

‘What matters is on the inside’

- *An exploratory study of the internal social network of a start-up*

Abstract:

Social networks have been found to be a key factor of performance and innovation as they allow for the search and transfer of knowledge. Networks have been perceived to be especially important in start-ups, due to the dynamic environments and limited resources available. Although networks have been used as a central concept in start-up literature, little actual network theory has been used. Consequently, there is little insight on what type of characteristics the internal networks of start-ups have. However, internal networks have been explored in mature companies but since these have different organizational characteristics, such as age and size, it is unclear whether the findings of these can be transferred to a start-up context. Therefore, the thesis conducts an exploratory study of a start-up, in order to compare the findings with mature network characteristics to distinguish between differences and to analyze which of the networks is more efficient at knowledge transfer. A mixed-method approach was used to conduct the social network analysis of the start-up.

The findings show that the start-up differed in metrics dependent on age, such as tie strength, but that density of networks was more dependent on the size of the organization, as smaller networks irrespective of age were more dense and cohesive. The start-up network was more symmetrical and reciprocal than the mature networks, yet tie strength was lower as the fostering of relationships takes time. In conclusion, the findings demonstrated that start-up networks are not inherently unique and some similarities can be seen with mature networks. Furthermore, start-up networks cannot be said to be superior in knowledge transfer, as the trade-off between the cohesive network displayed by start-ups, and the mature networks exhibiting structural holes and stronger ties, is dependent on the complexity of projects and aims of each organization.

Keywords: Start-up, Social network analysis (SNA), Internal network, Knowledge transfer

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Key concepts

Concept	Definition
Social network analysis	<p>The study of social networks involving social, mathematical, statistical, and computer sciences (Bandyopadhyay, Rao & Sinha 2011).</p> <p>For definition of social network measurements used in this thesis, see <i>Table 1,3 & 5</i>.</p>
Start-up	As defined by the authors of the thesis, a new venture in search of a viable business model, delimited to ventures younger than 5 years.
Mature company	Delimited by the authors to ventures which have existed for over 5 years.
Knowledge	“Facts, information, and skills acquired through experience or education; the theoretical or practical understanding of a subject.” (Oxford Dictionary, 2017)
Social capital	“Investments in social relations with expected returns in the marketplace” (Lin 2000, p.19).
Social network	<p>“...refers to the articulation of a social relationship, ascribed or achieved, among individuals, families, households, villages, communities, regions, and so on.” (Bandyopadhyay, Rao & Sinha 2011, p.2)</p> <p>Social networks are a sub-component of the social capital umbrella concept (Nahapiet & Ghoshal 1998).</p> <p>(Social network and network will be used interchangeably.)</p>
Node	An object – unit, individual, group or other - within the social network (Bandyopadhyay, Rao & Sinha 2011).
Tie	A relationship directed from one object, as specified above, to another. (Bandyopadhyay, Rao & Sinha 2011)

1. Introduction

1.1. Background & Problem Formulation

“Despite the wide media coverage of entrepreneurial gazelles that outpace established firms in terms of productivity, incumbents actually have a significantly higher productivity than new start-ups” (Anokhin & Wincent 2012, p.44). However, mature companies are also found to be too slow and rigid to keep up with ever-changing customer demands and dynamic environments, whereas younger ventures, such as start-ups, have learning advantages due to higher flexibility and decentralization (Wijk, Jansen & Lyles 2008; Frost, Birkinshaw, & Ensign 2002). Efficiency, productivity and flexibility are to a large extent an outcome of internal networks, as these are a mechanism for finding, creating and exchanging knowledge between various units and individuals (Nahapiet & Ghoshal 1998). The composition of an internal network and its characteristics are a function of the structure, size and age of an organization, though there is debate about which composition is most effective (Wijk, Jansen & Lyles 2008; Frost, Birkinshaw, & Ensign 2002). The contradictory academic discussion of networks in mature firms and start-ups currently gives little insight into what actual differences arise and what these may be caused by.

Networks are especially emphasized and highlighted in start-up literature, as many studies support the sentiment that effective networks, also referred to broadly as social capital, are a key resource for the ventures performance and survival (Nahapiet & Ghoshal 1998; Liao, Welsch & Stoica 2003). Start-ups are young ventures which operate in highly complex and dynamic environments, since material resources are in shortage and most uncertainties are impossible to predict ex ante, forcing start-ups to brace themselves against ‘unknown unknowns’ with few means readily available (Sommer, Loch, & Dong 2009). Due to the high uncertainty and few resources, 20% of new ventures fail within one year on average, and 66% fail within six years (Zacharakis, Meyer,

& DeCastro 1999). Mahroum (2016, p.233) paraphrases Tolstoy by claiming that “all unhappy start-ups are alike, but every happy start-up is happy in its own way”. Yet, Mahroum (2016) does identify a common key factor or ‘critical condition’ for start-up success in all of his case studies: the access to efficient networks. Consequently, if networks are a central resource for start-ups, does that imply that start-up networks are somehow unique and more efficient than those of mature companies or are they simply amplified in theory due to lack of other resources? Are all networks alike or are start-up networks unique in their own way? Against this background, the thesis aims to map an internal network of a start-up and compare it to that of mature companies to decipher whether there are any fundamental differences in how knowledge is transferred.

1.2. Earlier Research

Social capital and networks in start-ups have been studied from nuanced perspectives, considering both benefits and limitations, but research is unanimous that networks “plays a pivotal role on firm performance” (Pratano & Mahmood 2014, p.65). Although the majority of research examines internal outcomes, such as, the start-up’s performance or its innovative capabilities, the vast majority of studies have focused on external networks. For example, a study conducted by Lee, C., Lee, K. and Pennings (2001) suggests that the linkage between internal capabilities and external networks influence start-up performance. However, internal networks are a source of knowledge and information transfer, meaning that they are a foundation of internal capabilities (Wijk, Jansen & Lyles 2008). Network theory explicitly distinguishes between internal and external ties, implying that findings of studies on external networks cannot be directly transferred to internal ones (Adler & Kwon 2002). Consequently, little is known about the nature of internal start-up networks.

1.3. Research Gap & Research Question

The lack of focus on internal networks and the overwhelming focus on external actors gives the impression that start-ups are only as strong as their environment and how they relate to it. Yet, Zacharakis, Meyer & DeCastro (1999) show that both entrepreneurs and venture capitalists tend to overwhelmingly attribute the failure of new ventures to internal causes rather than external ones. As such, there appears to be an unexplored area of what role internal networks play in start-ups.

Start-ups have previously been depicted as solid units with little nuance of how knowledge spreads internally throughout the start-up as the focus has been placed on external networks (Adler & Kwon 2002). The lack of focus on internal networks may be explained by the fact that there is a general trend in start-up research to use networks as a static and theoretical concept, without directly using network theory and network analysis tools (Adler & Kwon 2002). Little consideration is given to cause-effect relationships of networks and very rarely is a distinction made between the different contexts of networks, i.e. whether they are external, internal or both (Adler & Kwon 2002). When taking such a distinction into account, it is evident that there is a predominant trend to explore external ties in start-ups with either customers or inter-firm relationships. Adler and Kwon (2002) argue that the lack of distinction between internal and external dimensions is followed by a lack of understanding which features of social structures encourage benefits and risks due to no systematic assessment.

A method for systematic assessment in network theory is social network analysis (SNA), i.e. a mathematical and sociological mapping and measure of relationships (Bandyopadhyay, Rao & Sinha 2011). To the knowledge of the authors of this thesis, no social network analysis has been done internally in the specific context of a start-up, despite the presence of a number of social

network analyses studies investigating the internal networks of mature companies. Start-ups differ from mature companies in a few regards, as mentioned earlier, primarily in their younger age, smaller size and extremely uncertain environment (Wijk, Jansen & Lyles 2008; Sommer, Loch, & Dong 2009). Yet, due to the lack of internal network analysis in start-ups, no insight is given on whether the structural internal landscape of a start-up actually differs from mature companies and perhaps is more or less efficient at knowledge transfer, or whether the findings of these studies can be applied to start-ups ‘as is’. As such, it is difficult to use any of the current network characteristic findings to gain any insight on a start-up network, without first conducting a proper social network analysis specifically on a start-up in order to identify similarities and differences.

Therefore, the guiding research question for the internal social network analysis conducted in this thesis is as stated below.

To what extent does the internal social network of a start-up differ from that of mature companies and which is more effective at knowledge transfer?

