
Entrepreneur online social networks – structure, diversity and impact on start-up survival

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Abstract: In this paper, we discuss the results of a pilot study in which we use a novel approach to collect entrepreneur online social network data from LinkedIn, Facebook and Twitter. We studied the size and structure of entrepreneur social networks by analysing the online network industry and location diversity. Our findings suggest that entrepreneurs use multiple online social networks that form their network-of networks (NoN). We examined the entrepreneurs' network size and diversity to gauge their impact on performance in terms of survival. Our findings suggest that the entrepreneurs' LinkedIn network size has a positive relationship with entrepreneurial survival. However, the size of the entrepreneurs' Facebook network is not related to their survival and the size of entrepreneurs' Twitter network has a negative relationship with performance. We visualised the entrepreneurs' LinkedIn network using industry diversity. Finally, we reflect on the implications for future research to uncover the structure of entrepreneur online social networks.

Keywords: online social network; network visualisation; network diversity; social network; entrepreneurial performance.

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1 Introduction

Social networks, and recently online social networks such as LinkedIn, Facebook and Twitter are attracting the attention of researchers. The study of social networks aims to uncover the complex relationships among groups and communities. As social network analysis focuses more on relationships rather than the attributes of the research objects, it has become a prominent theoretical perspective within the literature on entrepreneurship. For example, the social network approach has been used to explain why some entrepreneurs are more successful in starting and maintaining businesses than others (Aldrich and Zimmer, 1986; Brüderl and Preisendörfer, 1998). The increasing use of the internet makes the use of online social networks ubiquitous and offers an opportunity to study them. Meanwhile, it also becomes a necessary platform for entrepreneurs to build up their own social networks (Baum et al., 2000; Hansen, 1995; Larson, 1991; Nann et al., 2010). However, we don't know to what extent social networks contributes to their business success, if at all. In order to explore the functions and structures of entrepreneur online social networks, we collected data using the application programming interface (API) offered via the online social networks we studied.

Entrepreneurs are embedded in multiple social networks from which they seek opportunities and resources to start businesses. Each entrepreneurial firm constitutes a hub organisation with a small number of stable exchange relationships; in other words, a network connected with other companies. These relationships collectively form small, yet dense, networks of ties integrating a handful of outside firms. The firms they connect with can provide critical resources to entrepreneurial start-ups. During the process of starting up, entrepreneurs obtain information and resources from individuals and companies in their networks. Thus, the nodes that entrepreneurs connect to are used to get valuable information and resources at different stages of the start-up process. However, social network analysis has generally been constrained in accuracy, breadth, and depth due to a reliance on self-reported data (Eagle et al., 2009), and the lack of a quantitative approach (Brüderl and Preisendörfer, 1998). In order to understand the structure of the entrepreneurs' networks, we need to move beyond mere descriptive accounts to more in-depth explanations.

2 Social networks and entrepreneurship

A network is a set of actors connected by a set of ties. The actors can be persons, teams, organisations, or even concepts. Ties connecting pairs of actors can be directed or undirected and can be dichotomous or valued (Borgatti and Foster, 2003). Social network analysis is based on an assumption of the importance of relationships among interacting units. The relations defined by the connections among units are a fundamental component

of network theories. Actors and their actions are viewed as interdependent rather than independent (Wasserman and Faust, 1994).

Previous research on social networks and entrepreneurship were mainly conducted from three perspectives. First, from the perspective of collaborations among large number of subjects, the more collaborators an individual has, the higher the chances are that he or she will be invited to participate in subsequent collaborations. (Barabási, 2005; Raz and Gloor, 2007). Second, from the perspective of organisational level, social networks affects entrepreneur performance and entrepreneurial actions and thus entrepreneurial networking (Hansen, 1995; Larson, 1992). In the organisational context, a network is a collection of voluntary agreements between firms, which entail exchanges of information and the sharing existing knowledge (Gulati, 1998). The more collaborators an individual has, the higher the chances are that he or she will be invited to participate again (Barabási, 2005). Third, from the perspective of individual level, the focus will be on individual entrepreneurs,, in other words, the nodes and ties of the networks which consist of every form of communication or exchange between entrepreneurs (Brüderl and Preisendörfer, 1998; Granovetter, 1973). Additionally, research based on social capital, the theories of structure hole and brokerage (Burt, 1992) are still the main current of research.

