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Network structure and economic performance

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Abstract

Purpose - The purpose of this study is to examine and map out the network innovative companies and to calculate values of the network structure in order to compare them to different performance measures. Furthermore, we aim to investigate the trade-off efficiency of innovations in a particular network structure, more specifically to investigate if the same elements generating more innovations have a relationship with economic performance that originates from innovations.

Methodology - This study give emphasis to map and illustrate the Swedish companies on NASDAQ OMX First North network through direct and indirect connection and to compare the centrality, density and size of the companies ego network in our population with the performance measures which are logically connected with the launch of an innovation; average EBITDA (earnings before interest, taxes, depreciation and amortization) and average annual turnover.

Findings - First we noticed that there was a significant connection between a negative average EBITDA and positive average annual turnover for our population, as we foretold would occur during the launch of an innovation. Secondly, the paper suggests that there is a weak or near non-existent connection between the elements that generates more innovations and the result of innovations, e.g. the economic performance of innovative firms. This might indicate that the focus of recent studies in the subject might have been mistaken focusing on the quantity of innovation, when the basic assumption of an innovation is that it is qualitative and thereby generates money for the company. This study suggests that *more* innovations do not necessarily lead to better economic performance for the companies within our population.

Keywords – network; network structure; centrality; density; network size; economic performance; performance

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1 Introduction

This chapter aims to give the reader a better understanding of the research field and this study as a whole. The introduction will present and discuss the problem and purpose of the study.

Gerben van der Panne, Cees van Beers & Alfred Kleinknecht (2003) asks the question "Why does not everybody innovate? It is widely known that innovation is the key to economic performance of firms." Innovative firms grows faster and make higher profits. Innovation is a concept which is widely used, where most of the definitions focus on newness and novelty (Goswami & Mathew 2005). Furthermore, there are some more detailed definitions of an innovation, e.g. Damanpur (1991) "the generation, development and adaptation of novel ideas on the part of the firm", The European Commission Green paper (1999) "the successful production, assimilation and exploitation of novelty in the economic and social spheres" and Boer & During (2001) "Innovation is the creation of a new product-market-technology-organization combination". Innovation includes the creation of brand new knowledge and also the diffusion of existing knowledge (Goswami & Mathew 2005). According to Ellis (2011) is the element of an entrepreneur needed to take advantage of an opportunity, this paper also see the need of an entrepreneur for an innovation to come to life due to the similarities of the two concepts. Kirzner (1997) furthers this by stating that the opportunity can only be said to be entrepreneurial when it actually involves the creation of a new exchange relationship. Vasilchenko & Morrish (2011) suggests that networks generally consists of a set of actors interlinked by a number of relationships. The importance of recognizing the role of these relationships has recently been spreading and the ideas of its impacts on innovation (Chandra, Styles & Wilkinson 2009; Wilkinson 2008).

In wide terms, opportunities may be the chance to encounter a demand with a creative combination of resources to deliver value (Schumpeter 1934; Kirzner 1973; Casson 1982). The opportunities brought up the previously mentioned authors may be interpreted as the development of novelty (Ardichvili et al. 2003; Nooteboom & Gilsing 2005; Goswami & Mathew 2005) or, by taking it one step further, the development of innovations. Innovativeness usually arises from the interactions and exchanges between actors (Roxenhall 2013) which leads us to the role of networks and the positions within networks influencing the outcome for firms (Ahuja 2000). Innovativeness occurs between companies, not within companies (Roxenhall 2013) which partly originates from the knowledge of the actor (Panne, Beers & Kleinknecht 2003) and the knowledge it has access to which Ahuja (2000) suggests depends on the position of the actor within the network. The interest in the cooperation between businesses has increased in recent years (Roxenhall 2013) as well as the interest and need for a more conclusive view of the field of innovations and the factors influencing the outcome of innovations (Panne, Beers & Kleinknecht 2003).

Network theory has a remarkable role in existing innovation studies; one significant area is the impact of network structure on the capability of creating innovations. (Ibarra 1993; Tsai & Ghoshal 1998; Mehra et al., 2006; Balkundi & Harrison 2006; Roxenhall 2013) Several studies have suggested that the position of actors in a network affects the result of the network (Roxenhall 2011). However does the previous research in this field mainly focus on the *entire* network and the *amount* of innovations that a company creates based on the level of centralization the density of its network and the size of the network.

This paper will focus on the performance of innovations in terms of economic performance from an ego perspective; the perspective of each individual actor within a network. By quality, or performance, we mean the economic advantage the innovation creates for the company in question. It seems interesting to investigate if there is a connection between the same elements of network structure that leads to more innovation also is connected with the economic performance originating from innovation of innovative companies. We however reason that a greater quantity of innovations does not necessarily imply a greater economic performance; it might just be expensive. The question to pose oneself is what the previous studies actually characterized as an innovation. If it is solely based on novelty or if they took quality into account is a key question.

Past studies states that, from an ego perspective, a high degree of centrality, a high degree of density (Ibarra 1993, Tsai & Ghoshal 1998, Roxenhall 2013) and a large size of the network (Ahuja 2000) leads to more innovations. More innovations however, does not necessarily imply that the innovations produced are good or meaningful for the company. Why should more innovations actually be something positive for the company? *"Quality before quantity"* should naturally be tested on innovation studies. Therefore, if a company comes up with 100 new innovations, many of which turns out to be questionable and lacking in demand, it could lead to the bankruptcy of the company if they do not have the sufficient financial muscles to stay afloat. Innovation 101 might however become the innovation of the decade. Since there are many studies suggesting that network structure influences capabilities of producing innovations, there are no studies taking it one step further - actually looking at the fruits of an innovation, past the stage of innovating, in terms of economic performance.

1.1 Purpose

The purpose of this study is to examine and map out the network of innovative companies and to calculate values of the network structure in order to compare them to different performance measures. Furthermore, we aim to investigate the trade-off efficiency of innovations in a particular network structure, more specifically to investigate if the same elements generating more innovations have a relationship with economic performance originating from innovations.

1.2 Research question

Does network structure of the ego network have a connection with economic performance?

2 Theoretical framework

This chapter will present and discuss the theories concerning this research field. This is done to give the reader a deeper understanding of the subject matter and the included variables.

2.1 Theoretical introduction

According to Borgatti & Halgin (2011), a network consists of a number of actors or nodes together with a set of ties that links them. These ties could be a friendship tie or a business tie. Depending on the pattern of the particular network, a different network structure emerges and the nodes take on different positions within said network structure. Morrish & Vasilchenko (2011) furthers this by suggesting that networks are a set of actors that are linked by some sort of relationships. These relationships may differ in both the literature and in practice and is broadly distinguished by some researchers (Ellis 2011; Morrish & Vasilchenko 2011) as social relationships and business relationships which we will discuss further on in the paper.
Borgatti and Halgin (2011) continue to suggest that the researcher(s) is the one who defines the network. We are, in this paper, going to define a network as the set of direct or indirect business connections among a given list of firms.

Morrish & Vasilchenko (2011) points out that the importance of networks is emphasized for firms that are constrained by their amount of resources which makes networks the answer to overcoming the barriers of entering a new market. For example, the inherent weaknesses of smaller firms such as the inability to control or influence external factors can be helped with networking as an alternative strategy.

When it comes to internationalizing and the early step-taking into any market, Johanson, Vahlne & Schweizer (2010) suggests the importance of cooperative alliances and strategies as well as networks. These factors supports and contributes to the process of entering a new market in the sense that networks are linked relationships between firms and being a part of the appropriate networks are necessary for a profitable and successful move into the appropriate market. The concept of networks also assists in the explanation of speed and acceleration of firm internationalization (Morrish & Vasilchenko 2011).

Firms can apply and use their network in order to effectively enter international markets and to gain access and knowledge about opportunities in the global marketplace. Granovetter (1985) emphasizes the social network and the social context of economic exchange and states that it is impossible to investigate exchange without taking the social context into account which Morrish and Vasilchenko (2011) also brings up by pointing out the social relationships surrounding organizational and business behavior and the actions taken within the organization. The aforementioned relationships and networks become involved with one another which in turn make way for what Uzzi (1997) refer to as embedded networks.

Networks can, however, be divided into two different kinds of networks; business networks and social networks that are defined and discussed below. But many researchers say that there are many factors that influence what kind of network you are a part of.

For example; if you have a social relationship with a person, then he or she is a part of your social network, but if you make some kind of business exchange with the person, does he or she disappear from your social network and become a part of your business network? Or the other way around, if you meet someone from the business network outside of work, is he or she no longer a part of your business network? Due to this, it is difficult to distinguish if it is a social network or a business network (Granovetter 1985; Uzzi 1997).