1.4. Expected Contribution

Since efficient networks are a critical condition for start-up success according to Mahroum (2016), analyzing the characteristics of networks can provide appropriate strategy and management guidelines for improvement. Therefore, the exploratory study aims to fill the gap of internal social network analysis studies specifically on start-ups. The findings will be compared to previous social network analyses on mature companies to analyze whether internal networks of start-ups are unique or whether the capabilities mentioned in start-up literature is in fact based on the same internal predispositions that can be seen in mature companies. If there are similarities, the transferability of previous findings and theories may be possible to a start-up context and thus,

enhancing the available information on networks and social capital. However, if there are vast differences between the case study and previous research, the findings of this thesis may help guide future research by highlighting nuances and unique characteristics of start-up networks which are notable. The comparison will also add more empirical data on networks in different contexts and therefore, contribute to exploring the practical implications and roles of networks in organizations. The intent of this study is not to find universal generalizable laws for start-ups or networks, but rather to dig deeper beyond what has previously been taken for granted in order to gain a more nuanced insight.

2. Method

2.1. Research Method

The thesis was written in the positivist paradigm and aimed to use research to test and illuminate previous theory in order to use the scientific approach of natural sciences and apply it to a social reality of relationships and networks (Bryman & Bell 2015, p.28). The exploratory study aimed to gather observations, which could add structure and more systematic analysis to previous research, as the positivist paradigm entails that a “greater epistemological status is given to observations than to theory” (Bryman & Bell 2015, p.28). A deductive approach was used (Bryman & Bell 2015, p.28). However, as is most often the case, the process was non-linear and there was frequent iteration between data collection and analysis in relation to theory (Bryman & Bell 2015, p.23). At the same time, the thesis asserts that social relationships and interactions are a dynamic key resource and driving force within organizations (Bryman & Bell 2015, p.33).

Furthermore, a mixed methods approach was used in the exploratory study. Although quantitative data was used as the primary data collection source in the beginning, previous research indicates that there is a large risk of ‘recall bias’ in surveys, as participants forget or omit factors that may not feel or be perceived as notable (Rice, Holloway, Barman-Adhikari, Fuentes, Brown & Palinkas 2014). Therefore, a qualitative method in the form of semi-structured interviews was used to compliment and help explain data collected from the surveys in an exploratory sequential design, as illustrated below in *Figure 1* (Bryman & Bell 2015, p. 647).

Explanatory Sequential Design

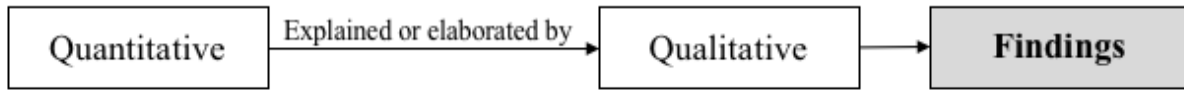


Figure 1. *The process of an explanatory sequential design.*

Cross-triangulation through mixed-methods is a way to enhance the findings from quantitative research by using different means to measure the same concept and thus, reduce the risk of omission or skewed data (Bryman & Bell, p. 648, 2015). Thus, the use of mixed-methods could gather a more precise and comprehensive depiction of a social network than using any one method by itself (Rice et. al. 2014). Finally, secondary data was used to a minor extent as records of employees and organizational charts were used to select key employees for interviews.

2.2. Research Design

The thesis is an exploratory case study where observations, using surveys and interviews, have been done at a single point in time for one case study, referred to as ‘the Start-up’. The choice of an exploratory case study was, on one hand, based on the emphasis of intensive research of a specific organization to achieve an in-depth systematic analysis and, on the other hand, the limitations resulting from the short time frame of the thesis and the complexity that a social network analysis of quality demands.

A case study at a single start-up cannot provide a basis for generalization but it can, in combination with and in comparison to earlier research, provide either nuances or add replicable systematic observations that either support or negate the previous theory about social networks and start-ups. A cross-sectional study could potentially provide a conclusion that can be generalized, but it was

not feasible for the purposes of this thesis as a complete social network analysis, even at a single organization, is a very rigorous and time-consuming task. However, as the aim of the study was to test rather than generate theory, the lack of generalizability is not detrimental to the contribution of the thesis. Instead, focus has been placed on transferability and replicability by attempting to explicitly clarify the contexts and assumptions of the case study, as well as, making it a point to systematically explain the definitions and metrics used, to allow for an evaluation by the reader if the case and findings can be used for future purposes. The thesis has thus, focused on using measures which are commonly used and are proven to have a linkage with the concept, as is required by the validity criteria (Bryman & Bell 2015, s.159). Therefore, quality and depth was chosen over quantity in terms of number of case studies, in order to achieve validity and replicability.

2.2.1. Case Selection & Delimitations

The Start-up is a technology firm who has employed 48 individuals within 3 years from its founding in 2015 in their headquarters in Stockholm, Sweden. The authors believed that the case would lend itself to an in-depth analysis as it fits the delimitations of the research question of a venture under 5 years in a dynamic start-up environment. The Start-up is smaller and younger than the mature companies handled in the comparison social network studies and thus, a comparison was deduced to be both possible and interesting. Another reason for choosing the case study was due to its practical ease, as the authors had full access granted to the employees due to an existing relationship with one of the authors.

The scope of the analysis was limited to the 48 employees in the Stockholm office, however, 5 employees at the corporate level were included as response options in the survey in order to allow for a mapping of relationships with upper management, although these 5 employees did not

themselves partake in the data collection. Other global offices were excluded since it was easier to gain access and have a better oversight of the local network.

2.3. Collection of Data

Contact was initiated by the author connected to the Start-up through an email to various members at the corporate level to gain permission to conduct the study. After permission was received both verbally and in writing, the study was presented at a meeting with the entire Stockholm office. The purpose of the study was explained to ensure that everyone felt comfortable by answering questions about the nature and extent of the study and explicitly ensure all participants of their own, as well as the Start-up's, anonymity. Following the meeting, a general message with the survey link was posted to an internal communication system and a general email to employees at the office. Individuals who did not respond by an agreed upon deadline, three weeks after the presentation, were followed up with repeated individual reminder emails at sparse intervals.

The mixed-method used was conducted in an exploratory sequential design, implying that quantitative data was collected first to give the authors an insight as to what type of qualitative data is needed to elaborate or explain the survey responses (Bryman & Bell, p. 647, 2015).

2.3.1. Quantitative Data

The quantitative data gathered was a sociometric whole systems analysis (Marin & Wellman 2014), meaning that data on the entire network was collected, as opposed to an egocentric one which is grounded in a specific individual's network, which would be more appropriate in the interpretivist paradigm. The data was collected through a survey sent out to all 48 employees at the Stockholm office and resulted in a 90% response rate. The 10% which failed to respond can mostly be attributed to parental leave or long-term absence due to illness.

The survey was built on name generator categories (Marin & Wellman 2014), i.e. the subject was asked to recall individuals that they have interacted with and then rank the relation based on a five-point scale. The five-point scale was intended to measure the strength of the relationship by asking the respondent to choose whether the relationship was purely professional (represented by the lowest score of 1) or a very personal friendship or relationship (represented by the highest score of 5). Each point on the scale was illustrated with an example statement to guide the respondents, see *Appendix 7.1.* for excerpts of the survey. By listing relationships and qualifying them, information could be gathered on the strength of relationships, which connections were mutual and where groups occurred. The respondent listed as many people as they could recall but also had the option at the end of the survey to state whether they believe did not manage to disclose all of their interactions and relationships. If a respondent filled in this question, they would receive an email about booking an interview.

2.3.2. Qualitative Data

Twenty-three respondents were contacted about an interview. However, in the end six interviews were selected due to a shortage of time and limited availability or lack of reply from respondents. Special care was given to ensure one respondent from each department and from different levels of the Start-up were included to obtain a variety of perspectives. Employees with the most central roles according to organizational charts and those who were most frequently named in the survey were among the six interviewees, as these were believed to have the most insight on a majority of the found relationships. Each interview lasted between 30-40 minutes. As the office is international the communication and survey were conducted in English to be inclusive but interviews were primarily conducted in Swedish as interviewees felt more comfortable doing so. The interviews were held at the office at the request and convenience of the interviewees. The interviews were

semi-structured and the questions focused on trying to overcome the recall bias in the survey and to get some more insight on socio-cognitive mapping, i.e. identifying clusters & cliques (Rice et. al. 2014). The semi-structured interview topics were divided into the following areas: additional and complimentary information to the survey, the perceived network within the interviewee's department, perceived inter-department networks, identifying internal groups within the Stockholm office and potential short-comings and strengths of the information flow within the Start-up.