Each entrepreneurial firm is a hub organisation with a small number of stable exchange relationships that are maintained with favourite outside companies (Larson, 1991). According to Bouchikhi (1993), the entrepreneurial outcome is determined neither by the entrepreneur nor by the context, but emerges in the process of their interaction. This view is supported by Sarasvathy and Venkataraman (2011), with the suggestion that the entrepreneurial process, the interaction, is an important source for opportunities. However, due to the lack of large amount of data as well as the sensitive nature of information from entrepreneurial networks, empirical studies focus more on the self-reported network data using offline questionnaires, and thereby lack the behavioural network information that is available in online social networks.

As ubiquitous usage of internet has increased human interactions and opportunities for the emergence of social networks, it is possible for us to analyse entrepreneur behavioural and longitudinal data using network data collected from their online communications. Online social networks contain important troves of information such as entrepreneur's profile information, entrepreneurs' connection with their friends and family as well as business partners.

The internet serves as an instrument for expanding social networks in a number of ways (Ahn et al., 2007). We draw upon Boyd and Ellison's (2007) definition of online social network as "web-based services that allow individuals (1) to construct a semi-public profile within a bounded system, (2) to articulate a list of other users with whom they share a connection, and (3) to view and transverse their list of connections and those made by others within the system".

Previous research on online social networks has primarily examined private interactions (Boyd, 2007; Boyd and Ellison, 2007; Ellison et al., 2007; Lee and Lee, 2010; Wellman et al., 2001). A few studies have been done on the value of online social networks, such as LinkedIn, for maintaining business networks (Nann et al., 2010; O'Murchu et al., 2004). Online social network sites support both the maintenance of existing social ties and the formation of new social connections (Ellison et al., 2007). The

internet neither increases nor decreases face-to-face or telephone communication but supplements social capital (Lee and Lee, 2010; Wellman et al., 2001).

Entrepreneurs use multiple online social networks. Therefore, we refer to entrepreneur network as network-of-networks (NoN), which includes LinkedIn, Facebook and Twitter in this study. The nodes and links can overlap in the entrepreneur's NoN. We use those overlapping nodes to link entrepreneur's different online social networks into their NoN. In this pilot study, we analysed the structure of entrepreneurs' online social networks NoN, namely LinkedIn, Facebook, and Twitter by comparing the diversity of their different online social networks.

3 Method

We introduced a novel method for the study of entrepreneur online social networks in our pilot study. We used the API of each of the online social networks we study to extract the entrepreneurs' profile and network data. We designed an online survey, to collect entrepreneurs' online social network data. The survey website used the official API to collect data from the different online social networks. Using the official API, we were able to collect actual behavioural data on the entrepreneurs – including profile information and connection information – from different social network sites. We did not use self-reported network data.

In order not to violate privacy regulations, we asked the agreement of the respondents before they logged into their online social networks through our survey. The online social networks included LinkedIn, Facebook and Twitter in this paper. We only generated a coded ID automatically instead of respondent's name. The data was coded and stored in our database for our analysis. Furthermore, the survey included a set of questions for measuring entrepreneurial performance in terms of survival, employee growth and revenue growth. The survey was distributed to entrepreneurs from different industries in the Netherlands. For this pilot study we selected 185 entrepreneurs from 345 participants. We use the data to create a visualisation map of the entrepreneurs' network.

The network data we collect is used to analyse entrepreneurs' online social network structure in terms of network size and network diversity and its possible impact on performance. Furthermore, the data collected using our approach makes it possible to create a visual map of entrepreneur's online network.

