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EVALUATING TIE STRENGTH FROM TWITTER DATA IN CONFERENCE SETTING: CASE CMAD

Master of Science thesis

Examiner: prof. Hannu Kärkkäinen
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ABSTRACT

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The concept of tie strength as well as the different kind of ties- strong and weak ties was introduced by Granovetter in his seminal paper titled "Strength of Weak Ties". Over the decades, this concept has been used in a variety of fields to study a lot of different phenomena. In the recent years, the rise of social media and social networking services has given rise to new ways of maintaining and establishing ties. This has resulted in studies that have used personal social media data to predict the tie strength of these online relationships. Social media is also being used in events like conferences for networking purposes. In this study we evaluate the tie strength and identify different kind of ties using publically available Twitter data in the context setting of a conference.

In order to address the formulated research problem, this study began by reviewing the relevant literature related to tie strength, social media and conference setting. From the literature review it was observed that: communication frequency was the most commonly used proxy for tie strength evaluation; social media was used for networking in conferences; and current methods of tie strength evaluation from social media use personal social media data which may not be accessible in case of conferences. The empirical study used the single-case based case of CMAD which is community managers' online discussions in social media in connection to yearly-organized Community Manager Appreciation Day event in Finland. Two different data sources (survey data and Twitter data) were used to carry out the analysis. Different social network analysis methods were used to analyze the case.

Based on the analysis, it was possible to identify potentially useful dimensions (e.g. amount of time, reciprocal services and structural factors) and measures (e.g. weighted degree, shortest path length) for evaluating tie strength in the context of events. These measures were useful in identifying to a useful extent the strong ties and the potential weak ties in the context of this study.

PREFACE

This study explores the concept of tie strength in the context of a conference using publically available social media data. The current study is part of the larger project COBWEB funded by the Academy of Finland.

I would like to firstly like to thank Prof. Hannu Kärkkäinen for not only providing me with an opportunity to work on such an interesting research topic but for his great guidance and support during the entire process. I would secondly like to thank Karan Menon for always being there whenever I needed any help. I would also like to thank Jukka Huhtamäki for explain the ideas related to network analysis and also helping with some of the coding stuff. Finally, I would like to thank my parents, relatives and all my friends for their continuous support.

Tampere, 2.8.2016

Jayesh Prakash Gupta

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ABBREVIATIONS

API	Application Programming Interface
SH	Structural Hole Theory
SNA	Social Network Analysis
SWT	Strength of Weak Ties

1. INTRODUCTION

1.1 Research background

The concept of tie strength as well as the related concept of strong and weak ties was introduced by Granovetter (1973) in his seminal study "The Strength of Weak Ties". Over the past four decades, this concept has attracted a lot of traction in the academic world and has been used in a variety of fields ranging like social science, economics, computer science, information science, innovation management, business and a variety of other fields. These concepts introduced by Granovetter (1973) are associated particularly to the transfer of novel information and knowledge between different people or more specifically between different kind of ties (Levin and Cross, 2004).

In recent years, the rise of social media and social networking sites have given rise to not only new ways of transfer information (Aral and Walker, 2014; Zhan Shi et al., 2014) but have also provide novel ways to establish, strengthen and manage new ties online (Ahn and Park, 2015; Boyd et al., 2010; Boyd and Ellison, 2007). This has resulted in studies which have used the social media data to evaluate the tie strength of these online ties. However, these studies have relied on using the personal social media data of the for the evaluation and prediction of these online relationships. For example, some studies used the study participants Facebook data related to their Facebook profile and friends to predict their tie strength with other Facebook friends (see e.g. Fogués et al., 2013; Gilbert and Karahalios, 2009; Panovich et al., 2012). On the other hand some studies used the study participants Twitter data related to their follower, followee, direct message and other personal details to predict their tie strength with other Twitter followers (see e.g. Gilbert, 2012). Some studies have also used the social media data from an organization's own enterprise social networking sites to calculate the tie strength in a professional context (see e.g. Wu et al., 2010). All these studies have relied on using the personal social media data for evaluating and predicting the tie strength. Recently, some studies have also used the publically available social media data for calculating tie strength. However, such studies have focused on tracing the actual information flow in large scale social networks. Thus, it can be seen that there are not many studies that have used the publically available social media data specifically for tie strength evaluation.

Conferences and events play a significant role in the transfer of scientific, managerial and other types of information and knowledge, as well as in the importance of networking and collaboration facilitation of conference participants. In recent years, one increasingly popular means of networking people in such conferences is the use of differ-

ent social media channels like Twitter and Facebook.(Aramo-Immonen et al., 2015; Reinhardt et al., 2009; Ross et al., 2011) The use of social media in conference context has brought advantages to both conference organizers e.g. in the form of improved understanding of conference participants' needs and improve conference content tailoring, as well as for conference participants in the form of better and efficient information sharing, and networking (Reinhardt et al., 2009; Ross et al., 2011). At the same time the social media has also been used to promote novel methods for networking and collaboration in conferences for e.g. through content analysis and visualization of social media data (see e.g. Aramo-Immonen et al., 2016, 2015; Jussila et al., 2013). In such a conference setting, the identification of different kind of ties by evaluating the tie strength from social media might be useful in developing more novel approaches for networking and collaboration. This may provide opportunities in the future to create system that could automatically detect different kind of ties and give recommendations based on them.

However, the current literature generally provides methods for tie strength evaluation and prediction using the personal social media data which may not be accessible in case of events like conferences. On the other hand, to the best of our knowledge, there are no published studies available that have done tie strength evaluation in the context of event setting like conference using social media data. Based on these factors, the current study tries to address this research gap. This is shown in Figure 1 below; the identified research gap is shown in green.