The interviews were recorded with permission and later on transcribed and translated by the authors, in the cases that the interviewee spoke Swedish. As none of the six interviewees requested to be anonymous to the author with relations to the Start-up, both authors could be present at all interviews and assist each other in transcribing and analyzing the interviews. The authors have decided to not code the anonymization of interviewees and only refer to each person as an 'interviewee', as there is no direct benefit in differentiating between them for the purpose of the social network analysis, while the risk of identifying the individual is high due to the small and closely connected office.

2.4. Method for Analysis of Data: Social Network Analysis

The key tool for analysis used throughout the thesis is a social network analysis. Social network analysis used in network theory is an interdisciplinary area of research, which aims to apply mathematical, statistical and computer sciences to social phenomena of relationships (Bandyopadhyay, Rao & Sinha 2011). The theory takes into account the direction and contents of exchanges as well as the norms and expectations underpinning reciprocal or non-reciprocal relationships allowing it to be comprehensive and flexible (Bandyopadhyay, Rao & Sinha 2011).

The concepts concretized by the social network analysis measures have often been used qualitatively in studies, e.g. as in the previous research of social capital and networks in start-ups and thus, the quantification of these concepts allows for a more systematic and comparable set of results, benefiting both validity and replicability of these studies. However, social network analysis is still a new tool that has been developed ad hoc, meaning that there is a lack of a universal approach to its use and it can be very flexible and inconsistent in its application (Bandyopadhyay, Rao & Sinha 2011). Furthermore, traditional statistical measures, such as regression analysis, are also difficult to apply to social network analyses as most tenants e.g. random selection and statistical independence of variables is blatantly violated as social networks are inherently dependent and the focus is on analyzing pairs of nodes as opposed to independent variables. To avoid such complexities of statistical inference, this thesis does not use other statistical tools and instead relies on social network analysis metrics in its analysis (Bandyopadhyay, Suraj 2011).

The respondents were assigned a letter which represented their department and then a number depending size of the department e.g. an employee in the Sales department could thus, be labelled between S1 and S8, while one in Technology department could be, for example T1. There is no department which is less than 2 people and therefore, there is a small risk that an employee or outsider could infer conclusions solely from the mapping. Furthermore, the anonymization was used for the purpose of data processing and labels of individuals are not included at all in the thesis. The survey data was then processed and structured to fit the layout of the social network analysis software used, NodeXL, an open-source template for Microsoft Excel. The same structure was then applied to data from the interviews, in order for the data to be combined in the software to produce a comprehensive graph including all the collected data. The aim of the mixed-methods approach is to “consider how the quantitative and qualitative components are related to each other

from the outset”, meaning that integration of the data was a key step for further analysis (Bryman & Bell 2015, p. 659).

To conceptualize the social network it was displayed as a graph with the help of NodeXL. The data was entered into the template in the program, by listing a relationship (tie) between two individuals (nodes) on a row, specifying the direction of the relationship by entering the node who identified the tie in the first column, with additional columns to fill in the weight for the strength of the tie (*see Figure 2 below for a simplified visualization of the components of a network*). The software then processed the entered information into a graph. However, as nodes and ties can be drawn in a myriad of different constellations, it was necessary to eliminate visual bias about the properties of the network by calculating a number of mathematical measures to represent the characteristics graphed (Bandyopadhyay, Rao & Sinha 2011; McGrath, Blythe, & Krackhardt, 1997) The software calculated the metrics based on the entered data. The definitions and calculations for the metrics used will be explicitly specified in *Section 3. Theory* below.

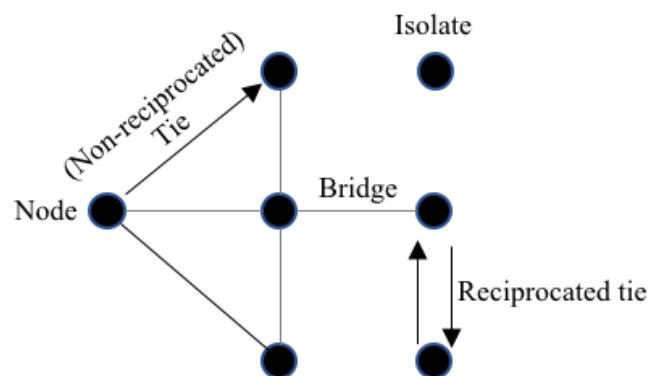


Figure 2. The main components of a simple network containing nodes, reciprocates resp. non-reciprocated ties, bridge and isolate.

Finally, although the purpose of the interviews was primarily to overcome recall bias by finding additional relationships omitted in the survey, some quotes and perspectives from the interviews are included in the analysis to add a deeper level of understanding of the networks and their implications.

2.5. Ethical Discussion

Social network analysis may be seen, by the respondent and the Start-up, as intrusive and personal as it concerns inquiry about professional and personal relationships. The authors aspired to achieve a neutral and non-judgmental interaction to create an environment where the respondents did not feel insecure. Anonymization of all data was a further measure to ensure this. By considering the four main areas of ethical considerations: harm to participants, lack of informed consent, invasion of privacy and deception (Diener & Grandall 1978), the authors attempted to take all necessary steps to gather data without creating an ethical conflict. Ethics, invasion of privacy and bias were essential concerns due to the involvement of one of the authors with the Start-up. Although the authors relation towards the Start-up is not a managerial or influential position, all participants were continuously supported and ensured of their anonymity. All raw data from the survey was codified before the author could access it and the interviewees had the option of only conducting the interview with the second author. Anonymization of the responses to avoid discomfort or harm for the individuals relational or career prospects were of utmost importance at all times as disclosing the extent of connectedness and centrality in the office may cause pressure from upper management or colleagues. The initial meeting was also intended to calm any feelings of intrusiveness by being open and transparent about the intents and extents of the study. Furthermore, it was made clear from the beginning that although the Start-up would have access

to the final thesis, all employees would still remain entirely anonymous to the Start-up, their colleagues and third parties.

Although the participation in the survey was voluntary, the need of the social network analysis to have a high response rate to be accurate may have caused some pressure to participate, as individuals who did not respond by the deadline were sent repeated reminders. However, the survey itself had few restrictions and participants could fill in as many or as few relationships as they wished. Those contacted for an interview were given the option to opt out without indicating any reason.

2.6. Reflexivity Discussion

Although measures were taken to ensure anonymity and avoid bias by the author with ties to the Start-up, reflexivity may have been difficult to control as previous knowledge of the network may have caused the author to have certain pre-determined perceptions of the network. However, as the analysis was entirely based on metrics and relationships disclosed through the data collection, any strictly personal opinions were not included unless they could be founded in the data. Furthermore, all gathered data was used, which included responses from all departments and levels and thus, ought to lessen the risk of skewed or biased interpretation. Nevertheless, the authors involvement was primarily evident in the interviews as the author could bring up previous events or information, which would most likely have been unknown to a completely objective third-party interviewer.

3. Theory

3.1. Social Capital & Social Network Theory

Networks are tools for knowledge transfer and sharing through relationships and are often broadly referred to as social capital that can be used by organizations (Ahuja 2000). Nahapiet and Ghoshal (1998) take apart the social capital concept by introducing its three dimensions: cognitive, relational and structural. A shared language, code and narratives are the key blocks for the cognitive dimension and the relational dimension consists of trust, norms, obligations, expectations and identification. Both of these dimensions are underpinned by the structural dimension, which creates and exchanges knowledge through network ties, network configurations and appropriable organizations (Nahapiet & Ghoshal 1998). Thus, the structural dimension, i.e. the network itself, enables and makes up the foundation for both the cognitive and relational dimension. Therefore, any systematic analysis of knowledge sharing through social capital ought to have its roots in the structural construct to achieve a fundamental and systematic analysis (Zheng 2010). A way to achieve a systematic approach for analyzing a network is to use social network analysis (Zheng 2010).

3.2. Internal Social Network Analysis: Network Characteristics

Although the facilitative role of networks in social capital has been established, there is still debate about the specific network attributes and characteristics which are most beneficial to an organization (Ahuja 2000). Therefore, it is useful to make a record of implications of various network metrics, as defined below.