4 Entrepreneurial performances

The essential act of entrepreneurship is a new entry, that is, the act of launching a new venture, either by a start-up firm, through an existing firm, or via 'internal corporate venturing' (Lumpkin and Dess, 1996). Building a new company is a highly competitive and risky endeavour (Toby et al., 1999), hence, entrepreneurs who start new ventures need to continuously seek opportunities and mobilise resources (Aldrich and Auster, 1986). Accessing financial, social and other types of resources is inherently a social process, resources are acquired primarily through relationships with parties outside the boundaries of these start-ups (Toby et al., 1999). According to Geroski (1995) survival rate of most entrants is low, and a successful entrant may take more than a decade to

achieve a size comparable to that of the average incumbent. Furthermore, the results suggest that the entry of innovative firms is more common but less successful than entry by diversification.

There are three streams of possible measurements to evaluate the success of an entrepreneurial endeavour (Witt, 2004). The first is based on self-evaluations of entrepreneurs' success of their business. However, as different entrepreneurs are not equally satisfied about their performance, this measure is not suitable to study the success of start-ups (Chandler and Hanks, 1993). The second measure is the survival year of new start-ups. The difficulty of taking firm survival into account is the determination of a minimum time period for survival. A short survival period might only cover a small part of the initial entrepreneurial phase and a long survival period might include established, developed companies instead of start-ups. Previous studies take 3 to 5 years in order to measure the survival as a parameter of entrepreneurial performance (Brüderl and Preisendörfer, 1998; Gartner et al., 1999). The last success measurement is the growth rates of the companies (Brüderl and Preisendörfer, 1998; Witt, 2004). The most common used growth rates are sales growth (Brüderl and Preisendörfer, 1998) and employment growth (Baum et al., 2000).

Studies on offline social networks have shown that entrepreneurs who are well connected are more successful (Baum et al., 2000; Raz and Gloor, 2007; Schilling and Phelps, 2005; Uzzi, 1997; Uzzi and Spiro, 2005). Empirical evidence exists for the importance of social networks for entrepreneurial performance in offline settings. We aim to investigate if the same holds true in the online realm by comparing online social network structures to entrepreneurial performance. Therefore, we need to take into consideration that measuring the performance construct is difficult given its multidimensional nature (Cameron, 1978; Chakravarthy, 1986). Furthermore, in the context of entrepreneurial start-ups, general performance measures, such as profit, are somewhat misleading given initial (sunk) costs that need to be regained (Bosma et al., 2004).

Previous research identified non-financial entrepreneurial performance measures, (Bosma et al., 2004; Bouchikhi, 1993; Gimeno et al., 1997; Lumpkin and Dess, 1996; Singh, 1997), namely:

- *Survival*: the hazard of business ownership. Information is available on the survival time of the start-ups in our study. We have constructed a variable measuring the number of years that a firm has been active.
- *Change in the number of employees*: the employment created by an entrepreneur can be seen as a social performance measure: the difference in the number of employees the start-up has at the current stage and at the founding stage.
- *Percent change in revenues*: the percent change in the company revenues.

Our data included a snapshot view at one particular point in time rather than longitudinal data. Longitudinal data would support using Compound Annual Growth Rate (CAGR) as performance measure so that the results can be compared between the ventures. In case where revenue information over time is not available, indirect performance measures such as the percent change in revenues and in the number of employees is used. In this study we focus on survival as a measurement of performance.

5 Hypotheses on online social network structure and entrepreneurial performance

Network structure is one of the most frequently used approaches to evaluate network role in entrepreneurship. We derived a set of hypotheses using the following variables: size and diversity as proposed by Witt (2004).

5.1 Network size

Network size refers to the number of network actors (Burt, 1983). The larger the network is, the greater the amount of information circulates in it. Previous studies show that the size of the network has a positive influence on entrepreneurial success (Baum et al., 2000; Hansen, 1995). Thus we have our first hypothesis:

H1a Entrepreneurs' online *network size* is positively related to the survival of their new venture.

5.2 Network diversity

Network diversity refers to several dimensions and there are several definitions of diversity (Harrison and Klein, 2007). Diversity is a unit-level, compositional construct which can be used to describe the distribution of differences among members of a unit with respect to common attributes, such as tenure, ethnicity, gender, conscientiousness, task attitude, or pay (Harrison and Klein, 2007). The diversity of networks includes nodes' attribute diversity within a certain network.