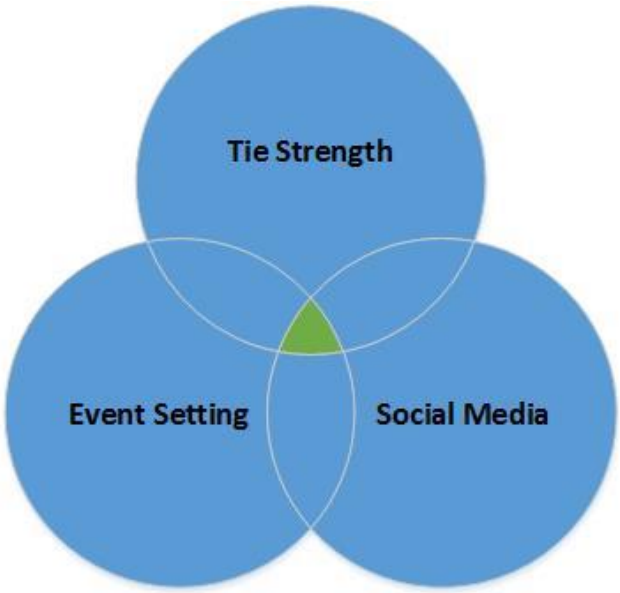

Figure 1. Research gap this thesis addresses

1.2 Research questions

As described in the previous section, over the past the few decades the concept of tie strength evaluation has been used to study different social phenomenon across various fields. The advent of social media and its proliferation in the past decade has led to new ways to communicate and establish new ties. This has resulted in the use of social media channels like Twitter even in case of events. In the past, some studies have used the personal social media data to predict tie strength of online relationships. However, these studies have not evaluated tie strength in the context of an event using publically available data. Taking into consideration the above described research gap in the current literature (see chapter 1.1), we can formalize the following problem statement that guides the research process in this thesis:

> *How can Twitter data be used to evaluate tie strength and identify different types of ties in the context of a conference?*

The problem statement fundamentally derives from the earlier mentioned background of the study. However, the problem statement in the current form is too extensive to cope within a single research. Thus, some supporting research questions that specify the scope of this study have been generated. These supporting questions are given below:

Q1. What is tie strength and what are the different kind of ties?

Q2. What are the different dimensions of tie strength presently known?

Q3. Which are the presently known different measures and predictors of tie strength in social media?

Q4. Why does the event setting like conference matter for tie strength evaluation using publically available social media data (especially Twitter)?

Q5. Can and how the different kind of ties be identified using the publically available Twitter data about the conference?

Q6. To what extent can presently known dimensions, measures and predictors of tie strength in social media be used in a conference setting to identify different kind of ties using publically available data?

Firstly, this study is based on the application of the concept of tie strength in the context of an event setting like conference. In order to carry out such a study it was important to define and clearly explain these concepts. The first three research questions were formulated to understand and bring together and summarize all these key concepts from the existing literature. The formulation of these three questions helps in making the identified research gap more visible. These three questions at a broader level contributes

toward the synthesis of the existing literature rather than adding to the existing knowledge.

The formulation of the fourth question was essential in order to explain the relation and connection between these three broad different topics of tie strength, social media and conference setting. This question also helps in bringing forth the practical significance as well as the academic novelty of such a study and why it is relevant to carry out this study. Thus, helping in making the practical relevance of this study evident.

Finally, in order to answer the 'how' part of main research question, the formulation of the last two questions was imperative. These two questions help in bringing out the new knowledge which is imperative for any research study. These two questions enable in satisfying the overall objective of this study and also help in adding new knowledge to the existing research. Hence, the formulation all these six supporting question help in understanding the current state of existing literature, the practical significance and the academic novelty of this study and also add new knowledge to the different streams of current research.

1.3 Research design

Essentially the fundamental purpose for carrying out research is to augment understanding on specific topic or aspects. Individuals and organizations constantly face various types of issues in their daily lives, and deciding on these issues needs gathering the suitable information and deeper investigation.(Ghauri and Grønhaug, 2005) Hence, embarking on research is actually about developing new knowledge (Saunders et al., 2009, p. 107).

Research is generally viewed as a process, where "a set of activities unfold overtime"(Ghauri and Grønhaug, 2005). Many authors and textbooks (see e.g. Dul and Hak, 2008; Ghauri and Grønhaug, 2005; Saunders et al., 2009) settle on the sequence of these activities: research processes generally start with defining the research topic and choosing methodological foundations for the research; continue with collecting and analyzing data; lastly ending in reporting the results. One of the effective research framework which illustrates these different phases beginning from the research philosophy ending in the actual data collection and analysis methods is the 'Research Onion' model developed by Saunders et al. (2009). In this model the different phases of the research design are represented by the different layers beginning from the outer layers related to adapted research philosophy to the innermost layer related to the actual techniques and procedures for data collection and analysis(Saunders et al., 2009). Figure 2 illustrates the application of the research onion framework in the context of this study.

Research philosophy forms the outermost layer of the research onion model. The research philosophy can be thought about in two major ways: ontology and epistemology.

Ontology refers to the researcher's view about the nature of reality while epistemology refers to the researcher's view about what constitutes as acceptable knowledge.(Saunders et al., 2009, pp. 109–117) According to Saunders et al. (2009), there are four major research philosophies in management research :Positivism, Realism, Interpretivism and Pragmatism. In this study different research philosophies may be useful in answering the research questions. Thus, as suggested by Tashakkori and Teddlie (1998), in case of this study pragmatism might be the most suitable research philosophy as it would be difficult to exclusively categorize this study as either positivism or interpretivism. As the pragmatism research philosophy allows the use of multiple philosophical perspective which would be useful in answering the research question (Saunders et al., 2009, p. 118) , this approach would be best possible categorization for this study. In terms of research approach there are two major approaches: deductive- from general to more specific and inductive- from specific observation to broader generalization. In the context of this study a large amount of literature related to the research topics is present. Based on one the practical criteria related to the availability of literature by Creswell (2002) present study would be deductive. However, based on major characteristics of both the research approaches presented (see Saunders et al., 2009, p. 127), this study to some extent also uses the inductive approach as well.