2.2 Business networks contra social networks

The different perspectives on the separate kinds of networks are mainly distinguished at the level of analysis of the relationship and the connected parties of which the network consists of. The business network is placed on the more formal end of the spectra, where goal-orientation is more emphasized (Vasilchenko & Morrish 2011). Ellis (2011) begins defining it as "a business network is normally described as a set of relationships linking one firm with other firms". This implies that the included parties are the firms that cooperate with one another with the intent of exchanging resources in order to resolve certain problems by formal agreements (Morrish & Vasilchenko 2011). Anderson, Håkansson and Johanson (1994) reinforces this by defining it as a set of two or more firms being connected where each exchange is between businesses.

In contrast to business networks, social networks has recently emerged in the research field (Ellis 2011) and the effects this has on an international level. The earlier research has mainly been within the entrepreneurial field but has lately gained popularity in internationalization research (Morrish & Vasilchenko 2011).
The social networks are placed on the informal end of the spectra as it is made up of the ties between people and the sum of relationships linking one person with another (Ellis 2011).
These social connections between people ease the flow of knowledge, resources and information (Clifton et al. 2010). In the field of entrepreneurship it is defined by Gilmore and Carson (1999) as a "collection of individuals who may or may not to be known to each other and who, in some way contribute something to the entrepreneur, either passively, reactively or proactively […]".

2.3 Network flow model

Social network analysis has recently gained recognition and popularity and the number of articles containing "social networks" has increased significantly over the past couple of years. The interest in networks now spans the entire field of social science. In management research, the analysis of networks has been used to understand *performance*, turnover, innovation and unethical behavior. Network analysis has even become standard diagnostic and prescriptive tools within management consulting (Borgatti & Halgin 2011). Social network analysis contains two different domains which Borgatti & Halgin (2011) refer to as "network theory" and "theory of networks". Network theory implies the processes and functions which contribute and interact with network structure that yields a specific outcome for individuals or groups.

Brass (2002) argues that network theory is about consequences of network variables. These variables could be the location (centralized) or the number of ties. Theory of networks, however, regards the process that determines the structure of the network (Borgatti & Halgin 2011).

Two well-known network theories are Granovetter's (1973) strength of weak ties and Burts (1992) structural holes theory. The theory regarding the strength of weak ties argues that the stronger the tie between parties, the higher probability for their respective social worlds to collide and/or overlap. This means that the social worlds will share the same third party, albeit with a weaker connection. Furthermore, the theory of strength of weak ties suggests that bridging ties can serve as sources for new information and new ideas. Through a bridging tie, a person can hear information and gain knowledge that is not known by his or her close friends. A bridging tie is usually of a weaker type of connection. The theory of structural holes concerns and focuses on *ego* networks where a specific actor is seen as the center of the actors within the network. Burt (1992) explains that a structural hole is the amount of nodes providing appropriate and useful information. Therefore, having more structural holes implies that that node has more useful ties. (Borgatti & Halgin 2011)

In both theories regarding networks, the strength of weak ties-theory and the theory of structural holes, is the function of the network is the same. The network acts as a system in which information and knowledge can flow to the different actors. This means furthermore that there is an underlying model of a social system, that the theories rely on, which is a network of paths that acts as channels for information to flow through. Borgatti & Halgin (2011) refer to this as the *network flow model.* This model has a basic assumption which explains that the longer the path is between nodes, the longer it takes for said information to travel from one point to another. Nodes that are decentralized will therefore receive information later than centrally positioned nodes.

2.4 Performance

Borgatti & Halgin (2011) suggests that within the field of management research, analyzing the network of firms has been used as a tool to understand performance. Network performance has been measured by Sandström & Carlsson (2008) and they defined it as "efficiency" and "innovation". By viewing this from another perspective, namely the *ego perspective* and thereby moving away from the performance of the network as a whole and instead examining individual firms within networks, one can also interpret performance as the economic performance for each firm, which is the definition we will use in our study.

Within the structure of the network, we argue, along with previously mentioned authors, that the function of a network is to ease to flow of resources, knowledge and information (Borgatti & Halgin 2011). Networks also assist in the process of entering a new market, international or domestic (Johanson, Vahlne & Schweizer 2010). What this does, is in other words, to aid firms or individuals to exploit opportunities that were previously only at a state of exploration. The network function may therefore lead to a possible improvement of the performance of the firm. With a more extensive network, the firm has greater access to *potential* resources.

One can therefore ask the question what a greater access to resources leads to in the subject of performance measurement.

Within network performance literature, several studies suggest that the structure of a network is an important element for innovations to form (Roxenhall 2011). He continues by stating that "[…] the number of collaborative relationships had a positive impact on the result of innovation." (Roxenhall 2011) The performance measurement here is innovations; that a particular network structure leads to more innovations. By keeping that in mind and furthering the idea – what does a higher potential of innovation lead to? Goswami & Mathew (2005) suggests that many definitions imply that the value of innovation lies in the contribution to profit or addition to economic performance. The aforementioned authors continues by bringing up Joseph Schumpeter and that he, in the 1930s, defined innovation as five different types, one of which were the "introduction of a new product or a qualitative change in an existing product" (Goswami & Mathew 2005). Furthermore, Boer & During (2011) defined innovation as the creation of a new product–market–technology–organization combination. A new product or technology, which is assumed to be successful in the context of innovations (although not always (Goswami & Mathew 2005)), or the improvement of an already existing product might logically lead to a higher market share or that more customers are going to be willing to purchase the innovation. This in turn leads to higher sales which also imply a higher turnover.

In this study we are therefore going to define performance by two different key performance indicators: the EBITDA (Earnings before interest, taxes, depreciation and amortization) by percentage of the turnover over time and the change in turnover over time. We are also going to define innovation as suggested by Boer & During (2001) where the definition emphasizes the novelty and the combination of new products and/or new markets.

2.5 Network structure

The structure of networks can be studied in different ways. A common perspective of examination is with a base in the central actor; the hub of the network for example (Roxenhall 2011). Another point of view is the perspective of several actors or even all actors within the network. Ahuja (2000) suggests that the structure of a network can be defined in three different dimensions: "1) number of direct relationships, 2) number of indirect relationships and 3) the degree to which the partners of the focal actor have relationships with one another" (Roxenhall 2011, p. 62). These three dimensions all concerns the same matter: the implication of relationships and the exchange occurring within these relationships and the impact this has on innovations and therefore also economic performance as previously argued in the paper.

The structure and the position of companies within networks can be measured by the density of the firms' ego-network, the degree of centrality that the firm occupies in the network and the size of a firms' ego-network (Roxenhall 2013). With a base in this we are examining the structure of the ego-networks of firms.

2.5.1 Network centrality

The degree of centrality within a network is the position between the most central nodes and the other nodes in the aforementioned network. Central nodes, or firms in our context, have the ability to control the flow of resources and knowledge whilst also acting as gatekeepers for information due to them being more connected than others (Mehra et al. 2006). Furthermore, centralized firms have greater access to precious knowledge regarding opportunities or information which might enhance and improve performance. A lower degree of centrality within a network conversely implies that the firms are more on the same level of connectivity in the network and that they occupy more or less the same position. Being on the same level makes the interdependencies between firms more equal which foster and improves cooperation. Oppositely, centralized firms are less dependent of other firms and might therefore act opportunistically and egotistically which in turn lowers the total performance of the network. (Roxenhall 2013)

The relationship between network centrality and innovations exists. There is a connection between the actors' degree of centrality and innovation based on trust (Tsai & Ghoshal 1998). The degree of centrality has a positive influence on administrative innovations (Ibarra 1993). Actors who is involved in innovation creation and in scientific production had a three respective four times stronger network position than the ones who was not involved (Roxenhall 2013). Therefore it seems logical to suppose that an actor who has a central role in the network has more opportunities to access important knowledge and other resources which is necessary to create innovations. The central actors are in less need of the actors in the periphery of the network, in contrary to the periphery-actors which is in great need of them. This gives the central actors an advantage (Roxenhall 2013). According to Roxenhall (2013) a higher degree of centrality leads to the creation of more innovations for an actor in a network.

Previous research still only refers to the quantity of innovations; the creation of more innovations. The fruits of an innovation in terms of economic performance is not included. A higher degree of centrality is in previous studies suggested to lead to more innovations, which seems logical due to the information that the central actor recieves. But previous studies does not measure how profitable an innovation is. To test the relationship between the network centrality and the economic outcome of innovation, we hypothesize the following.

> Hypothesis 1 (h1) - *The relationship between the degree of centrality and the average EBITDA is close to 0.*
>
> Hypothesis 2 (h2) – *The relationship between the degree of centrality and the average annual turnover is close to 0.*

2.5.2 Network density

The structure of the relationships in a network is most commonly measured by its network density. This implies the degree of connections in the network (Roxenhall 2013). Appropriate and functional network relations are a prerequisite for firms to be able to transfer and develop knowledge which enables a higher degree of performance for the affected firms. The network structure is therefore important and has a great impact on the firms which further implies that a higher density in the network eases the transfer, development and flow of knowledge and resources. Dense networks aid the establishment of relationships whilst also building trust and dependence. A lower degree of density however, leads to more difficulty transferring resources due to the lack of existing ties and established relationships.