Previous work on the impact of network diversity on entrepreneurial performance is still controversial. On one hand, entrepreneurs tend to become more successful if they can get access to diverse information and resources in their network (Brüderl and Preisendörfer, 1998). In other words, the diversity of social network can enhance the breadth of perspective, cognitive resource, and overall problem-solving capacity of the group (Hambrick et al., 1996) and thereby enhance entrepreneurial performance and the whole network performance. On the other hand, the diversity of demographic features, turn out to have a negative effect on team output (Harrison and Klein, 2007). Social networks may enhance communication problems and conflicts among different actors and thereby also decrease the performance of the networks.

Granovetter (1973), elaborated the diversity of a network by distinguishing between strong ties, relations with high levels of emotional underpinning, and weak ties, relations with a small emotional component but with greater rationality. In other words, weak ties are the source of network diversity. The network diversity describes the degree to which contacts are structurally 'non-redundant,' and there are both first order and second order dimensions of redundancy (Aral et al., 2009). The non-redundant nodes are connected by a structural hole. Individuals whose network is rich in structural holes have access to more opportunities, information and resources (Burt, 1992). Our research on network diversity will also help us understand whether structural holes also exist in the context of online social networks and the relationship to entrepreneurs' performance.

Small size social networks are effective in conserving resources while large networks enable the acquisition of new resources (Garton et al., 1999). In other words, the larger social networks have more heterogeneity in the social characteristics of network members

and more complexity in the structure of these networks. Hence, our second hypothesis based on the relationship between network size and network diversity:

H1b Entrepreneurs' online *network size* is positively related to *network diversity*.

If the network actors have similar backgrounds and work experience, they can more easily to share information and their experiences. However, this will also limit the information and resources that they can get from their network. The variety of changes with respect to relevant dimensions (e.g., sex, age, race, occupation, talents) can help the whole networks get new resources which can contribute to entrepreneurship and innovation (Burt, 1983). Entrepreneurs with better and more diverse interpersonal connections tend to earn more income and get more frequent promotions (Burt, 1997; Granovetter, 1985). We propose that entrepreneurs have preferences for connecting with various people for different purposes. The people they connect to might come from different industries. In order to further understand the structure of entrepreneur online social networks, we define the following hypothesis regarding diversity:

H2a The *industry diversity* of entrepreneurs' *LinkedIn network* is positively related to their entrepreneurial *survival*.

Entrepreneurs tend to become more successful if they gain access to most of the information and resources in their network (Brüderl and Preisendörfer, 1998). There is a common opinion that people share information with the people who are close to them. In offline networks geographical proximity facilitates information sharing. We use the following hypotheses for the relation between geographic diversity of the online social networks and performance in terms of survival. Most importantly, we investigate whether the geographic diversity of different online social networks influence their entrepreneurial performance. Thus we propose:

H2b The *geographic diversity* of entrepreneurs' *LinkedIn network* is positively related to their entrepreneurial *survival*.

H2c The *geographic diversity* of entrepreneurs' *Facebook network* is positively related to their entrepreneurial *survival*.

H2d The *geographic diversity* of entrepreneurs' *Twitter network* is positively related to their entrepreneurial *survival*.

Diversity is often used in sociology, ecology, and most areas of communication. We adopted the Blau Index of Variability (Blau, 1977) to measure the diversity of entrepreneurs' online social networks. The Blau diversity index is defined as

$$1 - \sum p_i^2,$$

where p is the proportion of categories in a given category and i is the number of different categories of the feature across all groups. For example, if an entrepreneur has 100 connections from 50 different countries, then p is the proportion of the entrepreneurs coming from city i (i is from 1 to 50). A perfectly homogenous network will have a diversity index of 0 (e.g., All entrepreneurs coming from the same city), and a perfectly heterogeneous network will have a diversity index of 1 (e.g., All entrepreneurs come from different cities). As number of categories increase, the maximum value of diversity index increases. Table 1 summarised the hypotheses we defined.