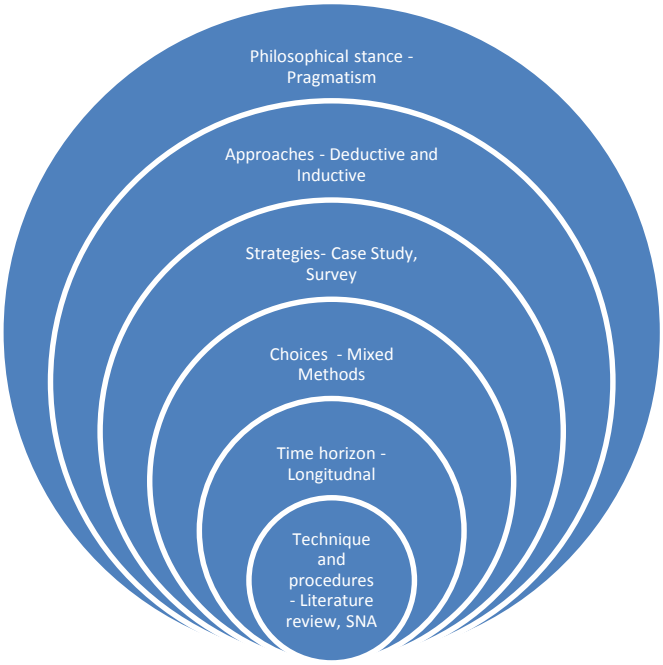

Figure 2. Research onion framework in the context of this study(adapted from Saunders et al., 2009, p. 108).

The purpose of the research is it helps in deciding the different research methods. This study can be categorized as an exploratory study. In an exploratory study, the search for relevant literature is essential in clarifying the understanding of the underlying research problem and also in deciding whether it's worth pursuing the study.(Saunders et al., 2009, pp. 138–139) In case of this study an extensive systematic review was done. This

is explained in detail while explaining the innermost layer of the research onion framework.

The third layer of the research onion is related to the research strategies which are used to address the formulated research question. In the context of this study the main research strategy was case study based on a single case. The reason for employing this approach is explained in later sections (see chapter 5.1 and 5.3.1). Another research strategy related to survey was used in parallel for collection of certain part of data. The survey design and the exact reason for using this research strategy are explained in detail in later chapter (see chapter 5.4.2).

The fourth layer of the research onion is related to choice of the method used. In this study two independent sources of data collection – Twitter data and survey data were used to corroborate the research findings. This reason made the use of mixed-method design (see Saunders et al., 2009, p. 154) most suitable in the context of this study. The fifth layer or one of the innermost layer of the research onion is related to the time horizon of the research. There are two kinds of time horizon: cross-sectional and longitudinal (Saunders et al., 2009, p. 155). In this study it was possible to use the social media data from two different years, thus, providing an opportunity to use the longitudinal time horizon in this research.

The innermost layer of research onion is related to techniques and processes used for data collection and analysis (Saunders et al., 2009, pp. 137–140). Since, this study was exploratory in nature, the collection of relevant literature was one of the critical elements of this study. The literature review was done in a systematic manner taking into consideration all the generally relevant guidelines for literature review (see Saunders et al., 2009, pp. 58–105). The specific keywords relevant for this study were defined (for example “tie strength”, “social media”, “conference”, “twitter”, “facebook”, “weak ties”). These keywords were used in combination to find the relevant literature using mainly the Thomson Reuters Web of Science™ database[1]. An inclusion exclusion criteria was used for shortlisting the final set of research articles. Only articles from journals and conferences which were categorized as level 3 or level 2 in the Finnish scientific publication classification system (JUFO[2]) were selected (Finnish scientific publication classification system classifies the scientific publication from level 0 to level 3 where level 3 are considered the highest quality academic publication-journal or conferences). This resulted in the selection of high quality research articles from journals (like Organization Science, MIS Quarterly, American Journal of Sociology, IEEE Transactions) and conferences (like CHI, CSCW). The empirical section of the study used data collected from Twitter and also through survey. The detailed process of this data collection is explained in later chapter (see chapter 5.4). This data was analyzed using certain techniques like SNA which is explained in detail in later chapter (see chapter 5.2).

[1] https://apps.webofknowledge.com
[2] https://www.tsv.fi/julkaisufoorumi

Thus, this section explains in brief the overall research design of this study. It can be seen from this section there are many different aspects related to the research design and it may not be possible to clearly demarcate every facet and the exact method used in each of these phases. The research onion model was used as a research framework in trying to explain in a more lucid and clear manner the overall research design of this study.

1.4 Structure of thesis

This section explains the overall structure of the thesis. At a broad level this thesis can be divided into four separate parts: introduction, literature study, empiric study and conclusions. This is illustrated in Figure 3. The first chapter of the thesis provides an overall overview of the subject of this study by describing the research gap and the subsequent formulation of the research questions based on the identified research gap. This chapter also provides an overview of the research design of this study.

The second part of the thesis related to literature study consists of the next three chapters. Chapter 2 provides the concepts and the relevant theories related to the topic of tie strength. Chapter 3 begins by providing a definition of social media relevant in this study and then goes on to explain the how the different social media channels can be used to provide different measures for evaluating tie strength from social media. Chapter 4 explains the different motives for attending conference and how these factors add up to make the evaluation of tie strength relevant in a conference.