When the density of a network becomes too high, problems may arise despite the positive implications mentioned above; there is a cost benefit-aspect connected to the degree of network density. Maintaining many relationships simultaneously might be expensive and time consuming which may lead to complications rather than improvements. The question to pose oneself is therefore if the benefits outweigh the costs connected to a dense network. The transfer of resources and the openness towards new information is strained when the density increases which impedes the performance of firms. Balkundi & Harrison (2006) states, however, that there is a strong correlation between the performance (team performance in this particular case, which can lead towards economic performance) of a firm and the density of the network in which it resides. Being in a dense network will make it easier for a firm to gain access and transfer knowledge, information and resources which, as stated before, leads to the creation of more innovations (Roxenhall 2013).

When the density is high, information and knowledge flows through the network more rapidly and more innovations is created which previous studies suggests. But nonetheless does not this suggest that the innovations that are created will bring a positive outcome in terms of economic performance. Maintaining many relationships may also result in a decrease in economic performance due to the costs connected to a denser network. We therefore hypothesize the following.

> Hypothesis 3 (h3) – *The relationship between the degree of density and the average EBITDA is close to 0.*

> Hypothesis 4 (h4) – *The relationship between the degree of density and the average annual turnover is close to 0.*

2.5.3 Network size

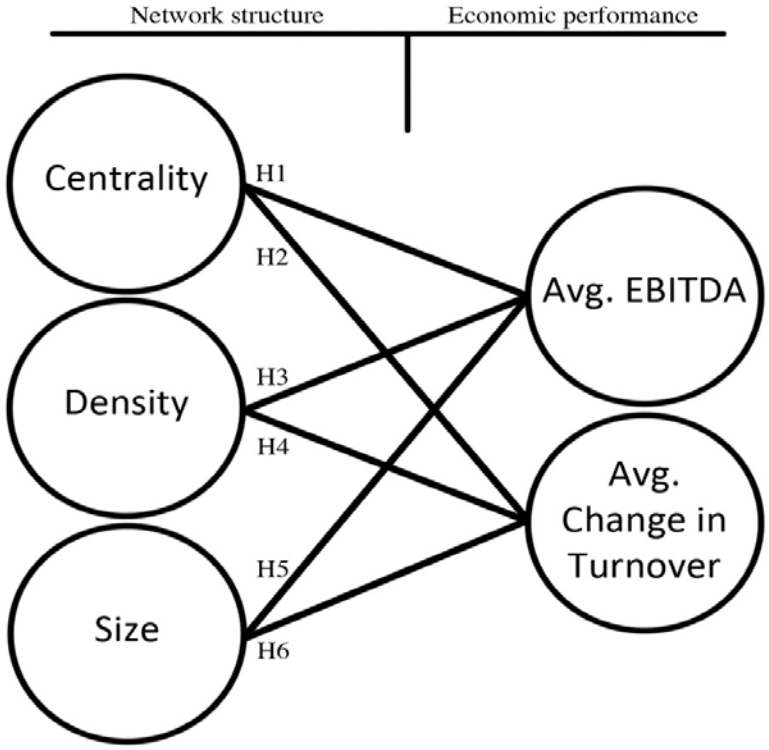
The size of the ego network of each company is the amount of connections that the ego network itself comprises. An increased amount of connections or relationships with other actors in the network implies an increased size of the ego network. A relationship, where knowledge or resources are able to flow, therefore implies that the actors both gain access to said knowledge or resources that either actors possesses. Ahuja (2000) investigated network size and he found that it was positively associated with innovation.

Larger networks however, are costly and might harm the company due to the difficulty of maintaining many relationships at once (Roxenhall 2013). Having weaker ties may therefore be more profitable due to the lack of network maintenance required to still enjoy some of the benefits of network size (Burt 1992).

The size of the network is, as stated, positively associated with innovativeness. Innovativeness does however not directly imply that the quality of the innovation is high. It might simply be costly and not profitable, despite the product or service being characterized as innovative. A larger network may also be costly due to the maintenance required which logically has a negative impact on the economic performance. In contrast to previous studies, we therefore propose the following hypotheses which will let us test the relationship.

> Hypothesis 5 (h5) – *The relationship between the ego network size and the average EBITDA is close to 0.*

> Hypothesis 6 (h6) – *The relationship between the ego network size and the average annual turnover is close to 0.*



The model presented to the left illustrates the main building blocks consisting of network structure, more specifically network centrality, density and size as well as the performance measurements average EBITDA and average change in turnover. The lines connecting the building blocks each represents a hypothesis presented previously in the paper.

Illustration 1. Conceptual model.

3 Methodology

We will in this chapter describe and present the course of action and the methods used in this paper. This section aims to explain how the gathering of data was performed as well as emphasize the importance of the reliability and validity in our study. We will also take ethical considerations into account.

3.1 Methodological introduction

Since the paper has its base in the mapping of inter-firm networks, gathering data from a large number of firms was required to get an appropriate view of the networks. This course of action required us to gather thousands of companies which a quantitative data analysis was best suitable for due to the fact that we wanted to search for characteristics in network structures of innovative and fast-growing companies. The quantitative data analysis consisted of five bivariate calculations since we made a connection between network density, centrality and size with the economic performance of firms. (Bryman & Bell 2011)
Furthermore, we chose to apply a hypothetical-deductive approach in this study in order to test the empirical data. We therefore went from theory to findings (Bryman & Bell 2011). The hypotheses were derived from the theoretical framework and then subjected to the empirical findings in order to be falsified or confirmed.

3.2 Selection of samples

The companies that we included in the study were taken from listings on NASDAQ OMX Nordic, Stockholm market and more specifically the First North-segment. First North is an alternative marketplace that is run by the different stock markets that is part of NASDAQ OMX. The companies listed on the First North-segment is characterized by being of higher risk and generally being smaller in size and faster growing than other segments (NASDAQ OMX Nordic 2013) That was very suitable for the study because we saw that a small fast growing company either took a part of the market by extending the supply with something novel, or created its own market. We saw this as clearly innovative due to the fact that an innovation of some sort had most likely been created. The First North-segment consists of Swedish, Danish, Finnish and Norwegian companies; we excluded all companies except the Swedish ones because we could not gain access to the desirable information from the others. We found the First North- segment suitable for our study due to the fact that many of the companies' board members had several engagements which directly led to several possible connections within our selection. This is also the reason to why we chose to investigate this segment in particular**;** due to the importance of networks for smaller firms in order to overcome contingent barriers and problems. The amount of data this resulted in was a total of 106 companies which made up our final population (Bryman & Bell 2011). This population of a total of 106 companies operates in different markets all over Sweden which gave us the wide geographic- and industry-spread that we wanted.

3.3 Collection of data

3.3.1 Population, individuals and additional firms

The list was gathered from NASDAQ OMXs official website (NASDAQ OMX Nordic 2013) and was then sorted and filtered to only include companies that use the Swedish krona (SEK) as their official trading currency and with a Swedish ISIN-number (International Securities Identification Number). This was done to make sure that we only included Swedish companies from the First North-segment since we only had access to Swedish corporate information**.** Furthermore, we visited a site that gathers and summarizes business data and information. The site is called Affärsdata which is part of Newsline Group AB which in turn is part of the Bisnode concern (Affärsdata 2013). From that site we retrieved the full list of the board members from our population and their respective list of engagements in corporations, partnerships, business associations and housing associations. The board members were immediately de-identified and replaced with a number. As stated before, we investigated the connections within our population and thereby received the network structure of the firms. Illustration 1 is an image of how we made the two types of connections between the firms, a direct connection and an indirect connection. They however represented the same connection-value. If a board member had an engagement in both selected companies their relation had a value of 1. If board members from our selected companies met in an additional company, the relation of the selected companies also had a value of 1.

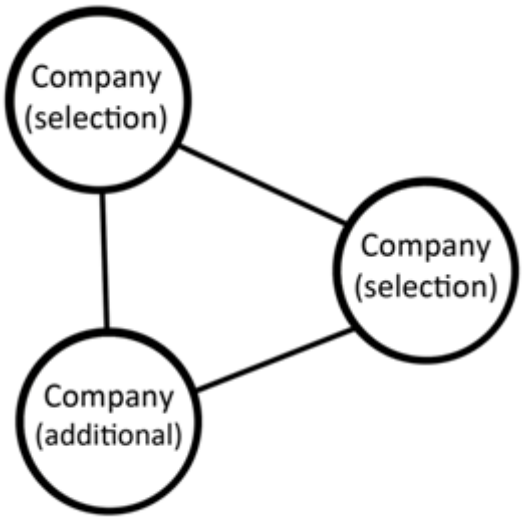


Illustration 2. Connection Schedule.

