designers are a rather hidden population. Some work in firms, some work as part-time freelancer, some have their own firms. This technique was a useful way to get a clearer picture of their network and relations.

We started spreading the questionnaire in January 2007. The results enabled us to construct the network between design en high-tech industries in July 29th 2007. At this point there were 468 names in the database. 405 persons received an invitation to participate⁸. A social network was constructed based on the names and corresponding relations mentioned by these respondents. The results reported in this paper are based on the main component of the network which includes 440 names and 584 relations mentioned by 93 respondents. We focus on the group of 93 respondents.

Social network analysis is used to draw the actual network and calculate the brokerage measures as proposed by Gould & Fernandez (1989)⁹ to detect brokers and brokerage roles¹⁰. The network had to be partitioned into three

8 63 Names were mentioned in the last wave and have not been mailed yet, 16 e-mail addresses were not available for the remaining persons, 16 people were mailed in the zero-wave, but wished not to participate. 104 Useful responses were obtained (25,7% of the invited people).

9 Brokerage occurs when, in a triad of nodes A, B and C, A has a tie to B, and B has a tie to C, but A has no tie to C. That is, A needs B to reach C, and B is therefore a broker. When A, B, and C may belong to different groups, 5 kinds of brokerage are possible. Since we are interested in ego's relations and not in group relations the unweighted approach was used when generating the brokerage roles (Borgatti, S.P., Everett, M.G. and Freeman, L.C., 2002; Hanneman and Riddle, 2005). Weighted (partial) brokerage scores show the degree to which an actor actually controls brokerage relations, the unweighed scores show the number of relations an actor is capable of mediating (Gould and Fernandez, 1989). As in Burt (2005) we work with a working definition of structural hole. There is no absolute meaning of the concept.

10 The ranking information could not be used, unfortunately, to distinguish the most successful brokers. The program saves data as a valued network to which it assigns tie strengths, based on the ordering. To calculate brokerage scores binary information was needed.

groups; i.e. profit, non-profit and science. The knowledge flows between these groups are most interesting to us since these groups are the focal point of EU and national knowledge stimulating programs (EC, 2006). Every actor can act as broker in relations among the groups. *Individual raw brokerage scores* provide information about the type of brokerage and the specific roles a person performs in the network. The sum of all the individual raw scores, the *overall raw brokerage level*, indicates the individual's total capacity for brokerage (Gould and Fernandez, 1989)¹¹. The latter measure is used in our research to construct the dependent variable brokerage. The counts indicate which person has the most brokerage opportunities, and thus, in our research, who is the most important broker in the field. The sum of all the overall scores, the *global raw brokerage level*, provides information about brokerage in general in the network between high-tech and design industries.

There are other measures to detect brokers, but they focus on centrality positions and do not take into account differences in actors' interests. A broker adds value by brokering connections between the clusters and creates opportunities to improve, heterogeneous, information flows. Consequently a broker must be a person that has connections that others do not have and connections which provide the actor with non-redundant information¹². The literature has come up

11 Occupancy of brokerage position is a necessary, but not sufficient condition for actual brokerage behavior (Burt, 2005; Gould and Fernandez, 1989).

12 Two signs of redundancy are cohesion and equivalence. Contacts that are strongly joined to one another are more likely to have redundant (homogeneous) information as are contacts that are positioned similarly in structure (Burt, in Lin et al., 2001).

with specific measures of brokerage: network constraint and betweenness centrality. Network constraint measures the extent to which a person's network time and energy is concentrated in one contact. A high constraint index score¹³ means that such a person's network contains few structural holes and thus faces limited brokerage opportunities (Burt, 1992). Network constraint is closely related to effective size, which measures the number of non-redundant contacts in a network. Borgatti (1997) showed that this redundancy measure, in turn, is highly correlated with degree centrality which measures the amount of direct ties a focal organization has relative to others in the network¹⁴. The latter is reason not to use network constraint in this paper. We are not looking for organizations which are in the thick of things. Betweenness centrality measures the extent to which a person brokers indirect connections between all other people in a network. In network terminology, it calculates the centrality of actors based on the frequency in which they are positioned between others on the shortest geodesic path. Central actors are in a position to control information flows (Wasserman and Faust, 1994). It is one of the most successful measures of centrality (Everett and Borgatti, 2005). However fulfilling a central position within the network does not provide information about a person's behavior. Although a person is positioned at the crossroads of a network, the way the actor bridges gaps will depend on its own background and with whom the actor has a relationship.