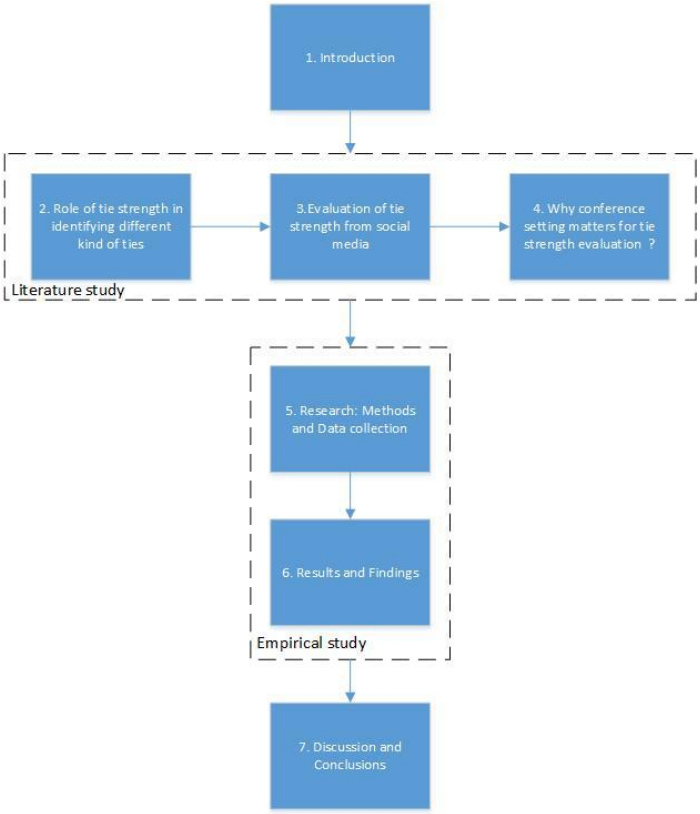

Figure 3. Thesis structure

The third part of the thesis related to empiric study consists of chapter 5 and 6. Chapter 5 explains use of the different methods and approaches related to the overall study and also specifically related to the data collection and analysis method used in this study. Chapter 6 provides the results and findings related to the case study done as a part of this empiric study.

Finally, the last part of this related to the conclusions of the study are shown in chapter 7. Chapter 7 begins by providing a discussion related to the findings of the empiric study, it then provides a conclusion of this study based on the discussion. This chapter also highlights the different academic contribution and the managerial implications which this study provides. The chapter ends by providing the limitations of this study and also the topics for future research.

2. ROLE OF TIE STRENGTH IN IDENTIFYING DIFFERENT KIND OF TIES

2.1 Concept of tie strength

This section helps to answer the research question Q1. This sections provides the definition of tie strength which has been commonly used in the literature. By providing the different widely accepted definitions of tie strength, the present section provides an answer to the research question Q1 about what is meant by tie strength.

The concept of tie strength gained popularity since its introduction in the seminal study by Grannovetter titled “Strength of Weak Ties”. According to Grannovetter (Granovetter, 1973) tie strength can be defined as "a (probably linear) combination of the amount of time, the emotional intensity, the intimacy (mutual confiding), and the reciprocal services which characterize the tie". Since, the definition provided by Granovetter many studies have relied on this definition to evaluate and measure tie strength (Marsden and Campbell, 1984). In the original the definition provided by Granovetter the tie strength evaluation was used to understand the different interpersonal relationships. In another words tie strength provided the degree of closeness between two individuals (Brown et al., 2007). Granovetter hypothesized that the tie strength provided a bridge between the macro level and micro level views of social network theory. It provided a connection between a micro level interaction with macro level patterns in a dyadic relationship of two individuals.(Granovetter, 1983, 1973)

Krackhardt (Krackhardt, 1992) provided another definition for tie strength which was based on the greek concept of Philos. According to this definition, Philos was a term which was more abstract and precise but similar in meaning to the word friend. Based on this concept, the Philos relationship between two individuals was present if it satisfied three necessary conditions. These three conditions were: firstly the two individuals should interact with each other; secondly the two individuals should have affection for each other; and finally the individuals should have a history of interaction which has lasted over a long period. When these three conditions were satisfied, the two individuals were said to be in Philos with each other.(Krackhardt, 1992) Thus, the definition of tie strength provided by Krackhardt laid more emphasis on the perspective of strong ties in a relationship.

This section presented the two most widely known definitions which have been used to define the concept of tie strength. However, most of the studies till date have relied on using the more intuitive definition provided by Granovetter. (Aral and Walker, 2014;

Fogués et al., 2013; Gilbert, 2012; Gilbert and Karahalios, 2009; Levin and Cross, 2004; Marsden and Campbell, 2012, 1984; Zhan Shi et al., 2014) Thus, using these two definitions while evaluating the tie strength in case of an event would be helpful to address the main research question of the study.

2.2 Different kind of ties

This section helps to answer the research question Q1. This sections defines the different kind of ties which have been defined in the literature. By providing the different kinds of ties this section also helps to answer research question Q5, as it provides an idea about the different kind of ties which may be present in an event.

Though, Granovetter left the precise definition of tie strength to future work, he did characterize the broad spectrum of ties which exist in any social network. (Gilbert and Karahalios, 2009) According to Granovetter (Granovetter, 1973), based on the tie strength it can intuitively be assumed that the tie between two individuals (or dyads) is either strong, weak or absent. This is also illustrated by a simple example in the figure below.