Firstly, we gathered the list of our selection and made an Excel document and sorted the selected companies from A to Z. We then started searching for the board members and their engagements. By listing these engagements, we were able to receive these possible connections. To save time and effort, we hired a database expert who created and programmed a website for us which connected the firms to each other automatically which saved us the time to do it manually. By entering the board members and their respective engagements, the website provided another Excel document with the full list of our selection, with our companies on a horizontal row and a vertical row and the connections between them with the number “1” representing one connection between two companies in our selection and a “2” represents two connections between companies and so on. The reason why we ordered the database expert to show the connections in that specific way was due to the fact that our program of analysis needed the data in that specific way.

The final collection of data resulted in, as stated before, 106 companies which is the selected population this study had its base in. The amount of de-identified board members from these companies resulted in 591 members. These members are together part of a total of 4870 different board engagements in Sweden.

3.3.2 Performance measurements

We decided to choose the EBITDA-value due to the firms' conscious and active choice to make or not to make depreciations which in turn does not have anything to do with the innovation(s) itself, but only with how the decisions regarding the depreciations are taken. If the firm decides to make depreciations it will affect the key performance indicator without any consideration to how successful the innovation itself is.

The performance measures were gathered from Affärsdata (Affärsdata 2013) as key performance indicators. The performance measures that we chose to include was the average change in turnover (4 year average, 2009 to 2012) and the average earnings before interest, taxes, depreciation and amortization (EBITDA), also over a 4 year (2009 to 2012) period of time. These were individually collected and inserted into Excel next to each corresponding firm. By creating an equation in Excel which added each of the values for the past four years together and then divided it, we received the average for each firm which we used in the study. The reason of the four year time period is due to the time it can possibly take for an innovation to actually reach the market and have an effect on the company's performance.

The equation that we constructed in Excel is exemplified below where the columns A1 to D1 are used as examples.

$$= \frac{SUM(A1{:}D1)}{4}$$

3.4 Handling of data collection

We met the expert by arranging an informal lunch meeting where we discussed the structure of our study and how we wanted the data to be structured in order to be properly analyzed. Our expert programmed the website by using the SQL-code (Structured Query Language), presented in the appendix, to automatically provide us with the connections between the firms of our population.

The website, programmed with the SQL-code, allowed us to insert each company in our population, each board member ID of the companies in our population and their respective engagements in other companies. The program did however not allow an identical value to be inserted twice so when we connected the board member ID to each board engagement and noticed that one was missing, we could tell that we had a connection due to the fact that a board engagement had already been registered and that these two ID's were therefore in the same company. By searching for that missing engagement and inserting it by the appropriate board member ID, we were done with one board member and could move on to the next.

When finishing this time consuming labor, the website provided us with an Excel-friendly file complete with each connection. The program of analysis that was used further on is explained below.

3.5 Data analysis

When we reached the point of having finished the Excel document with all the connections, we exported the data file to UCINET 6.64, which is a software package designed to analyze networks (Borgatti, Freeman & Everett 2002). The program gave us the proper tools to measure the proximity data such as density, centrality and size of the network. The proximity functions of UCINET allowed us to analyze the data from an ego perspective, this was crucial because we wanted to compare the companies to each other in relation to their performance. Furthermore does UCINET provide with a "NetDraw" function, which created a graphic illustration of the entire network. In NetDraw, a colorized node represented each company which in turn gave us a clear view of the network.

Network density in UCINET was calculated based on our raw data from Excel and gave us the extent to which companies were connected to each other in their ego network. At a value of 100, the company in question was connected to all other companies in the ego network. At a value of 0 the company had no connection at all and was totally isolated from the others.
The formula for density is adopted from Pryke (2005):

$$Density(\Delta)\ \imath n(n-1)$$

Raw data from excel and gave us the position of the companies that indicated the level of power in the network; to avoid any confusion, centrality was calculated by the following formula (Pryke 2005):

$$C_D = \frac{\sum_{i=1}^{g}\left[C_D(n^*) - C_D(n_i)\right]}{[(g-1)(g-2)]}$$

The network centrality was calculated based on Freemans (1978) definition where x is a given company within the network and n represents the total number of nodes in the data set. In-degree is the incoming relations and out-degree the outgoing relations. (Pryke 2005)

The size of the network was calculated by the program by adding up the number of nodes in the actors ego network. We did, however, not see the need to demonstrate the formula for this due to its simplicity.

3.6 Test of dependent variables

It seemed logical that the creation and the market launch of an innovation is expensive. So if a higher degree of network centrality leads to more innovations and innovations are most likely expensive to create and launch then this would probably have a temporary negative impact on the company's economic performance due to that the expenses of the innovation will probably not repay itself in an instant, it will probably take a while. This would lead to that, when the innovation reached the market it would have a positive impact on the annual turnover if the innovation is of good quality. By good quality we mean that the innovation is successful in the market. If the innovation did not have a positive impact on the annual turnover, the innovation might not be so great after all, or that it did not reach the market at all. With this in mind, we decided to test the variables of economic performance against one another in order to confirm our logical arguments. We therefore proposed the following:

A low degree of EBITDA is negatively associated with a high degree of average annual turnover.

The result of this test of economic performance variables:

Correlations: Average EBITDA; Average annual change in turnover
Pearson correlation of Average EBITDA and Average annual change in turnover = -0,778
P-Value = 0,000

The correlation demonstrated above indicated a strong correlation between the variables of economic performance proving that our arguments regarding what should happen when firms generate innovations is confirmed. Furthermore, the correlation assured us that the companies included in our study are were fact of the innovative kind.

3.7 Ethical considerations

The data that we collected in order to perform this study required us to search and investigate individuals and their respective engagements. We de-identified each individual and provided them with a unique ID to keep them separated. This is however not traceable back to the person, only to the company of its belonging. The only data that we stored was the number of board members for each firm in our population and which companies they are also part of.
The firms that participated in this study were not of aware of their participation but since we did not sought to point any negativity to any firm, only their connection with other firms, we did not believe that there existed sufficient amount of reason to let each individual firm know that we were performing this study. The information regarding the individuals, which was however codified with ID's, were only used in order to study and analyze network structures.
This makes the collection of information concerning individuals to fall into the sole purpose of this study and was not used in any other context or passed on to another party.

As mentioned before, we only sought to demonstrate connections between firms from a given list of firms which, in our opinion, should not be interpreted as negative or damaging for the included companies. All information included in the study is publicly available information to anyone with an internet connection.

3.8 Reliability

Reliability, as brought up by Bryman & Bell (2011), concerns the degree of replicability of a study. In our context, being able to replicate our study means using the same course of action as we did and getting the same results. We therefore chose to include the SQL-code and the equations to avoid any complications while replicating this study.
When performing the analysis of the collected data, we figured that a large amount of data also implies that there is a greater risk for error, especially the human error. We therefore decided to hire the database expert in order to minimize the risk of getting faulty data.

The four year time period might not be sufficient enough for an innovation to actually reach the market and influence the company in question. When we performed the study it would have been preferable to include data from a longer period of time and to thereby acquire more accurate performance measurements.

3.9 Validity

Since the purpose of the study was to demonstrate a relationship between two variables, we therefore imply that x has an effect on y (Bryman & Bell 2011). Previous studies, as discussed in the theoretical chapter, had shown a relationship between measurements of network structure and the amount of innovation. With a base in these studies, we took the idea further by making logical arguments what innovation might lead to in terms of economic performance. By doing this, our hypotheses had in our opinion been theoretically and logically deduced. We were however including firms from Sweden as a whole and not from any region in particular as well as any industry which made other factors able to intrude at a greater degree, due to the geographic spread and the possible differentiations in industry. We were aware of the fact that there are possibly other elements of business life that affects the performance of firms than solely firms' individual network structure. We are therefore only looking to point out that there is a relationship between the two variables and that network structure is one of the elements of business life affecting performance.

The data that we gathered had neither been tampered with nor had it been altered by us as researchers. The only change we performed was to de-identify the board members to not include any personal names. All other data was directly inserted into our database from publicly available sources.

4 Findings

This chapter will present the findings, such as correlations between the variables from the study as well as an image of the entire network as a whole with each individual company included.