Table 1 Overview of hypotheses

	Measurement	Hypothesis
Size	Online social network size	<i>H1a: Entrepreneurs' online network size is positively related to their (entrepreneurial) survival of new venture.</i> <i>H1b: Entrepreneurs' network size from different online social networks is positively related to network diversity</i>
Diversity	Industry diversity	<i>H2a: The industry diversity of entrepreneurs' LinkedIn network is positively related to their entrepreneurial survival</i>
	Geographic diversity	<i>H2b: The geographic diversity of entrepreneurs' LinkedIn network is positively related to their entrepreneurial survival.</i> <i>H2c: The geographic diversity of entrepreneurs' Facebook network is positively related to their entrepreneurial survival.</i> <i>H2d: The geographic diversity of entrepreneurs' Twitter network is positively related to their entrepreneurial survival.</i>

6 Data

We designed an online survey to collect data on entrepreneurial online social networks. The survey included demographic and business information, their profiles and their network data. Using the official API, we were able to collect actual entrepreneurs' behavioural data from different social network sites rather than relying on entrepreneurs' self-reporting network data.

In order to extract entrepreneurs' online social network data, the participants logged into their online social networks through links embedded in our online survey. We only get the data after the approval of the participants thus we overcome the privacy violation issue. There were three ways for us to reach entrepreneurs to participate our survey.

- 1 We invited entrepreneurs randomly through the people we had in our own networks.
- 2 We administered surveys through entrepreneur organisations such as consulting and social media companies.
- 3 We visited entrepreneurs personally if they were reluctant to participate our survey.

For purposes of this study we defined people as entrepreneurs by asking whether they were the owner/founder or co-owner/co-founder of one or more ventures. Meanwhile, we also asked their private and venture demographic information as well as performance in terms of survival, growth percentage in employees and revenues.

In total, 345 respondents participated on our survey. We filtered out non-entrepreneurs and respondents outside the Netherlands. We selected 185 entrepreneurs who shared their LinkedIn network information with us. We assume that the LinkedIn network to be more relevant to our study and thus we only selected entrepreneurs who had LinkedIn accounts. Of these 185 entrepreneurs, 114 people had both LinkedIn

network and Facebook network while 78 used all the three online social networks. Table 2 depicts a detailed breakdown of our data.

Table 2 Network data description

	<i>LinkedIn</i>	<i>LinkedIn +Facebook</i>	<i>LinkedIn + Facebook + Twitter (NoN)</i>
Number of respondents	185	114 (61%)	78 (42%)
Average network size (Nodes)	316	137 (Facebook nodes)	281/481 (Twitter friends/followers)
Average Industry Diversity Index	0.65		
Average City Diversity Index	0.87	0.67	0.97

Entrepreneurs' online social networks are highly heterogenous, with average industry diversity index of 0.65 and average geographical diversity index of 0.67–0.97. Our data suggests that using multiple online social networks (NoN), increases entrepreneurs network heterogeneity, having diversity index of 0.97. About 58%–61% of entrepreneurs used two online social networks and 42% used three online social networks, which suggests that entrepreneurs do not limit themselves to none online network but tend towards NoN. In the following section we will present analysis of entrepreneurial network structure on performance.

7 Results

All the entrepreneurs in our study use LinkedIn. In the first step of analysis, we did a one-way ANOVA analysis for the LinkedIn industry diversity and company ages to test the similarities among different groups (Table 3). We grouped the industries into ten categories. The respondents belonged to six of the groups, which are: industrial materials, service, health and financial ICT as well as telecommunication industries, though their networks were linked to nodes in all ten categories. We found that respondents in each of the categories had distinctively different levels of industry diversity ($F_{(5,183)} = 4.786$, $p < 0.001$). They also are significantly different in their companies' age ($F_{(5,183)} = 3.968$, $p = 0.002$). Among all the groups, the service industry has the lowest industry diversity in their online social networks. The rest groups are at the same level, while the health industry has the highest company age. The rest groups are at the same level.