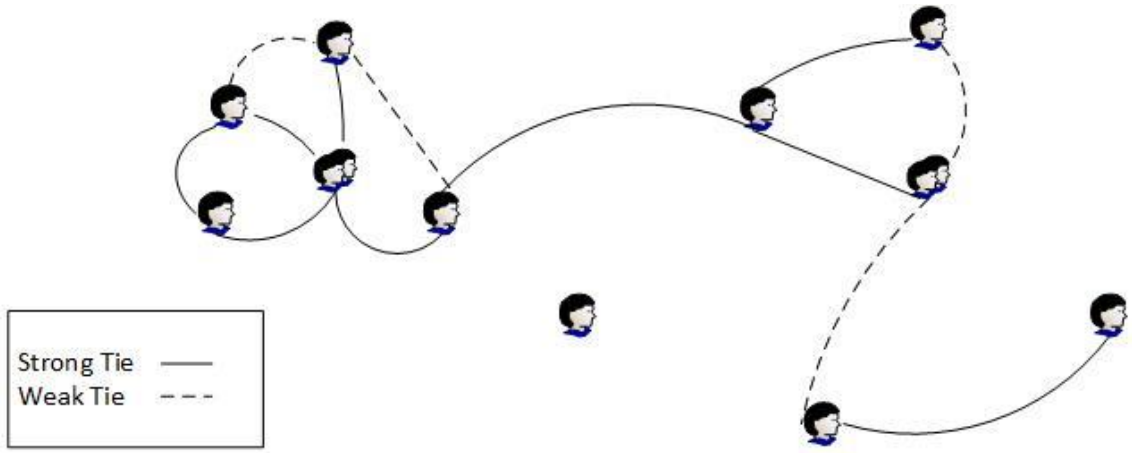

Figure 4. Various types of ties

Strong ties are people who you trust and whose social circles tightly overlap with your social circle.(Gilbert and Karahalios, 2009; Granovetter, 1973) In the personal context, it may be reflected in the people with whom you have a long relationship history, interact regularly, share every major and minor life experiences.(Granovetter, 1973; Krackhardt, 1992; Wu et al., 2010) In the professional context, the strong ties might be people with whom you work in a project or in the same group, exchange frequent information about work tasks and ask for personal advice. (Wu et al., 2010) Strong ties provide emotional support, are more stable and easy to rely upon. In professional context as well, people rely on their strong ties for protection and comfort in situations of uncertainty. (Granovetter, 1973; Krackhardt, 1992; Krackhardt and Stern, 1988) Organizations also rely on their strong ties during difficult times. (Krackhardt, 1992; Krackhardt

and Stern, 1988) Thus, the strong ties are useful in a variety of situations. Family members and close friends are some of the common examples of the strong ties.

On the other hand, weak ties are people with whom you merely have an acquaintance or have had a distant and infrequent interaction with. In the personal context, these might be people whom you may have met at some event like a friend's party.(Gilbert and Karahalios, 2009; Granovetter, 1973) In professional context, it might be people who work near you but not with you, with whom you may have some casual banter or who are part of the same professional organizations.(Wu et al., 2010) The weak ties are in many cases provide access to novel information, access to information not circulating in your strong ties social circle, help in diffusion of new ideas and also provide new knowledge.(Gilbert and Karahalios, 2009; Granovetter, 1983, 1973; Levin and Cross, 2004; Rogers Everett, 1995)

Table 1. Different ties and their importance

Type of Tie	Tie Characteristics	Importance	Example
Strong	• Trusted • Highly overlapping social circles • Long and frequent interaction history	• Are more accessible • Willing to be helpful • Conduit of useful knowledge • Provide emotional support, • Provide comfort and stability in uncertain situations	Family members, Close friends, Long time office colleague
Weak	• Have acquaintance • Low overlapping social circles • Distant and infrequent interaction	• Help in finding a job • May provide novel information • Help in diffusion of ideas • Provide new knowledge	Met in a party, Works in the same office building

The table above provides a brief summary of the different types of ties and their importance. In the recent years, authors have tried to classify the ties into more distinct kind of ties like latent ties (Haythornthwaite, 2002), dormant ties (Levin et al., 2011), intermediate ties (Retzer et al., 2010). However, these distinctions still fall under the broad spectrum of strong ties and weak ties and hence, have not been discussed as separate kind of tie in this study.

2.3 Significance of measuring tie strength

The current section helps to answer research question Q5 and Q4. This section shows the application of tie strength in different context and also at different level of analysis. Since, many of the context examples provided in this section (like information sharing, creative thinking, knowledge diffusion) are also relevant in case of an event, this section provides a partial answer to the need for tie strength evaluation in the context of an event.

In the study, "The Strength of Weak Ties", the tie strength was evaluated at an interpersonal level between job seekers to find the source of information for a new job. However, over the years the concept of tie strength has been used to study various social phenomenon at different level of analysis. The table below provides some of the areas and the example studies that have been used the concept of tie strength to study different social phenomenon.

Table 2. Use of tie strength concept to study different social phenomenon

Level of Analysis	**Area of Study / Context of Study**	**Example Studies**
Inter personal	• Job search • Collaboration • Gender based analysis • Information access • Information propagation • Innovation • Volunteerism and charitable giving • Behavior consistency • Content selection • Social similarity • Social influence • Knowledge quality • Co-authorship • Motivation and personality • Social media	(Ahn and Park, 2015; Boyd et al., 2010; Demirkan et al., 2013; Echebarria and Barrutia, 2013; Farrow and Yuan, 2011; Figueiredo et al., 2015; Fogués et al., 2013; Gilbert, 2012; Gilbert and Karahalios, 2009; Granovetter, 1973; Hutto et al., 2013; Kang and Johnson, 2015; Lin et al., 1981; Petersen, 2015; Reagans, 2010; Sohn, 2009; Villanueva-Felez et al., 2015)
Intra organizational	• Social support • Information flow • Social network analysis	(Daly and Haahr, 2009; McGuire and Bielby, 2016; Mizruchi et al., 2011; Tortoriello et al., 2011; Wu et