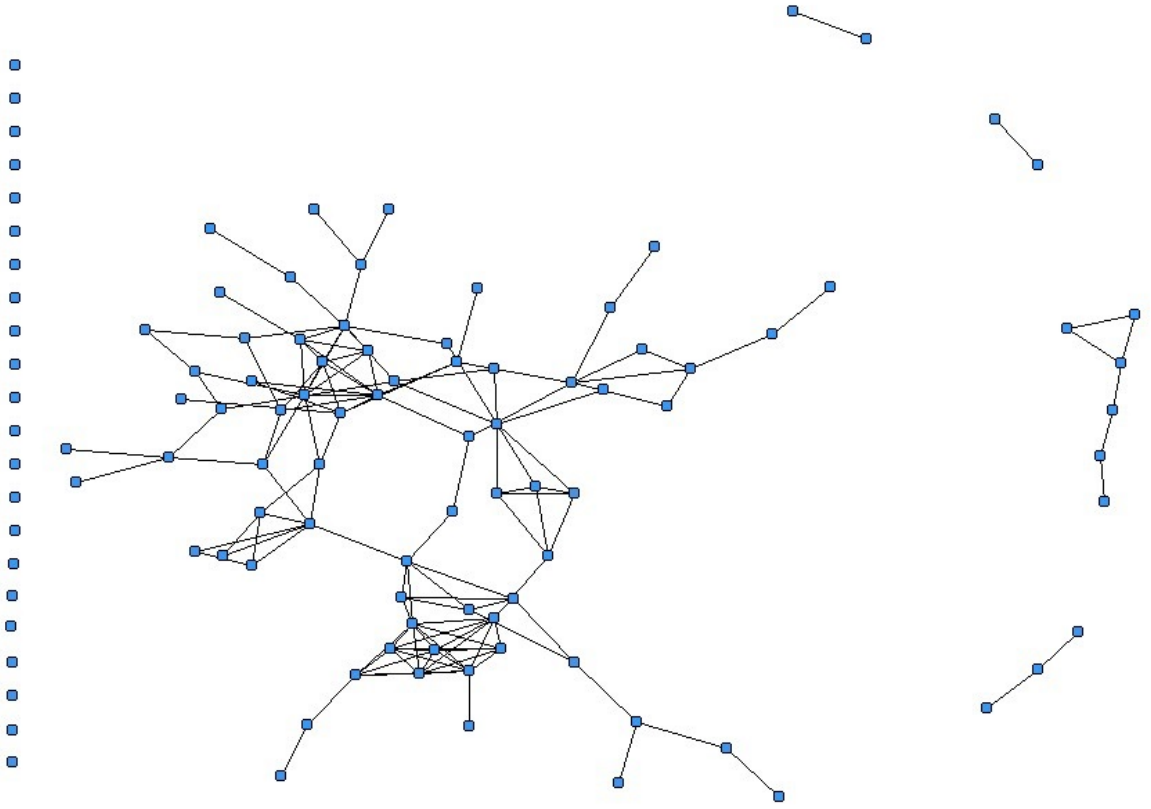


Illustration 3. Graphic illustration of the relationships between the firms that comprises NASDAQ OMX First North Sweden.

Illustrated above is the result of our mapping of the NASDAQ OMX First North companies, the high risk companies are Swedish, innovative and have a geographic range from far up north to the most southern point of Sweden. The companies are connected through 591 board members via a total of 4870 board engagements, although 23 companies are not connected, possibly due to a combination of lack in networking areas such as the number of board members, the number of engagements of the board members in the mentioned companies, geographic location and the type of industry they work in. A very specific industry might not need the surroundings for their business in same range as others. The companies illustrated above has in general a low degree of density, due to few companies being connected with more than one other actor. However, some companies have a very high density in their ego network. One actor has a density of 90.48 in their ego network which theoretically implies that they receive more useful information than others due to their increased density within our network, as explained by the theory of structural holes (Burt 1992). The centrality of the entire network is low. So, based on past studies (Ibarra 1993; Tsai & Ghoshal 1998; Mehra et al., 2006; Balkundi & Harrison 2006; Roxenhall 2013) made in the innovation research field, these companies should produce many innovations as a whole network, which seems logical due to the fact that all of the companies in our study is in fact innovative companies of some kind. However is our point of view from the ego perspective, which means that a central role

for one specific company would lead to more innovations for themselves, but none of our companies have a significant central position in their ego network but they have at least come up with one good innovation, as the companies in fact are characterized by being innovative and fast growing. The network illustrated in this study could possibly be called a business network due to the formal engagements everybody is connected through (Ellis 2011); however we cannot reject the idea of that the board members having a social relation. It is impossible to distinguish what it is (Granovetter 1985; Uzzi 1997). The board members in our selection attend formal meetings with each other where some kind of social interaction must take place during these meeting, it cannot all be business. Formal meetings within a social atmosphere ease the flow of knowledge, resources and information (Clifton et al. 2010).

The list of firms included in this study might not even be aware of the relationships that comprises the network. We however suggest that they in fact are part of of a network, due to the fact that we defined a network as "the set of direct or indirect business connections among (…) firms", which suggests that the firms can actually be called a network, despite them possibly not knowing that they are part of the network. The relationships between them does however exist due to the board members being in contact with each other and being in contact with the firms that they directly or in-directly know. These relationships make the flow of resources possible, such as knowledge, information, capital or experience. The potential access to resources these relationships imply leads to a greater opportunity, or chance, of creating novelty and thereby generate innovations for the sole company.

Whether the individual companies want to or not, they are somehow connected through the board members. What this should lead to is the companies taking advantage of each other through the board member(s) who probably seeks to generate money for oneself which originates from the performance of each firm that he or she is a part of. With this assumption taken into account, we can therefore suggest that the connections should imply that an exchange relationship is most likely taking place among the connected companies and to thereby suggest that the companies can be called a network.

4.1 Performance

To confirm our logical reasoning regarding what should happen to economic performance in the short term (four years) when companies create innovations, we performed a correlation analysis between the average annual turnover and the average EBITDA. We discussed in the methodology that the EBITDA-value should be a low value whilst the average annual turnover should be a higher value when innovating. To be able to get an accurate measurement of the two, we decided to remove extreme values that otherwise would have interfered with the results.

Correlations: Average EBITDA; Average annual change in turnover
Pearson correlation of Average EBITDA and Average annual change in turnover = -0,778
P-Value = 0,000

The correlation above suggests that companies with a higher annual turnover also have a lower EBITDA-value. The correlation is -0,778 which is a strong negative correlation.
Connecting this with h1 indicates that the hypothesis is confirmed. With this hypothesis confirmed we say that this is actually something that happens with the economic result when innovations are launched. First, it becomes expensive to get the novelty out on the market but after a period of time the product will take a part of the exciting and profitable market or it may have even created its own market. One will then experience an upswing in the company's economic performance, as previously argued. We are of course aware of that there are several other factors which influence the economic performance of a company. But during a launch of an innovation this still follows the logical pattern we argued it would.

4.2 Centrality, density and size

Below follows the four correlations between the variables degree of centrality, density, average EBITDA and average annual change in turnover.

Correlations: Degree of centrality; Average EBITDA
Pearson correlation of Degree of centrality and Average EBITDA = 0,034
P-Value = 0,728

Correlation analysis between the degrees of centrality and the average EBITDA for each individual company resulted in a weak and positive value of 0,034 which indicates that there is a weak connection between the variables.

Correlations: Degree of centrality; Average annual change in turnover
Pearson correlation of Degree of centrality and Average annual change in turnover = -0,032
P-Value = 0,748

Correlation analysis between the degrees of centrality and the average annual change in turnover for each individual company resulted in a weak and negative value of -0,032 which indicates that there is a weak connection between the variables.

Correlations: Density; Average EBITDA
Pearson correlation of Density and Average EBITDA = -0,166
P-Value = 0,089

Correlation analysis between the density of the ego-network of each individual firm and their average EBITDA resulted in a weak and negative value of -0,166 which indicates that there is a weak connection between the variables.

Correlations: Density; Average annual change in turnover
Pearson correlation of Density and Average annual change in turnover= 0,127
P-Value = 0,193

Correlation analysis between the density of the ego-network of each individual firm and their average annual change in turnover resulted in a weak and positive value of 0,127 which indicates that there is a weak connection between the variables.

Correlations: Size; Average EBITDA
Pearson correlation of Size and Average EBITDA= -0,060
P-Value = 0,057

Correlation analysis between size of the ego-networks of each individual firm and their average EBITDA resulted in a weak and negative value of -0,060 which indicates that there is a weak correlation betweel the variables.

Correlations: Size; Average annual change in turnover
Pearson correlation of Size and Average annual change in turnover= 0,097
P-Value = 0,072

Correlation analysis between size of the ego-networks of each individual firm and their average annual change in turn over resulted in a weak and positive value of 0,097 which indicates that there is a weak correlation betweel the variables.

	Mean	Std. Deviation	N	Density	EBITDA	Centrality	Turnover	Size
Density	24,4658	35,84977	106	1				
EBITDA	-1312,4131	5091,60772	106	-,166	1			
Centrality	1,6069	2,93600	106	,174	,034	1		
Turnover	195,8255	597,00673	106	,127	-,778	-,032	1	
Size	2,6415	2,45798	106	,503**	-,060	,569**	,097	1

Table 1. Descriptive statistics and correlations.

The values produced from the correlations are of such low degrees that one cannot state that there is any relationship between the economic performance of a firm and the network structure measurements that are used in this study; density, size and centrality, illustrated in Illustration 2 and the figures provided in Table 1. We therefore also argue that our hypotheses are confirmed. Past studies (Ibarra 1993, Tsai & Ghoshal 1998, Roxenhall 2013) have suggested that there is a clear connection between innovativeness, e.g. the number of innovations that a firm creates, and the structure of their network (density) and their position within it (ego centrality), as well as their size (Ahuja 2000). The network flow model (Borgatti & Halgin 2011) aids to explain this due to the flow of resources, knowledge and information within a network which can aid the process of creating innovations. Innovativeness however, does not imply success. It merely indicates the number of innovations produced.