13 A person's network constraint score is based on three ways that networks can be closed to brokerage: too few contacts (size), contacts too interconnected (density) or contacts too strongly connected indirectly through a central person (hierarchy) (Burt, 2005). The constraint measure is part of the structural hole computation which is composed of effective size, efficiency, constraint and hierarchy (for extended discussion, see Burt, 1992).

14 A reason for the high correlation can be that Burt was looking for a measure of network diversity when the basic measure of such diversity is simply the number of direct ties in a network; the degree centrality.

The dependent variable, raw brokerage scores, takes on only whole number values. Researchers often use Poisson regression to analyze such count data. However our data shows overdispersion - the variance is greater than the mean. There is dependence between events (in this case total brokerages role counts) and the mean and variance of the observed distribution are thus not equal. Negative binomial regression explicitly accommodates this overdispersion. According to this method individuals have a constant, but unequal probability of experiencing an event; brokerage capacity (Cameron and Trivedi, 1986; Fleming, 2001). Instead of using the expected mean (λt), like poisson models, it replaces the mean with a random variable. This replacement allows the predicted mean to vary randomly according to a probability law; distribution of the error term. The probability of the observed count of a person becomes conditional on the error distribution (Fleming, 2001). In this way inter-person heterogeneity is allowed for.

4 RESULTS

4.1 Brokerage in the network between design en high-tech industries

Investigations of the degree to which actors actually are capable of mediating brokerage relations in the actual SME network do show powerful brokers.

Almost every respondent has the capacity to broker. However the overall raw brokerage scores of respondents can be compared with random expected scores. It enables us to comprehend which brokers and types of brokerage roles are important¹⁵. Despite the fact that the network does not have a high density and that there are many cases where the expected random number of relations is small, the identified brokers all differ greatly from what would be expected by chance. There is a large deviation between the expected values and the actual scores, indicating that our data is interesting¹⁶.

To describe what kind of brokerage is important in the field the global raw brokerage scores are standardized. Table 2 shows the values. The significant values of gatekeepers and representatives suggest that actors in the system emphasize redundancy when searching for gatekeepers and representatives. In other words, organizations in the network tend to avoid depending on a few main brokers when they attempt to absorb knowledge from another group and when they use members of their group to communicate with other groups. The former is in line with the results of Cowan et al. (2007) who argue that a firm has a larger number of credible potential partners because it can gather reliable information about more firms. The significant value of liaisons suggests that there is close

15 Computer routines for calculating the expected values were requested from R. Fernandez. They matched Ucinet calculations almost completely.

16 Brokerage scores are highly related to ego-betweenness scores. Everett and Borgatti (2005) point out that ego-betweenness gives a good approximation to betweenness of an actor in the *whole* network if there are highly differentiated betweenness scores. Since this network shows small world properties this network falls in the category of networks with highly differentiated betweenness scores. In other words, also ego-betweenness scores show that it is highly likely that the person's who have high brokerage scores are important in the actual network.

collaboration between the three groups. The significant positive value for the total raw global measure implies that actors in the system have sufficient capacity to broker relations.

Table 2 standardized global raw brokerage scores

	Coordinator	Representative	Gatekeeper	Cosmopolitan	Liaison	Total
Scores β	-0,593	3,987***	5,019***	1,055	3,056**	3,087**

**p<0.01

***p<0.001

A lack of roles in a network tells us something about the flow and transformation of knowledge in the field. Coordinator and cosmopolitan roles are trivial. Few individuals broker the information within a group. This may indicate that most actors organize their own network relations. Limited mediation of an outsider between members of the same group indicates that possible problems are handled within the group. No outsiders are needed to exploit information.

This information provides insights about the mixture of relations in a SME network. It provides a relevant description of general broker characteristics in this field. The question remains if specific attributes are associated with the main brokers.

4.2 Characteristics of Brokerage

Table 3 presents estimates for the negative binomial regression models of overall raw brokerage counts. Model 1 estimates a model of controls only, model 2 includes all variables and model 3 adds only substantive variable to the baseline model.

Checking for multicollinearity, the first step in analyzing data, indicated no extreme correlations between the independent variables except, as expected, between the profit and nonprofit dummy variables. The nonprofit and science dummy variable show the least correlation and are therefore included in the model. Furthermore relations with competitors and distributors were not mentioned by respondents as most important work relations. Therefore no variables could be constructed for these partner roles.

Model 1 is constructed to identify the influence of the control variables on the dependent variable. A log-likelihood ratio test shows that the control variables significantly improve the constant-only model. The test compares the fit of more complete and restricted models to determine whether the inclusion of variables of interest improves the prediction of the dependent variable. However the control variables do not improve the prediction of the dependent variable largely. The

calculation of the adjusted pseudo R^2 (Hoetker, 2007) shows it is an improvement of just 1,7%¹⁷.