3.2.1. Degree

A directed graph displays which way relationships are stated, i.e. who disclosed the connection and whether it is reciprocated (Bandyopadhyay, Rao & Sinha 2011). Therefore, in a directed graph an individual stating their relationship to another does not automatically equal a reciprocated relationship, meaning that both individuals have to state the same relation for it to be graphed as mutual. Thus, it is possible to calculate how many ties move towards and away from a certain node in a directed graph, the in-degree and out-degree (Hanneman & Riddle 2016).

Metric	Calculation	Implication
In-degree & out-degree	The average amount of ties which are either directed towards (in-degree) or away from (out-degree) a node (Hanneman & Riddle 2016).	A high in-degree indicates that an individual is prominent and is trustworthy. A high out-degree is a sign of social ability and it indicates an influential individual (Hanneman & Riddle 2016).

Table 1. *The calculations and implications of in-degree and out-degree.*

The research on internal networks in mature companies summarized in *Table 2* below, has touched upon the measure of degree in an internal mature network.

Author & Research Focus	Method & Data Collection	Network Measure & Findings
Hansen (1999) The effect of tie strength on project completion.	Survey sent to all 41 business units within a global electronics company. 50 open-based interviews. Age: > 5 years Size: > \$5 billion in sales	In-degree: 6.28 (out of 41) Out-degree: 5.61 (out of 41)
Tsai (2000) The effect of the creation of new business units on social capital and strategic relatedness ¹ .	Longitudinal study. Questionnaire data from all 36 different units within a company in the food industry. Age: 29 years Size: \$4 billion in sales	Prior network centrality, trustworthiness (in-degree) and strategic relatedness significantly affect the rate of new linkage creation.
Tsai (2001) The effect of network position and absorptive capacity on business unit innovation and performance.	Questionnaire conducted at all 24 business units in a petrochemical company and all 36 business units in a food-manufacturing company in 1996 with a total of 120 respondents. Age: Unknown resp. 29 years Size: \$10.7 billion resp. \$4.1 billion in sales	Units with high network centrality (in-degree) and absorptive capacity perform better and are more innovative.

Table 2. Earlier research on intra-organizational networks in mature companies which have included in-degree or out-degree in their social network analysis.

Based on the findings above, in-degree and out-degree in mature networks were found to be central for project completion (Hansen 1999). Degree is a key metric for knowledge transfer as Tsai (2000) asserts that the centrality of individuals, i.e. higher degrees, indicate considerable power, since the central position entails access to unique and increased knowledge. Freeman (1979), in addition to Hanneman and Riddle (2016), signals that a higher in-degree indicates that the node is trusted and thus, can access knowledge better than an individual with a lower in-degree. A central position enables the individual to become a broker to find and filter relevant knowledge (Burt 1992).

¹ "Strategic relatedness characterizes the extent to which two organizational units are strategically similar" (Tsai 2000, p. 927).

Furthermore, Tsai (2001)² studied the effect of network position (in-degree) and absorptive capacity, i.e. how knowledge is internalized and used, on a business units innovation and performance. Tsai (2001) found that units with high network centrality, measured as the in-degree, and absorptive capacity perform better and are more innovative than units which do not to have as many ties. “Organizational units require access and internal capacity to learn from their peers” (Tsai 2001, p. 996). However, maintaining network centrality can entail a high administrative cost and efforts which can outweigh the benefits of a central position (Tsai 2001).

3.2.2. Density

The amount of ties can be used to calculate the density of the network and the geodesic distance, as defined in *Table 3* below.

Metric	Calculation	Implication
Density	The amount of ties a network has, divided by the total amount of ties a network could have if all nodes were connected. A ratio of 1 implies that all individuals in a network are connected (Hanneman & Riddle 2016).	High density indicates that the network is cohesive. (Hanneman & Riddle 2016). Density can be seen as a measure of global cohesion i.e. the closeness of the nodes in one network (Bandyopadhyay, Rao & Sinha 2011).
Maximum shortest path (Geodesic distance)	The maximum number of nodes that information has to flow through, by using the shortest path, from one individual to another (Hanneman & Riddle 2016).	A short geodesic distance demonstrates how close the network is, the density of it, and if it is clustered i.e. groups of high density of ties towards each other but few outwards (Hanneman & Riddle 2016).
Structural hole	Structural holes are gaps in information flows between individuals linked to the same node but not linked to each other (Ahuja, 2000).	Structural-hole-rich networks provide informational benefits because they allow for a flow of diverse information but the gaps can inhibit trust development (Ahuja 2000).

Table 3. *The calculations and implications of density, geodesic distance and structural holes.*

² Although in-degree was calculated, the metric could not be used for the purposes of this thesis as there was no defined maximum possible in-degree and thus, a ratio could not be calculated for comparison. The results however, gave a deeper understanding to how in-degree can affect the business unit's performance.

The research on internal networks in mature companies summarized in *Table 4* below has touched upon the measure of density.

Author & Research Focus	Method & Data Collection	Network Measure & Findings
Shrader, Lincoln & Hoffman (1989) The organizational structures effect on internal and external networks.	A survey sent to 36 private, not-for-profit agencies. Response rate of 87%. Interviews were held with the directors of each agency. Age: average 24 years Size: average 23 employees	Density: 0.24 ± 0.14 (out of 1) Max. shortest path: 3.69 ± 1.83 Geodesic distance increases in correlation to size, as a firm increases the number of nodes, the maximum shortest path increases as well.
Schenkel & Teigland (2016) The effect of downsizing on social capital, dynamic capabilities and firm performance.	Using literature and data from different areas (social capital, downsizing, networks and dynamic capabilities) to investigate how the parameters vary. Age: N/A Size: N/A	15% of the most central individuals often have 50% or more of the total amount of ties. 40% of the least central individuals have 5-10%.

Table 4. Earlier research on intra-organizational networks in mature companies which have included density, centrality or geodesic distance in their social network analysis.

The research above indicates that there are certain nodes whom are very central to the mature networks and possess a majority of the ties. Schenkel and Teigland (2016) found that the removal of such central nodes or dissolving the core/periphery of a network has negative effects on the firm's dynamic capabilities.

The implications of lower cohesiveness and symmetry are two-fold. First, a higher number of relations between units or organizations have been found to enable information processing, increasing the likelihood that important knowledge is found, meaning that lower density is detrimental to knowledge flow (Gupta & Govindarajan, 2000). Reagan and McEvily (2003) also found that range (diversity of individuals in a network) and cohesion (density) facilitate knowledge transfer within the network. Bandyopadhyay, Rao and Sinha (2011) argue that density becomes more complicated to obtain when the number of nodes increase as the size of the network grows. Second, although authors, such as Coleman (1988), argue that a high number of relationships and

connections between employees are optimal, other authors claim that many structural holes are most advantageous (Ahuja 2000). There appears to be a trade-off between the two arguments, as “densely interconnected networks enable trust but limit the inflow of diverse and fresh insights. Structural-hole-rich networks provide informational benefits but inhibit trust development” (Ahuja 2000, p. 452). Deciding on the trade-off between density and structural holes depends on the function of what the network and organization want to achieve.

3.2.3. Reciprocity & Tie strength

Tie strength is a measure which is not clearly defined, some researchers, such as Allen, James & Gamlen (2007), use reciprocity as a measure of tie strength, while other authors create their own scale (Reagan & McEviliy 2003; Hansen 1999). The definitions of these concepts as they are used in the thesis are specified in *Table 5* below.

Metric	Calculation	Implication
Reciprocity	The amount of relations (ties) which are mutual between the nodes within a network. A ratio of 1 equals that all relationships are mutual (reciprocated) (Hanneman & Riddle 2016).	A high reciprocity rate indicates that there is cohesion within the network and a higher amount of ties are mutual (Hanneman & Riddle 2016).
Tie strength/weakness	A scale where the respondent can subjectively choose the strength of a relationship. E.g. 5 = Strong relationship, 1 = Weak relationship. (See <i>Appendix 7.1.</i> for details on the scale used in this thesis)	According to scale described on the left, a high average tie strength (average closer to 5) indicates that the network has strong connection. Although, a strong tie, which is not the same as strong cohesion (density), facilitates all knowledge, both tacit and codified, better than a weak tie. (Reagan & McEvily 2003) <i>N.B. In the thesis, all relations above, and including, 3 are considered to be a strong relationship.</i>

Table 5. The calculations and implications of reciprocity and tie strength.

The research on internal networks in mature companies summarized in *Table 6* below has touched upon the measure of tie strength.