This has been brought up by Panne, Beers & Kleinknecht (2003) in terms of the lack of a more conclusive view of the factors influencing the outcome of innovations.

Since we are taking this idea one step further and viewing this one step beyond the number of innovations, and thereby looking at the financial outcome, it now lies in the performance of the innovations and how well they are received by the market. It thereby depends on the quality of innovations and what they in turn lead to for the company in terms of economic performance. It is, as we stated previously in the paper, a matter of quality over quantity where quantity does not necessarily equal profit but quality is however logically more likely to. Innovations may not always be valuable for the organization (Goswami & Mathew 2005). The quantity that the past studies confirmed may also arise from what they actually defined as an innovation. Defining it differently and counting minor changes or improvements as innovations, assumed in our context to be profitable, may distort the results. A new product or a technological change may be an innovation according to some, or even most people, but it however does not directly imply that it will be profitable, which our study has shown. We can therefore suggest that there is none or at the very most a weak connection between the structure of the network provided in Illustration 3 and economic performance, e.g. the results of an innovative company's innovations.

5 Conclusion

This chapter will connect the results of the study with the purpose of the paper.

This study examined and mapped out the network of smaller and more or less fast-growing innovative companies, namely the Swedish companies on NASDAQ OMX First North. The network of the companies in our population was connected via numerous board members by their board engagements. This was necessary to be able to calculate the values of the network structure; the values of the network structure that in previous research was strongly related with the creation of more innovations; centrality, density and size of each and every company's network. This study compared centrality, density and size with the performance measurements average EBITDA (Earnings before interest, taxes depreciation and amortization) and average annual change in turnover. The reason why these two economic performance measures were chosen was due to change and outcome of these ratios during the launch and market entry of an innovation.

Previous research revealed that values of network structure, e.g. degree of centrality, network density and size, had a strong correlation with a higher number of generated innovations. With a base in this we took it one step further and looked at the performance measures in terms of money that would be generated by more innovations. The centrality, size and density should therefore also, logically, have a strong correlation with the money connected to innovations. Conversely, our study contributes with the suggestion that there is a weak, close to non-existent, correlation between economic performance and values of the network structure for the companies within our selection.

The results, as suggested, indicated weak measurements of correlation which thereby indicates that there is something else, besides the values of the structure in the network we mapped out, affecting the economic performance of the innovative firms. This is a call for further research; investigating which elements that to a higher degree affects the economic performance, past the point of launching an innovation.

In this study have mapped out a network trough pure business connections. As previously stated, the companies in this study may not be aware of the network they in fact are part of. We therefore pose the question as to whether the awareness and consciousness of being part of a network influences the economic performance of the firms. This also calls for further research, to in fact investigate a network that consists of a set of actors that to a higher degree are aware of being a part of the network. Furthermore, to create more understanding if the awareness of the network affects the innovations offspring in terms of economic performance.

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7 Appendix

7.1 SQL-code

```
using System.Collections.Generic;
using System.Data;
using System.Data.SqlClient;
using System.Linq;
using System.Web;
using System.Web.UI;
using System.Web.UI.WebControls;
namespace William
{
public partial class _Default :
System.Web.UI.Page
{
public class DatabaseRow
{
public long id { get; set; }
public string value { get; set; }
}
private SqlConnection Connection;
protected void Page_Load(object sender,
EventArgs e)
{
var connectionString = "Server=SERVER\
\DATABASE;Database=Database;User
Id=user;Password=password;";
this.Connection = new
SqlConnection(connectionString);
this.PopulatePanels();
}
protected void AddCompanies(Object sender,
EventArgs e)
{
var input =
this.CompaniesTextBox.Text.Replace("\n",
"¨").Replace("\r", string.Empty);
if (input.Substring(input.Length - 1).Equals("¨"))
{
input = input.Substring(0, input.Length - 1);
}
var companies = input.Split('¨');
this.Connection.Open();
foreach (var company in companies)
{
var command = new SqlCommand
{
CommandType = CommandType.Text,
Connection = Connection,
CommandText = string.Format("SELECT ID,
CompanyName FROM [Companies] WHERE
CompanyName='{0}'", company)
};
var resultSet = command.ExecuteReader();
if (!resultSet.HasRows)
{
resultSet.Close();
command.Dispose();
command = new SqlCommand
{
CommandType = CommandType.Text,
Connection = Connection,
CommandText = string.Format("INSERT INTO
[Companies] (CompanyName) VALUES ('{0}')",
company)
};
command.ExecuteNonQuery();
}
resultSet.Close();
command.Dispose();
}
this.Connection.Close();
Response.Redirect(HttpContext.Current.Reque
st.Url.AbsoluteUri);
}
protected void AddBoardMembers(Object
sender, EventArgs e)
{
var input =
this.BoardMembersTextBox.Text.Replace("\n",
"¨").Replace("\r", string.Empty);
if (input.Substring(input.Length - 1).Equals("¨"))
{
input = input.Substring(0, input.Length - 1);
}
var boardMembers = input.Split('¨');
this.Connection.Open();
foreach (var boardMember in boardMembers)
{
var command = new SqlCommand
{
CommandType = CommandType.Text,
Connection = Connection,
CommandText = string.Format("SELECT ID,
BoardMemberName FROM [BoardMembers]
WHERE BoardMemberName='{0}'",
boardMember)
};
var resultSet = command.ExecuteReader();
if (!resultSet.HasRows)
{
resultSet.Close();
command.Dispose();
command = new SqlCommand
{
CommandType = CommandType.Text,
Connection = Connection,
CommandText = string.Format("INSERT INTO
[BoardMembers] (BoardMemberName)
VALUES ('{0}')", boardMember)
};
command.ExecuteNonQuery();
}
resultSet.Close();
command.Dispose();
}
this.Connection.Close();
Response.Redirect(HttpContext.Current.Reque
st.Url.AbsoluteUri);
}
private void PopulatePanels()
{
foreach (var company in this.GetCompanies())
{
var companyDeleteButton = new ImageButton
{
ID = string.Format("companyDeleteButton_{0}",
company.id),
ImageUrl = "delete.png",
AlternateText = "Ta bort",
ToolTip = "Ta bort",
BorderWidth = 0
};
companyDeleteButton.Click += new
ImageClickEventHandler(DeleteCompany);
this.CompaniesPanel.Controls.Add(new Label {
Text =
string.Format("{0} ", company.value) });
this.CompaniesPanel.Controls.Add(new
HyperLink
{ ImageUrl = "edit.png", NavigateUrl =
string.Format("~/
LinkBoardMembers.aspx?company={0}",
company.id), ToolTip = "Redigera
styrelsemedlemmar", BorderWidth = 0 });
this.CompaniesPanel.Controls.Add(new Label {
Text =
" " });
this.CompaniesPanel.Controls.Add(companyDe
leteButton);
this.CompaniesPanel.Controls.Add(new Label {
Text =
"<br />" });
}
foreach (var boardMember in
this.GetBoardMembers())
{
var boardMemberDeleteButton = new
ImageButton
{
ID =
string.Format("boardMemberDeleteButton_{0}",
boardMember.id),
ImageUrl = "delete.png",
AlternateText = "Ta bort",
ToolTip = "Ta bort",
BorderWidth = 0
};
boardMemberDeleteButton.Click += new
ImageClickEventHandler(DeleteBoardMember);
this.BoardMembersPanel.Controls.Add(new
Label { Text
= string.Format("{0} ",
boardMember.value) });
this.BoardMembersPanel.Controls.Add(new
HyperLink
{ ImageUrl = "edit.png", NavigateUrl =
string.Format("~/
LinkCompanies.aspx?boardMember={0}",
boardMember.id), ToolTip =
"Redigera företag", BorderWidth = 0 });
this.BoardMembersPanel.Controls.Add(new
Label { Text
= " " });
this.BoardMembersPanel.Controls.Add(boardM
emberDeleteButton);
this.BoardMembersPanel.Controls.Add(new
Label { Text
= "<br />" });
}
}
private void DeleteCompany(object sender,
ImageClickEventArgs e)
{
var companyDeleteButton = sender as
ImageButton;
if (companyDeleteButton != null)
{
var companyId =
companyDeleteButton.ID.Replace("companyDe
leteButton_",
string.Empty);
this.Connection.Open();
var command = new SqlCommand
{
CommandType = CommandType.Text,
Connection = Connection,
CommandText = string.Format("DELETE
FROM
[Companies] WHERE ID='{0}'", companyId)
};
command.ExecuteNonQuery();
command.Dispose();
command = new SqlCommand
{
CommandType = CommandType.Text,
Connection = Connection,
CommandText = string.Format("DELETE
FROM
[CompanyBoardMembers] WHERE
CompanyID='{0}'", companyId)
};
command.ExecuteNonQuery();
command.Dispose();
this.Connection.Close();
}
Response.Redirect(HttpContext.Current.Reque
st.Url.AbsoluteUri);
}
private void DeleteBoardMember(object sender,
ImageClickEventArgs e)
{
var boardMemberDeleteButton = sender as
ImageButton;
if (boardMemberDeleteButton != null)
{
var boardMemberId =
boardMemberDeleteButton.ID.Replace("board
MemberDeleteButton_",
string.Empty);
this.Connection.Open();
var command = new SqlCommand
{
CommandType = CommandType.Text,
Connection = Connection,
CommandText = string.Format("DELETE
FROM
[BoardMembers] WHERE ID='{0}'",
boardMemberId)
};
command.ExecuteNonQuery();
command.Dispose();
command = new SqlCommand
{
CommandType = CommandType.Text,
Connection = Connection,
CommandText = string.Format("DELETE
FROM
[CompanyBoardMembers] WHERE
BoardMemberID='{0}'", boardMemberId)
};
command.ExecuteNonQuery();
command.Dispose();
this.Connection.Close();
}
Response.Redirect(HttpContext.Current.Reque
st.Url.AbsoluteUri);
}
private List<DatabaseRow> GetCompanies()
{
var companies = new List<DatabaseRow>();
this.Connection.Open();
var command = new SqlCommand
{
CommandType = CommandType.Text,
Connection = Connection,
CommandText = "SELECT ID, CompanyName
FROM
[Companies]"
};
var resultSet = command.ExecuteReader();
if (resultSet.HasRows)
```

```
{
while (resultSet.Read())
{
companies.Add(new DatabaseRow { id =
resultSet.GetInt64(resultSet.GetOrdinal("ID")),
value =
resultSet.GetString(resultSet.GetOrdinal("Comp
anyName")) });
}
}
resultSet.Close();
command.Dispose();
this.Connection.Close();
return companies;
}
```