Table 3 Negative Binomial Models of Overall Raw Brokerage Counts

	Model 1 controls		Model 2 all variables		Model 3 substantives	
Variable	Coef.	P> z 	Coef.	P> z 	Coef.	P> z
gender	-.012175	0.966	-.148024	0.501	-.086658	0.650
education	-.262290	0.196	.182856	0.262	.118291	0.439
years branch 1						
years branch 2	.091633	0.719	.211207	0.232	.167240	0.334
years branch 3	.64228	0.007**	.437421	0.013*	.513333	0.001**
nonprofit			.313062	0.078a	.3007	0.074a
science			.439013	0.042*	.390485	0.067a
profit						
customer			-.011546	0.905		
consultant			.011149	0.901		
co-supplier			.05079	0.616		
non-profit consultant			.14370	0.134	.16165	0.027*
supplier			.056896	0.597		
knowledge supplier			.073144	0.559		
competitor						
distributor						
informal			.036113	0.712		
innovation			.15467	0.087a	.171449	0.000***
finance			.264938	0.075a	.283848	0.020*
marketing			.161982	0.152	.204037	0.023*
management			.046477	0.640		
network			.311864	0.000***	.31068	0.000***
operation			.104587	0.311	.1391732	0.003**
person			-.151356	0.461		
constant	2.13355	0.000***	.364912	0.126	.489483	0.021*

17 Calculations were made with STATA. The program calculates a McFadden's pseudo- R^2 ; an equivalent goodness-of-fit measure to R^2 in OLS. Since it is a pseudo statistic it should interpreted with caution. To avoid an overly optimistic sense of the models' fit, the adjusted pseudo- R^2 was calculated alternatively.

log likelihood	-309.541	-247.801	-250.248
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a $p < 0.1$

* $p < 0.05$

** $p < 0.01$

*** $p < 0.001$

By taking model 1 as the baseline model in further calculations, log-likelihood ratio tests of the models 2 and 3 shows that both significantly increase the explanatory power of model 1 at the p-value of 0.001. A comparison of the log-likelihood of model 2 and 3 also demonstrates that model 2 clearly contains variables of no influence. Besides we have to be cautious in putting too many variables in the model regarding the amount of observations. A model with substantive variables only improves, in this case, the prediction of the dependent variable best. To construct model 3, log-likelihood ratio tests are performed each time a variable was included until none of the variables left improved the model significantly at the p-value of 0.05. The adjusted pseudo R^2 shows an improvement of model 3 by 16,58%.

Turning back to the results: Brokers seem to be present in the nonprofit and science sector. Both sectors have a positive, but moderate significant coefficient estimate. (The opposite is true for the profit sector which is moderate significantly, negatively related to being a broker.) The work of Van der Meulen and Rip (1998) points out that the main task of intermediaries in The Netherlands is to identify directions for programming 'relevant research' and thus linking basic science to socio-economic objectives. In other words, nonprofit organizations are

intermediaries between the science sector and profit sector. This observation is in line with our results. However individuals in the science sector also seem to have (moderate) brokerage capacity. Apparently those who are actually performing research are also at the crossroads of the network. It is important to be perceived as independent and objective in a brokerage role (Winch and Courtney, 2007). SMEs that want to engage in novel organizational forms have to discover opportunities, secure resources and organize legitimacy in order to survive and perform (Baum et al., 2000; Elfring and Hulsink, 2003). A nonprofit and science actor can provide cognitive and socio-political support (Aldrich and Fiol, 1994) especially when novelty is high. They can be perceived as key stakeholders in their field, besides a handful of big profit organizations, who know about accepted rules and standards. Finally there is a trend towards scientific collaboration in contemporary science; big science. Large scale research in life sciences is set up among various countries involving huge amounts of money and asking for careful planning and coordination. Scientists in this field have to play new roles and have to engage in discussions with managers, politicians and policy makers (Vermeulen, 2009). The stimulation of research activities by the EU is in line of this trend. Affiliation indeed influences behavior of people and consequently their personal network.

The results indicate that high capacity brokers get information via nonprofit consultants. Brokers in the nonprofit sector have important relations with others in their own surroundings. It is an indication of the strength of the nonprofit sector

regarding brokerage activities. The other kinds of partner variables only improve the model marginally. Although brokers indeed interact with various partners (Gould and Fernandez, 1989; Powell et al., 2005; Howells, 2006), no other partner roles significantly relate to being a broker.