Table 3 ANOVA

		<i>Sum of squares</i>	<i>df</i>	<i>Mean square</i>	<i>F</i>	<i>Sig.</i>
Industry diversity	Between groups	.228	5	.046	4.786	.000*
	Within groups	1.698	178	.010		
	Total	1.926	183			
Company age	Between groups	418.065	5	83.613	3.968	.002*
	Within groups	3,750.668	178	21.071		
	Total	4,168.734	183			

We hypothesise that the size of entrepreneur's network is related to performance. In Table 4 we present the results of the second step of our analysis – regression analysis testing impact of network size on performance in terms of survival.

Table 4 Regression coefficients with survival as dependent variable

<i>Predictors</i>	<i>P-value (Std. β)</i>
LinkedIn network size	.01 (0.28)*
Facebook network size	.83 (0.02)
Twitter network size	.03 (–0.20)*
The age of entrepreneurs	.00(0.43)*
R_2 (R_2 <i>adj</i>)	38% (34%)

The results suggest that LinkedIn network size is significantly related to entrepreneurial performance in terms of survival (H1a). However, entrepreneurs' Facebook network size has no correlation with performance in terms of survival. Entrepreneurs' Twitter network size is negatively related to entrepreneurial performance in terms of survival. The results of this pilot study suggest that entrepreneurial survival rate will be higher as LinkedIn network size grows. However, entrepreneurs' survival rate will decrease as Twitter network size grows. This model as a whole explained 34% of the variance in entrepreneurial performance in terms of survival. In total, this model implies that network size for LinkedIn has a positive relation to entrepreneurial survival. A plausible explanation is that entrepreneurs might use Facebook for purposes other than business. Twitter, which is a directed network, has both friends and followers. The impact of size on performance has a negative effect to their performance. Twitter may require more 'online time' and if this indeed is the case it may impact entrepreneurs' performance. In this pilot study we did not include measurements for the time spent by entrepreneurs on each of their online social networks. This may be an interesting opportunity for future research.

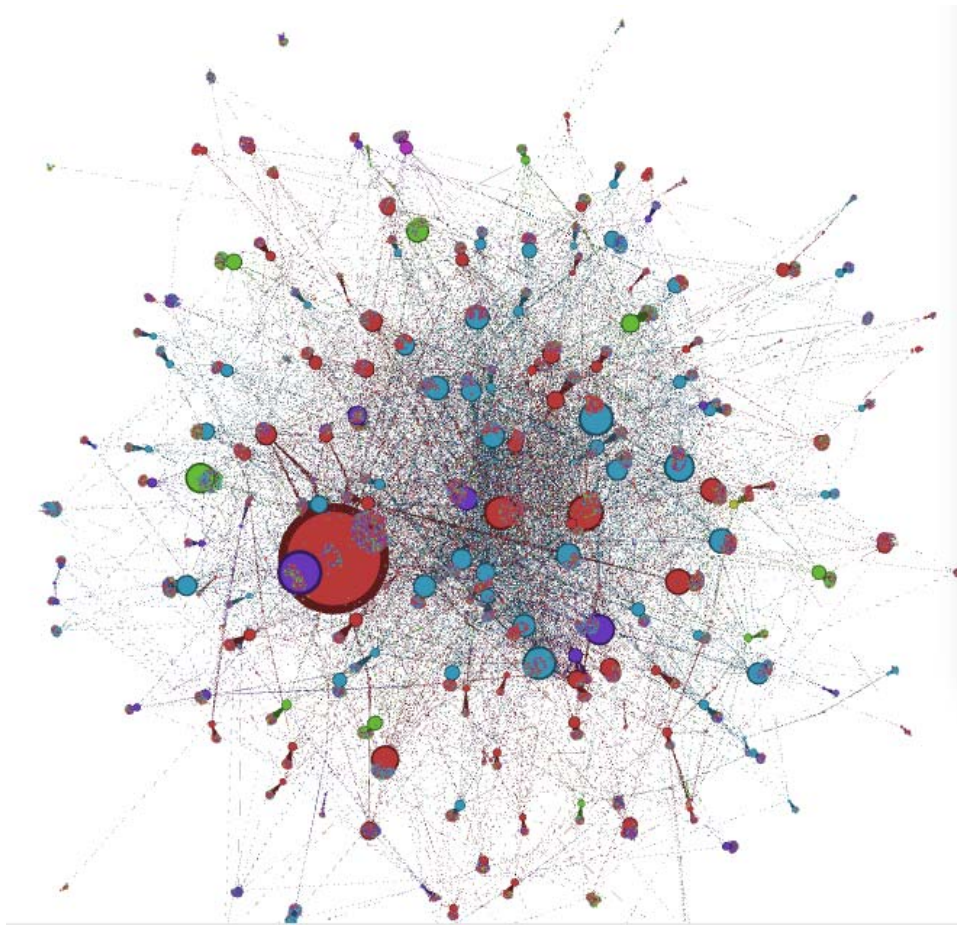
These results indicate that entrepreneur's use of LinkedIn, in terms of network size, has positive impact on venture's survival. However, this finding raises a question regarding the causality between network size and its impact on survival: do successful entrepreneurs establish larger network because of their success or large networks are making successful entrepreneurs? In this pilot study we analysed only snapshot data, whereas addressing this question requires longitudinal data, which will be collected in the next phase of the study. However, there is no relationship between entrepreneurs' online social network diversity and entrepreneurial performance in terms of employee and revenue growth.