Author & Research Focus	Method & Data Collection	Network Measure & Findings
Reagans & McEvily (2003) The effect that cohesion and range has on the network structure and knowledge transfer.	A survey sent to 113 employees at a R&D firm in the American Midwest with a response rate of 94%. Age: 15 years Size: 113 employees	Tie strength: 2.9 ± 0.87 (out of 6)
Hansen (1999) The effect of tie strength on project completion.	Survey sent to 41 units within a electronics company. 50 open-based interviews.	Reciprocity: 0.53 Tie strength: 2.90 (out of 6)

Table 6. Earlier research on intra-organizational networks in mature companies which have included reciprocity and tie strength in their social network analysis.

In both studies mentioned in *Table 6* above, the tie strength was found to be 2.9 on a 7-point scale, where 1 is the maximum strength. Only circa half of the relationships found in the Hansen (1999) study are mutual but according to Allen, James and Gamlen (2007) a higher reciprocity is desirable. A lower ratio of reciprocated ties indicates that a network is fragile and less is required to impair the network. (Allen, James & Gamlen 2007) Reciprocity increases over time, implying that older and more mature networks should have more potential to achieve a higher number of mutual relationships (Hanneman & Riddle 2014). Companies, which invest time and resources in relationship-building, should therefore, experience a higher reciprocity (Hanneman & Riddle 2014).

Although reciprocity is important, it is the tie strength and trust between two individuals which streamlines the knowledge transfer between units within companies (Hansen, 1999; Reagans & McEvily 2003). Relational capital, i.e. tie strength and trust, is “arguably the most important network-level driver of organizational knowledge transfer both within and across organizations”

(Wijk, Jansen & Lyles 2008, p. 845). A higher number of relationships which are also stronger generally create a more central position within the network (Wijk, Jansen & Lyles 2008).

However, strong ties are not always optimal. Hansen (1999), when researching the strength of ties and the effect of completions of projects, found that complex projects benefit the most from strong ties within the network, whereas weak ties, have a stronger net effect if the project is more straightforward. Also, weak ties can be more advantageous in some setting since they are not as costly in time and effort to maintain (Hansen 1999). Parallels can be drawn to Tsai (2001) whom found that higher centrality can be costly to maintain and thus, costs of strengthening a network could outweigh the benefits.

3.2.4. Organizational characteristics

The organizational characteristics, e.g. size, age, formal structures and hierarchies, are an important component determining the configuration of the resulting network of the organization (Wijk, Jansen & Lyles 2008).

The research on internal networks in mature companies summarized in *Table 7* below has touched upon organizational characteristics by comparing the formal and informal networks of a company.

Author & Research Focus	Method & Data Collection	Network Measure & Findings
Allen, James & Gamlen (2007) The role of social networks in managerial practice. Comparing formal and informal organizational structures.	Survey sent to 152 senior R&D-personnel at a global, multi-divisional chemicals company. Response rate of 86%. 4 businesses were the units of analysis. Age: 81 years Size: 400 R&D employees	Outliers: 11/49 outliers in one business unit A single boundary-spanning individual (bridge) within one business.

Table 7. Earlier research on intra-organizational networks in mature companies which have investigated organizational characteristics effect.

Allen, James and Gamlen (2007) found that the formal knowledge-sharing structures differed significantly from the informal networks. Instead, the formal structures created fragmentations, i.e. “islands of knowledge”³, as well as little cohesion and therefore, Allen, James and Gamlen (2007) suggest that mapping of networks could make formal structures more efficient and effective. The authors explain that ineffective networks are a result of managers’ blatant disregard for informal relations when creating formal structures and therefore, social network analysis is a central tool for organizational structuring.

The characteristics of a business can affect how the internal network is structured. Cyert and March (1963) found that aging firms tend to have limited ability to learn and adapt. The act of transferring knowledge between units via internal networks is restricted as the firm becomes older and mature firms do not, to the same extent as younger firms, have the ability to face changing circumstances (Frost, Birkinshaw, & Ensign 2002). Large firms with multi-level hierarchies, which are both vertically and horizontally diversified, tend to have less dense networks, lower cohesiveness and weaker relationships (Shrader, Lincoln & Hoffman 1989). Nevertheless, the size of a company can positively affect the flow of information since larger firm can dedicate more resources to the process (Gupta & Govindarajan, 2000). A mature company thus, has characteristics which can both foster and hinder the flow of knowledge.

³ The existence of hard structures of units and departments which hinder informal relations to build inter-departmental relations and therefore, inhibiting knowledge transfer (Allen, James & Gamlen 2007).

4. Empirical Data & Analysis

4.1. Internal Network at the Start-up

The mixed method study contained both qualitative and quantitative data, which was integrated to map the Start-up's network. *Figure 3* depicts the data collected solely through the survey, whereas *Figure 4* illustrates the connections found through the interviews which were not previously known through the quantitative method. The colors in the figures represent the direction of the relationships, i.e. the outward relationships from each department. For example, all dark blue ties are outward relationships from the Technology department and green from the Sales department.

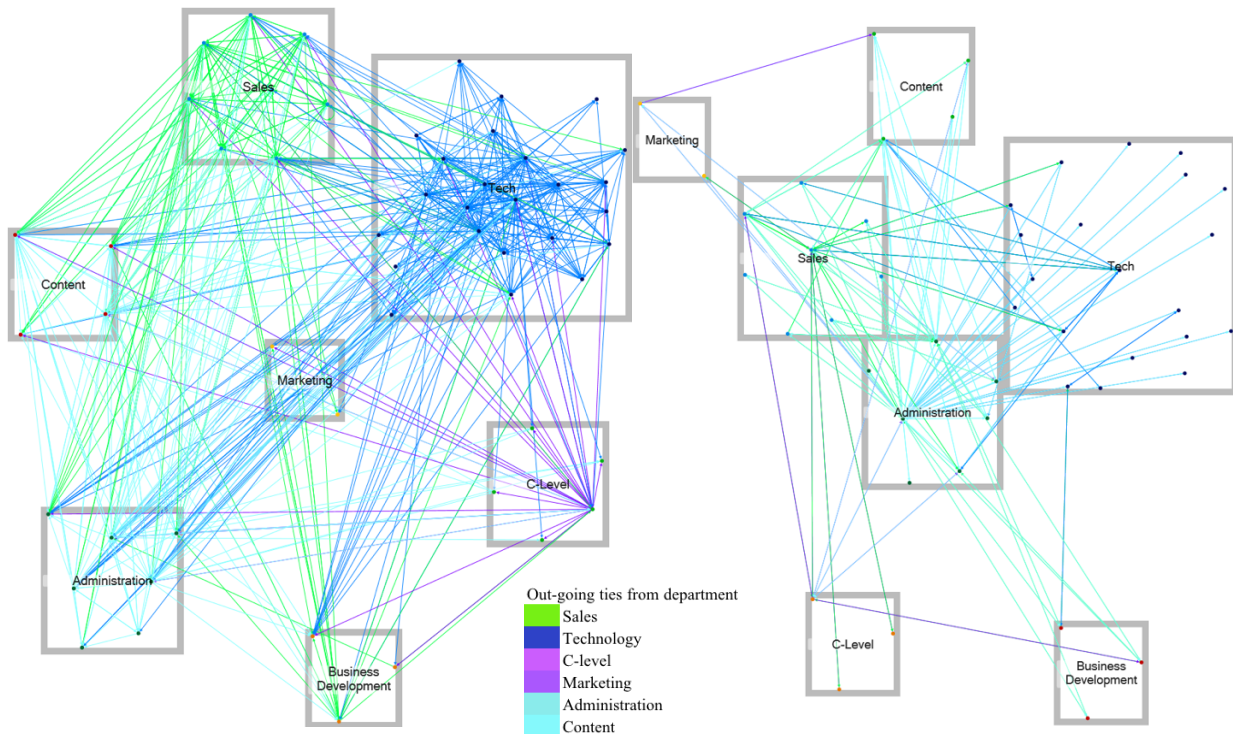


Figure 3 & 4. Left showing the gathered data from the survey. Right showing the gathered data from the interviews which were not already known through the survey.

The integration of qualitative and quantitative data using a mixed-method approach yielded the visualization shown in *Figure 5*. The combined visualization displays all the relationships between

the employees at the Start-up deduced from the collected data. Squares have been added to the graph to aid the visual interpretation of which nodes belong to which department.