The kinds of information variables show a different pattern. Innovation, network, operation, marketing and finance are significantly positively related with being a broker. Brokers have in-depth technical information and possess information on how to finance and market ideas. It seems that they are also operationally involved in brokerage activities. Furthermore they have valuable network information; they know people who might be of importance to others. The results are in line with Howells (2006) who argues that brokers fulfill many brokerage roles and thus also discuss a variety of information with relations. Totterman and Sten (2005) argue in particular that finance related initiatives are not the key aspect of support toward new companies. Focus should possibly be on the development of business networks. The results affirm that being positioned at the crossroads of a network has the advantage of occupying a wider diversity of information (Burt, in Lin et al., 2001). Results regarding brokerage roles show that brokers perform as representatives, gatekeepers and liaisons. They provide information, filter information and inform various others more than they coordinate information among insiders. These results also indicate that brokers must have a more varied set of information present. The outcome regarding the kind of information shows that information on various topics is of equal importance

to actors in the field and therefore discussed altogether with intermediaries in order to reduce uncertainty.

In all the models experience in the branch is significantly important. Apparently it takes time to become a stakeholder in a sector (and branch) and gain relevant information on various topics. Although we asked respondents to mention who is an important business partner the last 5 years, the results indicate that those who have high brokerage capacity have been involved in the branch for more than 20 years. The main brokers must have been involved in various projects, as a direct business partner or indirect, in this field at least a decade.

5 CONCLUSIONS

This paper investigated the existence of main brokers in the network across design and high-tech industries and modeled the relationship between a person's brokerage capacity and its characteristics. Since the world surrounding organizations becomes more and more complex, organizations will have to rely more on brokers to access external knowledge. Many companies find that they do not possess the necessary (scientific) resources to cope with additional burdens and seek external support to overcome their own cognitive and technical limitations. It is argued that the most successful brokers must have specific characteristics that enable them to transfer and development knowledge in an

optimal way. The paper highlights individual's affiliation, kind of partner and kind of partner information as sources of brokerage capacity influence.

Empirical results show that the most influential brokers are found in the nonprofit and science sector and have a long track record in their branch. It seems that discussing finance is not sufficient. Actors in the field foremost would like to discuss practical support in the form of valuable contacts and innovation-related information with intermediaries. However, finance, marketing and operational information is also discussed with them. The results show what specific characteristics influence the capacity of brokers. They also provide insight into how brokers bridge the cognitive and technical distance between parties. SMEs know what to pay attention to when searching for a broker.

Regarding the limitations of this study, we have little information on the representativeness of our sample for the total group of people involved in design and high-tech industries. A possible source of bias may be that the persons in the initial sample and first two waves have the advantage of being among the first mentioned. They have had more chance of being mentioned more often. Another possible source of bias is that the invitation to participate in the survey was signed by ourselves. Respondents might consider ourselves to be associated with a particular group, non-profit, and hence this may influence the willingness to participate in the survey. The male respondents are slightly overrepresented in the sample (79/14), so are respondents from the nonprofit

sector (nonprofit 31; science 12; profit 50). However relations in the field are dynamic patterns of growth and development and (brokerage) positions in a network reflect partly the past. The network represents a network across design and high-tech industries in the Southeast Netherlands, with all its particular structures. In other countries, other relations are present. For example, in China the absence of institutional trust based on unpredictable government action and control, mistrust of strangers and shortage of reliable market information, leads to an absolute reliance on trust-based personal connections as a means for almost any transaction. The so-called *Guanxi* is the Chinese version of social networks (Zhou et al., 2007). The interaction between nonprofit, science and profit sector are different in this country; therefore characteristics of brokers will be different. Related to this point, relations of people will vary per lifecycle stage of the industries. We noticed that only recently collaborations between design and high-tech industries are stimulated. This particular network may be in an early life cycle stage.

We look at brokerage capacity from a network perspective. Network analysis is limited to tertius gaudens measurements. It is not yet possible to measure the also not yet possible to look at closed triple relations. Progress in those areas would be interesting. We do not measure the amount of brokerage an actor actually performs, although opportunity and actual behavior will probably correlate highly. What level of brokerage, what exactly is being brokered is also not measured (Burt, 2005). Future, qualitative, research can complement this

investigation by taking an in-depth look at what brokers actually do. In spite of these limitations, this paper represents one of the first empirical contributions discussing the issue of brokerage in SME networks. A better understanding of brokers in SME networks can be a starting point for more work on the managerial and policy implications of brokerage.

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