We conducted a regression analysis with regards to the diversity in the network. We found that entrepreneur online network diversity has no relation to the performance in terms of survival (H2a–H2d). This can be caused by the data on survival, which is not strong enough to explain entrepreneurs' performance.

In order to explore future steps for this research project, we carried out correlation on all of the study variables we have. We found that entrepreneurs' industry diversity is correlated with entrepreneurs' network size (H1b). Entrepreneurs' city diversity demonstrates significant correlation with entrepreneurial network size.

We used the degree centrality to generated network map based on the entrepreneurs' LinkedIn accounts (Figure 1). The dataset included 184 respondents and a network of more then 58,000 nodes. The circle size depicts entrepreneur's importance in terms of degree centrality and network size. The different colours of the nodes represent entrepreneurs from different industries. The industries in which entrepreneurs have networks showing higher degree centrality (larger networks) are business services, ICT and the financial industry.

Figure1 Entrepreneurs' LinkedIn network structure by degree centrality (see online version for colours)



8 Discussion

In this pilot study we introduced a novel approach to the study entrepreneur online social networks and their NoN, through the extraction of data from their LinkedIn, Facebook and Twitter profile and network data with the API. Our method improved the quality of the data in comparison to self-reported data used in previous studies of social networks.

Our sample includes 184 entrepreneurs of which 114 use LinkedIn and Facebook, and 78 use LinkedIn, Facebook and Twitter. Our dataset includes more than 58,000 nodes. Though our method was used in this pilot study to generate a snapshot view of the networks, it is useable for longitudinal studies in which the dynamics of the networks can be explored over time. This will support better analyses of the impact that network structure and dynamics may have on performance over time. Furthermore our approach resolves the privacy issue by inviting respondents to log into their networks from within the online survey application we designed based on official API for each online social network.

We use the data to study entrepreneurs' network structure, diversity and conduct an analysis of networks impact on entrepreneur's performance measured by survival. We find that LinkedIn network size is positively correlated with performance in term of venture's survival and that network diversity does not impact performance.

This study makes several important contributions. First, it demonstrates the feasibility of a novel approach to access and collect online social network profile and network information. The results suggest that online social network structure in terms of network diversity is different from what had been expected. Entrepreneurs tend to have very diverse networks. However, all the networks are not related to each other, which can be interpreted that entrepreneurs don't use all online social networks for their business or the purpose of entrepreneurs using online social networks are different.

Secondly, as a contribution to the literature on online social networks, which has been primarily focused on private use, our study provides new insights on the use of online social networks by entrepreneurs and its effect on entrepreneurial survival. To the literature on entrepreneurship we provide some initial insights into aspects of online social network structures that positively influence performance and how this influence may be different from offline social networks.

Thirdly, empirical research on entrepreneurial network dynamics has been limited by a lack of longitudinal data and process-oriented data. Therefore, it neither addresses the emergence and dynamics of networks over time nor provides links to venture performance. Our methodology makes it possible to collect entrepreneur online social network data longitudinally for a dynamic network analysis.

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