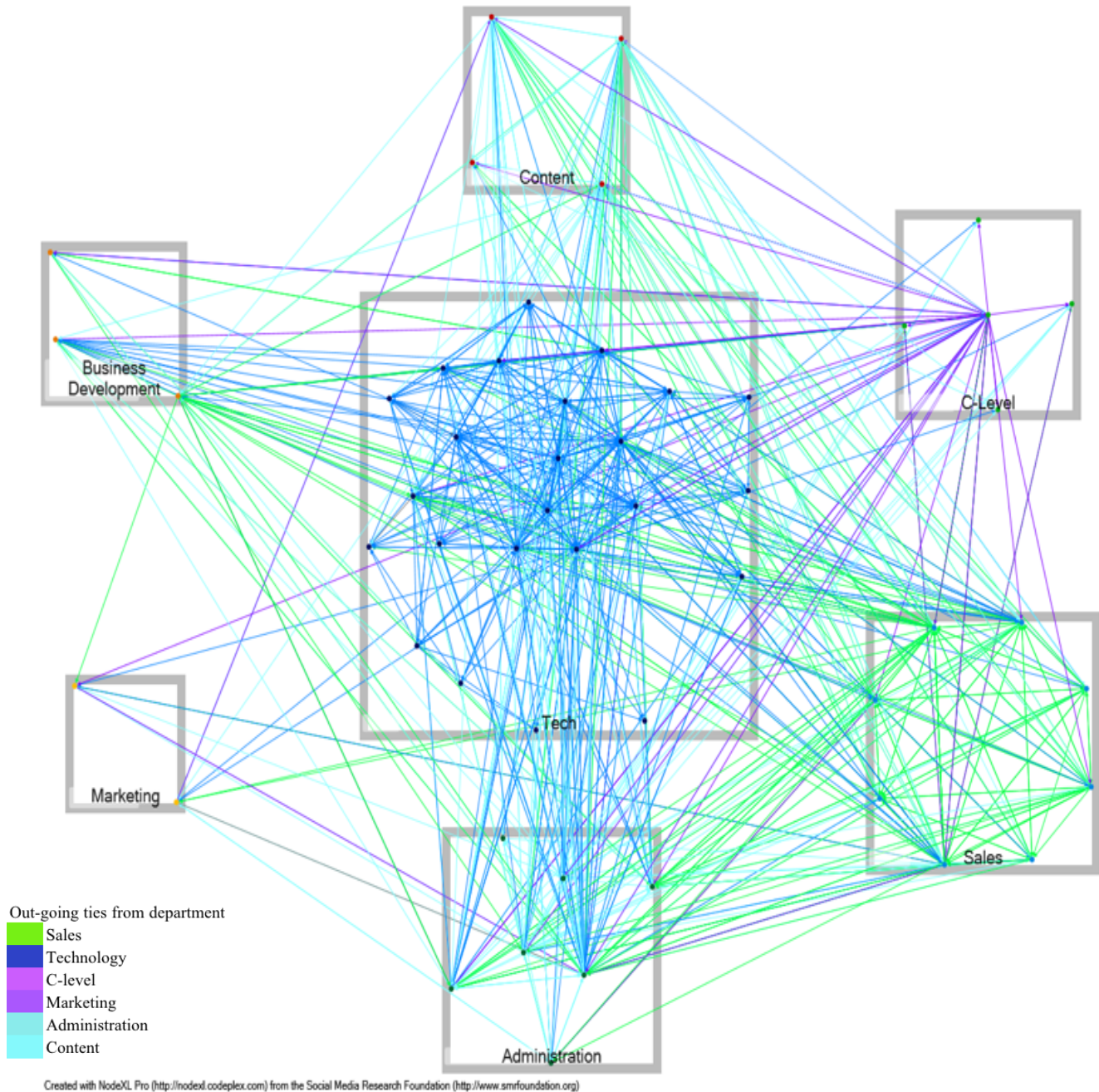


Figure 5. The visualization of the internal network within the Start-up with directed ties grouped by the Start-up's departments.

The Start-up is a technology start-up and therefore, roughly half of the employees are in the Technology department, illustrated by the large amount of nodes within the ‘Tech’ cluster. The business is focused around its technological capabilities, with other departments acting as support and business functions and are therefore, placed around the central department.

In total, 53 nodes are connected through 765 ties. From the visualization alone, the Technology department appears to be very connected, which is also supported by opinions from the interviews. One interviewee described the Technology department as the ‘beating heart’ of the business. However, although Technology is by far the largest department with 24 nodes and 225 ties, the reciprocated edge (tie) ratio, average geodesic distance, and graph density are by far the weakest of all departments (*see Table 8 below*). As such, the Technology department is less well connected and information has to travel through longer paths than in the remaining departments. The cause of this could intuitively be that the department is a lot bigger and many employees are recent hires, since both reciprocity and density are related to age (Hanneman & Riddle 2016). However, it can also be due to the fact that the other departments serve as a support functions and their tasks are inherently dependent on communication and information channeling to the core. Nevertheless, it is worth emphasizing that the geodesic distance is short in all departments as all metrics are below 1.5, and relationships are especially frequent and reciprocated in the Sales and Content departments. Based solely on the visualization, the Start-up appears to be well connected and symmetrical in its relationships, which would lend itself to the conclusions from previous theory that start-up networks are flexible and dynamic due to their high density and cohesiveness (Wijk, Jansen & Lyles 2008).

Department	Total nodes	Total ties	Reciprocated edge (tie) ratio	Average geodesic distance	Graph density	Average In-degree	Average Out-degree
Technology	24	225	0.58	1.36	0.4§	12.96	14.13
Sales	8	53	0.94	0.88	0.95	19.25	16.88
Administration	7	28	0.86	1.06	0.67	19.71	21.71
Content	4	11	0.91	0.75	0.92	19.00	20.50

Table 8. Summary of group metrics of the Start-up using NodeXL. (C-level and marketing are purposefully left out as these are the 5 people not participating in the survey. Business development is also omitted as the response rate was very low for this department, skewing the metrics for the department itself.) N.B. See Appendix 7.2. for a summary of all measurements.

However, it remains uncertain how the Start-up metrics compare to those found in mature companies. Therefore, a comparison is conducted below.

4.2. Network Characteristic Comparison

4.2.1. Degree

As the graphed network of the Start-up is directed, local density could be measured. In- and out-degree are the two most common measures of local density, which show how many ties are directed towards or away from a node (Bandyopadhyay, Rao and Sinha 2011). The Start-up has both an average in- and out-degree of 14.43 out of 53 nodes. However, on a department level the degrees were much higher for all departments, except for the Technology department, as displayed in Table 8. Hansen (1999) presented an in-degree of 6.28 and an out-degree of 5.61 (out of 41 divisions) in the global electronics company studied.⁴ Since the Start-up has more individual connections and inter-departmental ties than the mature company has inter-unit ties between the

⁴ Mature companies often calculate in- and out-degree on a business unit level, instead of on an individual or department level, which means that the metrics may not be directly comparable. Yet, for the purposes of the general comparison, the metrics were still considered to give useful insight on implications for the network characteristics.

41 divisions, the data indicates that the Start-up's employees socialize more and are trusted by each other to a greater extent (Hanneman & Riddle 2016). A higher in-degree indicates that the node is trusted and thus, can access knowledge better than an individual with a lower in-degree (Freeman 1979). As socialization appears to be higher at the Start-up than at the mature companies, the network ought to be more efficient at spreading knowledge. The conclusion is drawn since an individual, on average has the possibility to reach 14 out of 53 nodes in the Start-up, while a business unit only reaches 5 units out of 41 at a mature company thus, resulting in a more than doubled ratio of influence. Since the spread of knowledge is greater due to large in- and out-degree in the Start-up, the probability that the information will reach the designated person faster becomes more likely, especially as the shortest path (geodesic distance) decreases in networks with high degrees (Hanneman & Riddle 2016).

Furthermore, relationships to individuals are generally not spread equally or symmetrically in the mature companies but there are individuals which are more central and possess more relationships than others, as illustrated by the degree metric. Schenkel and Teigland (2016) present the findings that 15% of the most central individuals possess 50% of the ties while 40% of the least central individuals have 5-10%. As individuals, or units, become more central the access to information for these is improved since the position facilitates the access to unique knowledge (Tsai 2000). The findings from the Start-up do not reflect the same notion as the ties are more symmetrically spread across the network. 15% of the most central individuals have 28% of the total amount of ties and 40% of the least central individuals have 21%. As the most central individuals in the network at the Start-up possesses less ties than in mature companies, the results entail that the distribution of ties is more symmetrical. Fewer central individuals within the network, implies that there is no individual which maintains a position with considerable power in the Start-up (Tsai

2000). A network with more central individuals, as in a mature company, suggests hierarchical structures and therefore, lower centrality is a testimony to the decentralized and less formalized structure of the Start-up (Shrader, Lincoln & Hoffman 1989). Likewise, the more symmetric network could be a reflection of the fact the employees across all departments in the Start-up generally work together on projects, as one interviewee described.