.Close();

```
using System;
using System.Collections.Generic;
using System.Data;
using System.Data.SqlClient;
using System.Linq;
using System.Web;
using System.Web.UI;
using System.Web.UI.WebControls;
namespace William
{
public partial class LinkBoardMembers :
System.Web.UI.Page
{
public class BoardMember
{
public long id { get; set; }
public string name { get; set; }
}
private SqlConnection Connection;
private SqlConnection SecondConnection;
private long _companyId;
protected void Page_Load(object sender,
EventArgs e)
{
long.TryParse(Request.QueryString["company"]
, out _companyId);
if ((_companyId != null) &&
(!_companyId.Equals(0)))
{
var connectionString =
"Server=SERVER\\DATABASE;Database=Data
base;User Id=user;Password=password;";
this.Connection = new
SqlConnection(connectionString);
this.SecondConnection = new
SqlConnection(connectionString);
this.CompanyLabel.Text =
GetCompanyName();
this.AddBoardMembers();
this.SubmitButton.Visible = true;
}
}
private void AddBoardMembers()
{
this.Connection.Open();
var command = new SqlCommand
{
CommandType = CommandType.Text,
Connection = Connection,
CommandText = "SELECT ID,
BoardMemberName FROM [BoardMembers]"
};
var resultSet = command.ExecuteReader();
if (resultSet.HasRows)
{
while (resultSet.Read())
{
var boardMemberId =
resultSet.GetInt64(resultSet.GetOrdinal("ID"));
var boardMemberName =
resultSet.GetString(resultSet.GetOrdinal("Board
MemberName"));
var boardMemberChecked = false;
this.SecondConnection.Open();
var secondCommand = new SqlCommand
{
CommandType = CommandType.Text,
Connection = SecondConnection,
CommandText = string.Format("SELECT
BoardMemberID FROM
[CompanyBoardMembers] WHERE
BoardMemberID='{0}' AND CompanyID='{1}'",
boardMemberId, _companyId)
};
var secondResultSet =
secondCommand.ExecuteReader();
if (secondResultSet.HasRows)
{
boardMemberChecked = true;
}
secondResultSet.Close();
secondCommand.Dispose();
this.SecondConnection.Close();
this.BoardMembersPanel.Controls.Add(new
CheckBox { ID =
string.Format("boardMemberCheckBox_{0}",
boardMemberId), Checked =
boardMemberChecked });
this.BoardMembersPanel.Controls.Add(new
Label { Text = string.Format(" {0}<br />",
boardMemberName) });
}
}
resultSet.Close();
command.Dispose();
this.Connection.Close();
}
private string GetCompanyName()
{
this.Connection.Open();
var returnValue = string.Empty;
var command = new SqlCommand
{
CommandType = CommandType.Text,
Connection = Connection,
CommandText = string.Format("SELECT
CompanyName FROM [Companies] WHERE
ID = '{0}'", _companyId)
};
var resultSet = command.ExecuteReader();
if (resultSet.HasRows)
{
while (resultSet.Read())
{
returnValue =
resultSet.GetString(resultSet.GetOrdinal("Comp
anyName"));
}
}
resultSet.Close();
command.Dispose();
this.Connection.Close();
return returnValue;
}
protected void Save(Object sender, EventArgs
e)
{
this.Connection.Open();
foreach (var control in
this.BoardMembersPanel.Controls)
{
var checkBox = control as CheckBox;
if (checkBox != null)
{
var boardMemberId =
checkBox.ID.Replace("boardMemberCheckBox
_", string.Empty);
if (checkBox.Checked)
{
var command = new SqlCommand
{
CommandType = CommandType.Text,
Connection = Connection,
CommandText = string.Format("SELECT
BoardMemberID FROM
[CompanyBoardMembers] WHERE
BoardMemberID='{0}' AND CompanyID='{1}'",
boardMemberId, _companyId)
};
var resultSet = command.ExecuteReader();
if (!resultSet.HasRows)
{
resultSet.Close();
command.Dispose();
command = new SqlCommand
{
CommandType = CommandType.Text,
Connection = Connection,
CommandText = string.Format("INSERT INTO
[CompanyBoardMembers] (CompanyID,
BoardMemberID) VALUES ('{0}','{1}')",
_companyId, boardMemberId)
};
command.ExecuteNonQuery();
}
else
{
resultSet.Close();
}
command.Dispose();
}
else
{
var command = new SqlCommand
{
CommandType = CommandType.Text,
Connection = Connection,
CommandText = string.Format("DELETE
FROM [CompanyBoardMembers] WHERE
BoardMemberID = '{0}' AND CompanyID='{1}'",
boardMemberId, _companyId)
};
command.ExecuteNonQuery();
command.Dispose();
}
}
}
this.Connection.Close();
this.MessagePanel.Controls.Clear();
this.MessagePanel.Controls.Add(new Label {
Text = "Sparat" });
}
}
}
```

```
using System;
using System.Collections.Generic;
using System.Data;
using System.Data.SqlClient;
using System.Linq;
using System.Web;
using System.Web.UI;
using System.Web.UI.WebControls;
namespace William
{
public partial class LinkCompanies :
System.Web.UI.Page
{
public class Company
{
public long id { get; set; }
public string name { get; set; }
}
private SqlConnection Connection;
private SqlConnection SecondConnection;
private long _boardMemberId;
protected void Page_Load(object sender,
EventArgs e)
{
long.TryParse(Request.QueryString["boardMe
mber"], out _boardMemberId);
if ((_boardMemberId != null) &&
(!_boardMemberId.Equals(0)))
{
var connectionString =
"Server=SERVER\\DATABASE;Database=Data
base;User Id=user;Password=password;";
this.Connection = new
SqlConnection(connectionString);
this.SecondConnection = new
SqlConnection(connectionString);
this.BoardMemberLabel.Text =
GetBoardMemberName();
this.AddCompanies();
this.SubmitButton.Visible = true;
}
}
private void AddCompanies()
{
```

```
this.Connection.Open();
var command = new SqlCommand
{
CommandType = CommandType.Text,
Connection = Connection,
CommandText = "SELECT ID, CompanyName
FROM [Companies]"
};
var resultSet = command.ExecuteReader();
if (resultSet.HasRows)
{
while (resultSet.Read())
{
var companyId =
resultSet.GetInt64(resultSet.GetOrdinal("ID"));
var companyName =
resultSet.GetString(resultSet.GetOrdinal("Comp
anyName"));
var companyChecked = false;
this.SecondConnection.Open();
var secondCommand = new SqlCommand
{
CommandType = CommandType.Text,
Connection = SecondConnection,
CommandText = string.Format("SELECT
CompanyID FROM [CompanyBoardMembers]
WHERE BoardMemberID='{0}' AND
CompanyID='{1}'", _boardMemberId,
companyId)
};
var secondResultSet =
secondCommand.ExecuteReader();
if (secondResultSet.HasRows)
{
companyChecked = true;
}
secondResultSet.Close();
secondCommand.Dispose();
this.SecondConnection.Close();
this.CompaniesPanel.Controls.Add(new
CheckBox { ID =
string.Format("companyCheckBox_{0}",
companyId), Checked = companyChecked });
this.CompaniesPanel.Controls.Add(new Label {
Text = string.Format(" {0}<br />",
companyName) });
}
}
resultSet.Close();
command.Dispose();
this.Connection.Close();
}
private string GetBoardMemberName()
{
this.Connection.Open();
var returnValue = string.Empty;
var command = new SqlCommand
{
CommandType = CommandType.Text,
Connection = Connection,
CommandText = string.Format("SELECT
BoardMemberName FROM [BoardMembers]
WHERE ID = '{0}'", _boardMemberId)
};
var resultSet = command.ExecuteReader();
if (resultSet.HasRows)
{
while (resultSet.Read())
{
returnValue =
resultSet.GetString(resultSet.GetOrdinal("Board
MemberName"));
}
}
resultSet.Close();
command.Dispose();
this.Connection.Close();