	• Knowledge transfer • Performance • Enterprise social networks	al., 2010)
Inter organizational	• Knowledge transfer • Trust • Collaboration • Social similarity • Multipartner alliances • Entrepreneurship • New business development	(Heidl et al., 2014; Hemmert et al., 2014; Hirai et al., 2013; Levin and Cross, 2004; Li et al., 2013; Reagans, 2010; Retzer et al., 2010)
At a country level or across countries	• Job search • Knowledge transfer • Large scale networked experiment • Information diffusion and spreading • Social effects • Response to referrals • Collaboration • Gender based analysis • Innovation • Trust • Travel behavior • Egocentric contact networks • Research performance • Social media	(Aral and Walker, 2014; Dávid et al., 2016; Echebarria and Barrutia, 2013; Hemmert et al., 2014; Kowald et al., 2013; Kumar et al., 2014; Levin and Cross, 2004; Nitzan and Libai, 2011; Onnela et al., 2007; Petersen, 2015; Verlegh et al., 2013; Villanueva-Felez et al., 2015)
Miscellaneous	• Clustering measures • Representative network elicitation method • Home location estimation • Information propagation • Journalist source relation	(Chen et al., 2016; Cheng and Lee, 2015; Daly and Haahr, 2009; McCarty et al., 1997; Phan et al., 2013; K. Zhao et al., 2011)

The table above provides some of the field of studies where the concept of tie strength has been used to study a certain phenomenon. It can be seen that tie strength evaluation has been done at interpersonal level, intra organizational level, inter organizational level, across different countries and in some cases to develop new measures or methods to study another phenomenon (reflected by the column miscellaneous). The list of the studies and the area or context of studies provided in the above table are not exhaustive but are some of the common themes where concept of tie strength has been used. However, based on the above table it can be observed that themes related to event set-tings or conferences have not yet been addressed by the current literature of tie strength. Hence, the above table points towards a research gap which the current study is trying to address at the interpersonal level and which the future studies can try to address at multiple different level of analysis.

Thus, this section provides an overview of the application and relevance of tie strength in studying various phenomenon. Since, many of the themes/context like collaboration, knowledge transfer, innovation, information propagation, information access and many others also relevant in case of an event; thus, it would make sense to try to evaluate tie strength in the context of an event.

2.4 Major theories related to tie strength and tie identification

This section helps to answer the research question Q1, Q2, Q3 and question Q5. The following subsection about strength of weak ties helps to understand the concept of tie strength and also help in identifying the different kind of ties. This section provides the two most important theories related to tie strength and identification of the different kind of ties. This section helps to answer the research question Q1 which is related to the concept of tie strength and different kind of ties by providing the brief summary of the theory that defines the concept of tie strength. Research questions Q2, Q3 and Q5 which are related to different dimensions, measures and predictors of tie strength and also to the importance of tie strength are partially answered in this section as this section provides the two most relevant theories related to tie strength and tie identification. These theories help provide the different dimensions, measures and also their importance in tie strength calculation.

Before delving into the topic of tie strength and tie identification, it is important to understand the meaning of a network. As the theories and hypothesis presented in this section are based on network and also deal with the implication which they have on the network. According to (Borgatti and Halgin, 2011), a network consists of a set of actors or nodes along with a set of ties of a stated type (like friendship) that link them. The choice of a set of nodes and a type of tie chosen by a research defines a specific network. It is actually dictated by the research question and one’s explanatory theory.

An important role which the networks play is to bridge the local and global – to offer explanation that simple processes at the level of individual nodes and links can have complex effect on the network as a whole. (Easley and Kleinberg, 2010) Though the two specific theories Strength of Weak Ties and Structural Hole theory are different in the explanation they offer about the reason weak ties are useful; at a broad level they both show that weak ties tend to bridge different network clusters. The Granovetter's SWT provides an appealingly ironic and counterintuitive story line for this; while Burt's SH offers a causal agent directly and thus actually provides a stronger foundation for the SWT theory.(Borgatti and Halgin, 2011; Burt, 2004, 1992, Granovetter, 1983, 1973) Based on these commonalities, it can be seen that both the theories of Strength of Weak Ties and Structural Hole Theory have small differences in ornamentation but are based on how networks work(Borgatti and Halgin, 2011).Hence, the two theories add to the evaluation of tie strength and help in identification of different ties and can be used in conjugation to identify different kind of ties. These two theories are explained in brief in the subsections below.

2.4.1 Strength of weak ties

This subsection helps to answer the research question Q1, Q2, Q3 and Q5 which are related to the tie strength, different kind of ties, dimensions and measures of ties and also about how different kind of ties can be identified. By providing a brief description of the original theory proposed by Mark Granovetter in his seminal study, this subsection provides answers to the research questions Q1, Q2 and partially to questions Q3 and Q4.

During the 1960s, Mark Granovetter conducted a study to understand how people looking for a new job found information about these new job vacancies. From his study he found that most of these people found information about the new job through personal contacts. However, these personal contacts were not their close friends but were people with whom they had acquaintance.(Easley and Kleinberg, 2010; Granovetter, 1973) Granovetter proposed a reason for this observation by proposing the strength of weak ties theory.

According to Granovetter (1973), there were no previous sociological theories that had tried to relate the micro level interactions (like interpersonal relations) with macro level phenomena (like social mobility, community organization and political structure). The SWT was a partial attempt to bridge this micro-macro gap. The SWT was limited to small scale interactions- strength of interpersonal ties and how the network analysis of this aspect could relate to the largely varied macro phenomena such as diffusion, social mobility, community organization and political structure in general.(Granovetter, 1983, 1973). The 'strength' of an interpersonal tie needed to satisfy the following definition: "the strength of a tie is (probably linear) combination of the amount of time, the emotional intensity, the intimacy (mutual confiding), and the reciprocal services which

characterize the tie".(Granovetter, 1973) This definition is commonly referred to as the definition of tie strength. Based on this definition Granovetter suggested three possible situations between two people: the tie was strong; the tie was weak; or the tie was absent.(Granovetter, 1983, 1973) This resulted in two kinds of ties – strong ties and weak ties. Granovetter explained how this idea of tie strength was useful in the establishing the micro- macro bridge by giving the following example: Consider two people A and B and a set of people S = C, D, E… with ties to either or both of A and B. The stronger the tie between A and B, the larger the proportion of people in set S that A and B will be tied to that is have a strong or a weak tie. (Granovetter, 1973) Thus providing the state of the overall network at a macro level.