4.2.2. Density

The graph density of the Start-up's internal network is 28% and is seen as a measure of "global cohesion" (Bandyopadhyay, Rao and Sinha 2011). Shrader, Lincoln and Hoffman (1989) found the density to be 24% in a mature network, which was similar in size to the Start-up. Compared, there is no notable difference between the organizations. However, Allen, James and Gamlen (2007) noted that there was a single bridging node within a business in their study on a large mature network, implying that the average density and connectedness was very low. This generates an interesting nuance in the comparison, as perhaps differences in density between the Start-up and mature companies are more related to size than the age or environment. The effect of size has been argued to play a crucial role and could explain the lack of difference in density when similarly sized organizations are compared to the Start-up but large differences when large networks are used for comparison (Frost, Birkinshaw & Ensign 2002; Gupta & Govindarajan, 2000). Consequently, since density facilitates knowledge transfer, regardless of the strength or direction of ties, the Start-up network can only be said to be more efficient than that of larger companies in this regard (Reagan & McEvily 2003).

The geodesic distance (the maximum shortest path) at the Start-up is 3.0 compared to the mature company similar in size to the Start-up, at 3.69 (Shrader, Lincoln & Hoffman, 1989). Whereas,

Allen, James and Gamlen (2007) found that one person was a bridge within a whole business unit in the mature network and consequently, without the individual the network would be divided. The geodesic distance is not presented in the study but it can imply that the maximum shortest path would be longer, as there is less density (Reagans & McEvily 2003). Therefore, the Start-up metrics are comparable to those of a network similar in size but differ from larger networks, irrespective of differences in age. However, the argument which network is more efficient is multifaceted as there is discussion whether cohesion and density or structural holes are more beneficial for knowledge transfer (Ahuja 2000). On one hand, the density of a network fosters a shorter path as in the Start-up and smaller mature network, and thus, knowledge can reach more individuals within the network (Reagans & McEvily 2003). On the other hand, structural holes often present in larger hierarchical networks, rather than density, provide diversity in knowledge within the network (Ahuja 2000). The conclusion for which network characteristic is more efficient is ambiguous as it is depend on what the preferable outcome and aim is of the organization, increased knowledge and performance or diverse knowledge and innovation (Ahuja 2000).

4.2.3. Reciprocity & Tie Strength

The reciprocity of the Start-up is 67.97%, meaning that the majority of the relationships are mutual in the highly dense and symmetrical network. Reciprocity can be seen as a measure of cohesion, much like density, and often increases over time (Hanneman & Riddle 2016). Therefore, it ought to be higher for mature companies which have had the time to build relationships (Hanneman & Riddle 2016). However, when Hansen (1999) looked at reciprocity, the number was lower than at the Start-up since a 53% reciprocity rate was found between units. An interviewee, at the Start-up, explained that although all employees naturally begin relationship-building within their

department, the projects and daily operations require interactions with all departments continuously and so incorporation and the creation of relations throughout the Start-up can occur quickly. The inter-departmental projects and lack of separate business units could therefore, be the cause of the high ratio of reciprocity at the Start-up. The lower reciprocity in mature networks can be caused by the opposite phenomena of formalized working structures and hierarchies, leading to rigidity and therefore, lessened cross-unit interactions (Frost, Birkinshaw, & Ensign 2002).

Reciprocity indicates that there is trust between both parties, which could be a sign of relational strength or simply that information can flow in both directions (Allen, James & Gamlen 2007). A lack of reciprocated ties indicates that the network is fragile and little is required to impair the network (Allen, James & Gamlen 2007). The Start-up ought to be less prone to a fragmented network than the mature companies who were found to have lower reciprocity. Therefore, there is a lower risk of isolated individuals or departments as well as ‘islands of knowledge’, which are a bottleneck for information flow (Allen, James & Gamlen 2007).

However, the use of a scale for the respondent to rate the relations themselves diminished the assumption that a relation is strong simply because it is mutual. The tie strength of the Start-up is 2.76 (54%) on a five point-scale, where 5 (100%) equals the strongest relationship. The tie strength found by Hansen (1999), adjusted to a similar ratio, in a global electronics company is found to be 58.57%, which was also supported by Reagan and McEvily (2003) whom found the tie strength to be the same in their study on a large R&D firm.⁵ As such, although the reciprocity was greater at the Start-up, mature companies and the Start-up do not differ to the same extent when it comes to strength. One interviewee explains that there is a stable but high turn-over, a characteristic which

⁵ Both researchers adopted a seven point-scale where 2.9 equaled the tie strength, but instead 1 equals the strongest relationship thus, a reversal was needed in order to maintain a comparable ratio.

is common among start-ups, and could also give an insight why the Start-up experiences more frequent but less strong relations, as these take time to foster. Since reciprocity is built over time, it should not be incoherent that tie strength is also affected and dependent on the length and stability of the relation, which is lower in young ventures (Hanneman & Riddle 2014).

The strength of a relationship is generally considered the most important network characteristic when it comes to knowledge transfer (Ahuja 2000; Hansen 1999; Wijk, Jansen & Lyles 2008). Although, focusing solely on the strength of a relationship could imply excessive time and effort spent outweighing benefits (Hansen 1999). When projects are not complex, weak ties are to prefer as they are more productive and therefore, it becomes an inefficient cost to increase effort to build strong relations, when they are unnecessary and may even be detrimental to performance (Hansen 1999). Yet, a network with high density and cohesion may foster trust and therefore, stronger ties may be needed in the face of a turbulent start-up environment or a threat. Whereas, a network with many structural holes may be optimal in a highly technological organization, which must be innovative and enhance the flow of new and diverse information (Ahuja 2000). Consequently, comparing which network is more effective becomes ambiguous and dependent on the aims of the organization, much like the findings of the density metric.

4.2.4. Organizational Characteristics

As common for most start-ups, the Start-up has grown very quickly and ad hoc since it was founded in 2015 and therefore, there is no formal knowledge sharing structure or map, according to an interviewee. Most of the departments also do not have any formalized organizational map, although there are appointed heads of departments and a formal role for each employee. Yet, as can be seen by the high density and degrees, information does not solely travel through formal

hierarchies or channels. One interviewee explains how communication is done via their internal communication system and that they see no problem with the flow as they can reach anyone with a simple message. Another interviewee signals that the communication is primarily dependent on the individuals own initiative and depends on their social ability, as there are few structural or formal hindrances to communication. The individuals own ability to communicate is therefore, of more importance than the department head's role to facilitate and share information within the department by acting as a bridge. Although, the head of the department is responsible for facilitating and aiding the information flow when it is hindered, according to one interviewee, but the respondent clarifies that they are not necessary for the information flow on a daily basis.

The short geodesic distance depicts that information can effectively flow throughout the entire organization through a multitude of paths with few information flow bottlenecks (Hanneman & Riddle 2016). Such a network structure is a stark contrast to the social network analysis conducted by Allen, James and Gamlen (2007), where the informal and formal knowledge sharing structures were mismatched to a large extent. By structuring knowledge sharing through a formal map which ignored the informal ties, it effectively caused fragmentation, little cohesion and 'islands of knowledge', causing information flow bottlenecks and many isolated employees (Allen, James & Gamlen (2007). Furthermore, communication in one of the businesses was entirely dependent on a bridging node, entirely unlike the findings in the Start-up. Allen, James & Gamlen (2007) extends the argument that such ineffective networks are a result of managers' blatant disregard for informal relations when creating formal structures. Shrader, Lincoln and Hoffman (1989) suggest that lower density, more non-reciprocated ties and lower cohesiveness are a consequence of more hierarchical and formalized organizations. As the Start-up is growing and ageing, consequently beginning to enter a stage of structural changes and formalization, using the findings of their

internal social network analysis can be vital for avoiding the creation of ‘islands of knowledge’ resulting from inorganic and ineffective ties or obstructing ones already in place.

5. Conclusion

Although the importance of networks in start-ups is not negated, the findings from the internal social network analysis of the Start-up do not give strong support that the network is inherently unique or more effective than that of mature companies, despite the claim that younger firms have learning advantages and superior flexibility. The findings of the internal social network study provide varying conclusions based on which metric is examined.