return returnValue;
}
protected void Save(Object sender, EventArgs
e)
{
this.Connection.Open();
foreach (var control in
this.CompaniesPanel.Controls)
{
var checkBox = control as CheckBox;
if (checkBox != null)
{
var companyId =
checkBox.ID.Replace("companyCheckBox_",
string.Empty);
if (checkBox.Checked)
{
var command = new SqlCommand
{
CommandType = CommandType.Text,
Connection = Connection,
CommandText = string.Format("SELECT
CompanyID FROM [CompanyBoardMembers]
WHERE BoardMemberID='{0}' AND
CompanyID='{1}'", _boardMemberId,
companyId)
};
var resultSet = command.ExecuteReader();
if (!resultSet.HasRows)
{
resultSet.Close();
command.Dispose();
command = new SqlCommand
{
CommandType = CommandType.Text,
Connection = Connection,
CommandText = string.Format("INSERT INTO
[CompanyBoardMembers] (CompanyID,
BoardMemberID) VALUES ('{0}','{1}')",
companyId, _boardMemberId)
};
command.ExecuteNonQuery();
}
else
{
resultSet.Close();
}
command.Dispose();
}
else
{
var command = new SqlCommand
{
CommandType = CommandType.Text,
Connection = Connection,
CommandText = string.Format("DELETE
FROM [CompanyBoardMembers] WHERE
BoardMemberID = '{0}' AND CompanyID='{1}'",
_boardMemberId, companyId)
};
command.ExecuteNonQuery();
command.Dispose();
}
}
}
this.Connection.Close();
this.MessagePanel.Controls.Clear();
this.MessagePanel.Controls.Add(new Label {
Text = "Sparat" });
}
}
}


using System;
using System.Collections.Generic;
using System.Data;
using System.Data.SqlClient;
using System.Linq;
using System.Web;
using System.Web.UI;
using System.Web.UI.WebControls;
namespace William
{
public partial class ViewConnections :
System.Web.UI.Page
{
public class DatabaseRow
{
public long id { get; set; }
public string value { get; set; }
}
public class CompanyBoardMember
{
public long CompanyId { get; set; }
public long BoardMemberId { get; set; }
}
private SqlConnection Connection;
private List<DatabaseRow> Companies;
private List<CompanyBoardMember>
CompanyBoardMembers;
protected override void OnInit(EventArgs e)
{
base.OnInit(e);
}
protected override void
OnPreRender(EventArgs e)
{
base.OnPreRender(e);
this.BuildFilterList();
}
protected void Page_Load(object sender,
EventArgs e)
{
var connectionString =
"Server=SERVER\\DATABASE;Database=Data
base;User Id=user;Password=password;";
this.Connection = new
SqlConnection(connectionString);
this.Companies = this.GetCompanies();
this.CompanyBoardMembers =
this.GetCompanyBoardMembers();
this.BuildCheckBoxList();
}
private void BuildCheckBoxList()
{
EnsureChildControls();
foreach (var company in this.Companies)
{
this.CompaniesPanel.Controls.Add(new
CheckBox { ID =
string.Format("companyCheckBox_{0}",
company.id), Checked = false });
this.CompaniesPanel.Controls.Add(new Label {
Text = string.Format(" {0}<br />",
company.value.Replace(" ", " ")) });
}
}
private void BuildFilterList()
{
var filteredCompanies = new
List<DatabaseRow>();
var headerRow = new TableHeaderRow();
headerRow.Cells.Add(new TableHeaderCell());
foreach (var control in
this.CompaniesPanel.Controls)
{
var checkbox = control as CheckBox;
if ((checkbox != null) && (checkbox.Checked))
{
var companyId =
checkbox.ID.Replace("companyCheckBox_",
string.Empty);
var companyName = string.Empty;
DatabaseRow company = new DatabaseRow();
;
foreach (var existingCompany in
this.Companies)
{
if
(existingCompany.id.ToString().Equals(compan
yId))
{
companyName = existingCompany.value;
company = existingCompany;
break;
}
}
var headerCell = new TableHeaderCell();
headerCell.Text = companyName.Replace(" ",
" ");
headerRow.Cells.Add(headerCell);
filteredCompanies.Add(new DatabaseRow { id
= company.id, value = companyName });
}
}
this.CompaniesTable.Rows.Add(headerRow);
foreach (var filteredCompany in
filteredCompanies)
{
var tableRow = new TableRow();
tableRow.Cells.Add(new TableCell { Text =
string.Format("<strong>{0}</strong>",
filteredCompany.value.Replace(" ", " "))
});
foreach (var connectedCompany in
filteredCompanies)
{
var connectionStrength = 0;
if
(!filteredCompany.id.Equals(connectedCompan
y.id))
{
foreach (DatabaseRow filteredBoardMember in
this.GetBoardMembers(filteredCompany.id))
{
foreach (DatabaseRow
connectedBoardMember in
this.GetBoardMembers(connectedCompany.id))
{
if
(filteredBoardMember.id.Equals(connectedBoar
dMember.id))
{
connectionStrength += 1;
}
foreach (var subFilteredCompany in
this.GetCompanies(filteredBoardMember.id))
{
foreach (var subConnectedCompany in
this.GetCompanies(connectedBoardMember.id)
)
{
if
(subFilteredCompany.id.Equals(subConnected
Company.id) &&
!subFilteredCompany.id.Equals(filteredCompan
y.id) &&
!subFilteredCompany.id.Equals(connectedCom
pany.id) &&
!subConnectedCompany.id.Equals(filteredCom
pany.id) &&
!subConnectedCompany.id.Equals(connectedC
ompany.id))
{
connectionStrength += 1;
}
}
}
```

```
}
}
}
tableRow.Cells.Add(new TableCell { Text =
connectionStrength.ToString() });
}
this.CompaniesTable.Rows.Add(tableRow);
}
}
private List<CompanyBoardMember>
GetCompanyBoardMembers()
{
var connections = new
List<CompanyBoardMember>();
this.Connection.Open();
var command = new SqlCommand
{
CommandType = CommandType.Text,
Connection = Connection,
CommandText = "SELECT
BoardMemberID,CompanyID FROM
[CompanyBoardMembers]"
};
var resultSet = command.ExecuteReader();
if (resultSet.HasRows)
{
while (resultSet.Read())
{
connections.Add(new CompanyBoardMember {
BoardMemberId =
resultSet.GetInt64(resultSet.GetOrdinal("Board
MemberID")), CompanyId =
resultSet.GetInt64(resultSet.GetOrdinal("Comp
anyID")) });
}
}
resultSet.Close();
command.Dispose();
this.Connection.Close();
return connections;
}
private List<DatabaseRow>
GetBoardMembers(long companyId)
{
var boardMembers = new
List<DatabaseRow>();
foreach (var connection in
this.CompanyBoardMembers)
{
if (connection.CompanyId.Equals(companyId))
{
boardMembers.Add(new DatabaseRow { id =
connection.BoardMemberId, value =
string.Empty });
}
}
return boardMembers;
}
private List<DatabaseRow>
GetCompanies(long boardMemberId)
{
var companies = new List<DatabaseRow>();
foreach (var connection in
this.CompanyBoardMembers)
{
if
(connection.BoardMemberId.Equals(boardMem
berId))
{
companies.Add(new DatabaseRow { id =
connection.CompanyId, value = string.Empty });
}
}
return companies;
}
private List<DatabaseRow> GetCompanies()
{
var companies = new List<DatabaseRow>();
this.Connection.Open();
var command = new SqlCommand
{
CommandType = CommandType.Text,
Connection = Connection,
CommandText = "SELECT ID, CompanyName
FROM [Companies]"
};
var resultSet = command.ExecuteReader();
if (resultSet.HasRows)
{
while (resultSet.Read())
{
companies.Add(new DatabaseRow { id =
resultSet.GetInt64(resultSet.GetOrdinal("ID")),
value =
resultSet.GetString(resultSet.GetOrdinal("Comp
anyName")) });
}
}
resultSet.Close();
command.Dispose();
this.Connection.Close();
return companies;
}
protected void Update(Object sender,
EventArgs e)
{
}
}
}
```