Granovetter explained the concept of strong triadic closure property or the forbidden triad in order to explain the explain the findings of his study related to find a new job. He based this property on the theory of cognitive balance (Heider, 1958) and the general property of triadic closure (Rapoport, 1953).(Easley and Kleinberg, 2010, pp. 47–56; Granovetter, 1973) According to the property of triadic closure "If two people in a social network have a friend in common, then there is an increased likelihood that they will become friends themselves at some point in the future" (Rapoport, 1953). Based on these properties the concept of strong triadic closure was defined as: if A and B have strong ties and also B and C have strong ties then A and C will at least have a weak tie (Easley and Kleinberg, 2010; Granovetter, 1973). Granovetter used this idea of strong triadic closure property to explain that only weak ties could act as the bridges between two or more different groups. Bridge can be defined as a line in a network which provides the only path between two nodes.(Easley and Kleinberg, 2010; Granovetter, 1983, 1973)

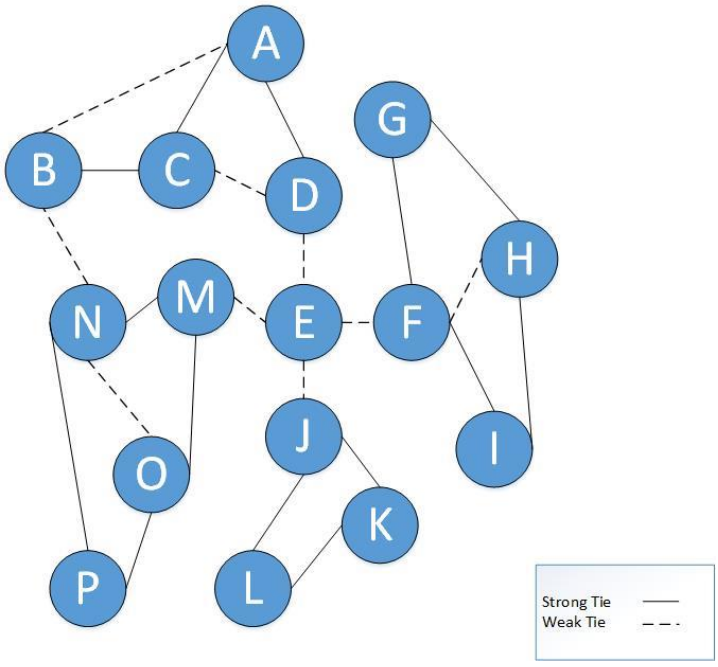

Figure 5. Weak ties as bridge between different groups.

Consider the Figure 5 above, it can be seen that all the nodes in the figure satisfy the strong triadic closure property. It can be seen from the figure that if any information needs to reach from group of nodes J, K, L to the any of the nodes group A, B, C, D then it needs to cross through the node E. Hence, connection with node E can give access to information which would otherwise might not have been possible to gain. Similarly, there are also other bridges in the network shown in Figure 5 like the bridge between node B and node N.

Granovetter emphasized that the weak ties were important for the diffusion of information across any network and the absence of weak ties which could act as bridge between the different groups in a network could reduce or stop the information flow in such networks.(Easley and Kleinberg, 2010; Granovetter, 1983, 1973) He emphasized that more the weak ties per person, the more cohesive the group's ability to act collectively. Through his theory of SWT, Granovetter emphasized the need to have weak ties and also their utility as novel information sources and also as a novel knowledge sources(Levin and Cross, 2004) in some cases. The identification of the different kind of ties could be done by measuring the tie strength.(Easley and Kleinberg, 2010; Granovetter, 1973, 1973)

2.4.2 Structural hole theory

This sub section helps to answer the research question Q1 by providing one of the background theory to identify different kind of ties. The Structural Hole theory complements and provides further empirical proof for the Strength of Weak Ties theory.

Structural holes appear in social networks. According to (Easley and Kleinberg, 2010), a structural hole in an organization is "the 'empty space' in the network between two sets of nodes that do not otherwise interact closely." Structural holes appear in literature extensively in different forms, often in the context of social capital and creativity or the creation of new knowledge (Burt, 2004). An individual bridging a structural hole is able to increase his/her social capital through accumulating non-redundant information from varied sources (Burt, 2004, 1992).

Interestingly, opposite viewpoints to structural holes as source of social capital exist (Burt, 2000): on one hand, areas in a social network where connections between actors are missing provide new opportunities for actors to form bridges, therefore structural holes serve as a potential source for social capital (Burt, 2004). Alternatively, dense network structure can be perceived as high social capital as the removal of individual connections serving as bridges does not affect the overall network (Coleman, 1997, 1988).

The concept of structural hole was originally introduced by Ronald Burt to help explain the origin of the social capital. The structural hole theory to some extent also relies on

the property of network closure i.e. most social structures tend to be characterized by dense clusters of strong connections. The structural hole theory also relies on a basic assumption that the homogeneity of information, new ideas, and behavior is in general higher within any group of people as compared to that in between two groups of people.(Burt, 2004, 1992) An individual who acts as a bridge between two or more closely connected groups of people can gain significant comparative advantages. This bridging position allows him or her to act as a gatekeeper of valuable information from one group to another. (Burt, 1995) Additionally, it also provides an opportunity to combine all the different ideas he or she receives from various sources and combine them to come up with most innovative idea among all.(Burt, 2004) On the other hand, being a broker between different groups can be difficult at times, as maintaining ties with disparate groups can be fragile and time consuming to maintain (Burt, 2000).