The Start-up has higher degree and more symmetrical spread of ties than all of the mature networks compared, implying that there is a higher level of socialization and trust among employees, lowering the risk of fragmentation or knowledge transfer bottlenecks. However, although the density is higher than large networks, the metric is close to that of mature networks which are similar in size to the Start-up, indicating that density is perhaps more dependent on the size of a network rather than age or environment. Finally, although the Start-up exhibits higher reciprocity than the mature companies, this does not translate into tie strength, as the Start-up on average has weaker relationships than both similar and larger mature networks. The implications of both density and tie strength on knowledge transfer is inherently dependent on the aim of the organization and the complexity of the projects at hand. Stronger ties and higher density may be needed in turbulent environments and complex tasks. However, structural holes and strong ties are needed when highly innovative and diverse information is sought after, whereas high density and weaker ties are more productive when simple tasks are managed.

Therefore, claiming that either the Start-up's internal network, or those of the compared mature companies, is more efficient at knowledge transfer cannot be done solely based on this study without having defined the aims and intentions of each network. However, conclusions about the characteristics of the networks based on organizational structures and operations can be inferred.

The even distribution of ties and strong reciprocity are an indication that density is a result of small networks, with more decentralization and lack of vertical hierarchies. Although, the symmetry and reciprocity are a function of size, strength and trust are more closely related to age as relationships need time to foster and develop. Therefore, as the Start-up network grows there is a possibility that it will become less cohesive and symmetrical, potentially leading to fragmentation and a more fragile structure, but can gain structural holes and stronger ties in some areas. Consequently, taking a social network analysis into account can overcome managers' 'blatant disregard' for informal ties and thus, fragmenting and inhibiting ties.

Although these findings are not generalizable to all start-ups or comparisons between start-ups and mature companies, the exploratory study does give some indication that current start-up social capital and network research is neither conclusive nor complete in its analysis of underlying structures and nuances of start-up networks.

6. Discussion

6.1. Implications for Practice

Although the exploratory study was only a brief insight into the Start-up's current network, the implications for its further structuring and managerial strategies can be quite valuable. Since the inter-connectedness and symmetry may primarily be a result of size, it is possible that as the Start-up will grow and diversify, its network will adopt similar characteristics to those of the large mature companies. A main concern in the compared mature networks was the high number of outliers, few central bridges connecting isolated departments as well as the discrepancy between the formal and informal network, leading to ineffective knowledge flows and 'islands of knowledge'. Therefore, it appears imperative that social network analysis is used and updated over

time to inform organizational structuring and management strategy as the Start-up continues to develop. Such an analysis can inform the formal structuring by indicating where effective exchanges occur or whether there are any bottlenecks or vulnerable linkages dependent on a few bridging nodes holding a majority of ties. Thus, the Start-up can be given agency to affect and exploit their network to fit their aims, instead of taking the network and thus, internal capabilities founded on it, as a given.

6.2. Implications for Theory & Academia

The exploratory study findings suggest that perhaps certain metrics of previous internal social network analyses can be transferable to a start-up context. Earlier research on mature companies similar in size can provide insight on density and degree metrics, which are found to be related to size, but may give little insight on age-dependent metrics, such as tie strength. However, this requires further research and testing to verify whether this can be a generalizable conclusion or not.

Instead, the primary contribution of the thesis is the revealed lack of a standardized way of defining and applying social network analysis as a tool. Although social network analysis is a mathematical and statistical tool aiming to add replicability and transparency to network research, there is a prevalent lack of consistency in regards to definitions and use of metrics. The attempt to standardize definitions in order to allow for comparison between the exploratory study presented in the thesis compared with previous social network analyses, is a first attempt to increase replicability and validity of the research using this tool. Such standardization is necessary in order for network theory to gain momentum in start-up research as a notable and useful tool. Research on social capital and networks, not only in start-ups but also as was noted in the studies on mature

companies, currently lacks the systematization and standardization of analysis that is possible through social network analysis.

6.3. Further Research

As mentioned, the thesis is an exploratory case study aimed to initiate a further discussion about the internal networks within start-ups. The limitations of the thesis is thus, that it cannot make generalizations. Therefore, further research is needed to add more extensive empirics and observations to enable generalizable findings and conclusions about the nature of start-up internal networks and their comparison against larger or more mature networks. A suggestion is that a longitudinal study or multiple case study (cross-sectional research design) is optimal in order to capture the dynamic nature of networks over time and how they develop as an organization grows or ages. The multiple case study could also include start-ups or companies with varying levels of success and growth, in order to avoid survivor bias, which tends to skew findings by excluding certain samples, leading to findings to be perceived as unique while they could in fact be coincidence or have similar features to the those samples which were excluded.

The findings support the idea that the Start-up and smaller mature companies are more alike in network structure than larger networks, however, as mentioned in the conclusion, different metrics implied different benefits or restraints for knowledge transfer. Therefore, it may be interesting to further research which metric has the largest impact on knowledge transfer and consequently, what type of network structure is most desirable in different contexts.

Finally, a substantial problem experienced throughout the study was the discrepancy and lack of standardization in definitions and concepts concerning metrics. Further research needs to have a systematic approach, both in regards to theory used and analysis of data, concerning the

measurements used in a social network analysis. The focus on validity and replicability is necessary in order to sustain the social network analysis as a distinguished method, rather than an umbrella term for researching networks.

7. References

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8. Appendix

8.1. Excerpts from survey

The screenshots below are excerpts from the quantitative survey created in Qualtrics.

Please select your name from the dropdown list below.

Who do you interact with on a **daily/weekly basis**?

- ☐ [REDACTED]
- ☐ [REDACTED]
- ☐ [REDACTED]
- ☐ [REDACTED]
- ☐ [REDACTED]

You will now explain your relationship with this person. It is single answers so consider what statement fits your relationship with the individual the most. The answers increase in **strength** from left to right.

	Do you consider this person a...		I would feel comfortable asking this person for...				
	Colleague	Friend	A pen	Work-related advice	An after work/dinner	Personal advice e.g. "My partner left me. What do I do?"	A loan (equivalent to ca 1 month's salary) during a crisis
[REDACTED]	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Thank you for participating in our survey!

The following statement and question concern your opinion about the survey and handling of raw data.

I feel as though I have not been able to state all of my relations at the [REDACTED]
[REDACTED]

- ☐ Agree
- ☐ Do not agree

One of the students conducting the thesis [REDACTED] would you like to make your answers anonymous to [REDACTED]? (All answers are anonymous to all third parties, this only concerns the handling of raw data initially until the names are codified)

- ☐ Yes, I want it codified and completely anonymous [REDACTED]
- ☐ No, I don't mind if both students handle the raw data

8.2. Metrics from NodeXL

The measures presented below are screenshots from NodeXL.

N.B. All metrics have not been used in the analysis but for the purpose of replicability and potential future research these are summarized here.

Graph Metric	Value
Graph Type	Directed
Vertices	53
Unique Edges	765
Edges With Duplicates	0
Total Edges	765
Self-Loops	0
Reciprocated Vertex Pair Ratio	0,514851485
Reciprocated Edge Ratio	0,679738562
Connected Components	1
Single-Vertex Connected Components	0
Maximum Vertices in a Connected Component	53
Maximum Edges in a Connected Component	765
Maximum Geodesic Distance (Diameter)	3
Average Geodesic Distance	1,61837
Graph Density	0,277576197
Modularity	0,158878
NodeXL Version	1.0.1.396
Minimum In-Degree	3
Maximum In-Degree	43
Average In-Degree	14,434
Median In-Degree	14
Minimum Out-Degree	0
Maximum Out-Degree	43
Average Out-Degree	14,434
Median Out-Degree	11

Minimum Betweenness Centrality	0
Maximum Betweenness Centrality	350,702
Average Betweenness Centrality	33,774
Median Betweenness Centrality	8,314
Minimum Closeness Centrality	0,009
Maximum Closeness Centrality	0,016
Average Closeness Centrality	0,012
Median Closeness Centrality	0,012
Minimum Eigenvector Centrality	0,003
Maximum Eigenvector Centrality	0,037
Average Eigenvector Centrality	0,019
Median Eigenvector Centrality	0,019
Minimum Clustering Coefficient	0,285
Maximum Clustering Coefficient	1
Average Clustering Coefficient	0,625
Median Clustering Coefficient	0,596