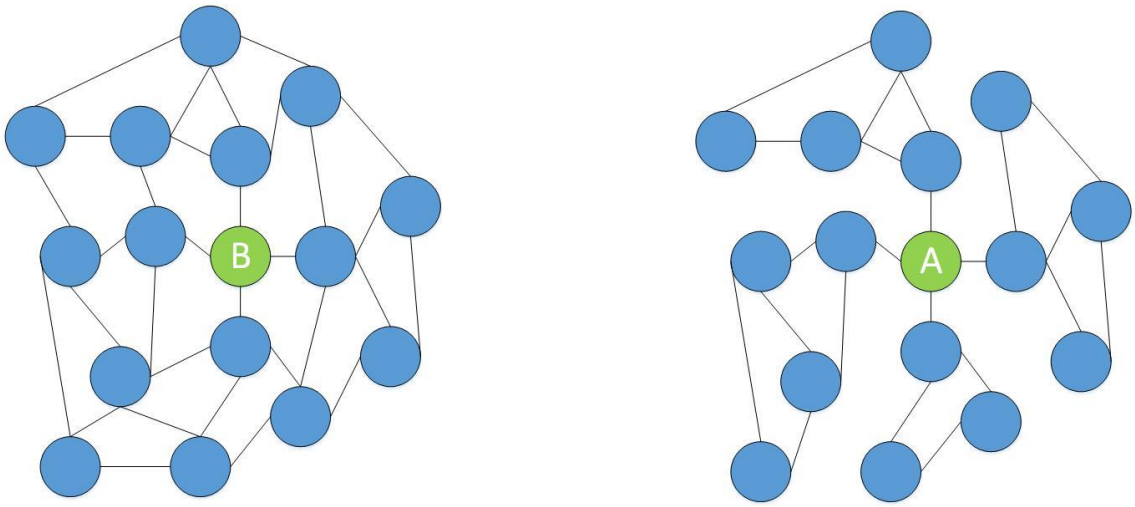

Figure 6. Two different kind of network structures

In the Figure 6. Two different kind of network structuresabove, node A has a higher chance to receive novel information than node B, even though they have the same number of links. The reason for this is that nodes connected to B are also highly connected between each other. Thus, it's as easy to get the any information from B as it is to get from any other node as well. Also, the information, which B gets from different connections, is likely to be overlapping, so connections involving node B are said to be redundant. On the other hand, the position of node A makes it a bridge or a broker between four different clusters. Hence, node A is likely to receive some non-redundant information from its contacts. The term 'structural holes' is used for the gap between non-redundant contacts. As a consequence of this hole between two contacts, they provide network benefits to the third party (to node A). Thus, the bridging actor filling the structural hole will likely be a weak tie which would be node A while node B would likely be a strong tie.

2.5 Different dimensions of tie strength

This section helps to answer research question Q2. The section provides an overview of the different dimensions of tie strength that are commonly accepted in the current literature. Thus, this section helps in answering the research question Q2 by providing the definitions of the various dimensions of tie strength.

Based on the definition of tie strength provided by Granovetter, tie strength consists of four dimensions: amount of time, emotional intensity, intimacy and reciprocal services.(Granovetter, 1973) However, over the years many authors have suggested more dimensions of tie strength. Currently, about seven dimensions of tie strength are commonly attributed to tie strength. These are shown in Figure 7. Dimensions of tie strength

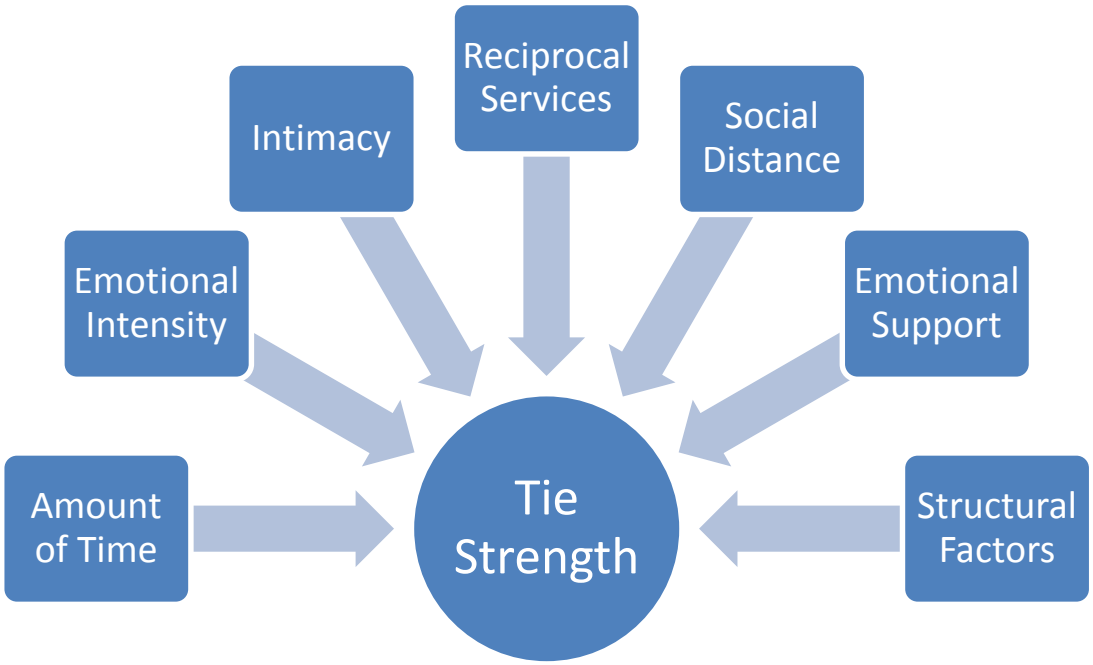

Figure 7. Dimensions of tie strength

Amount of time can be addressed by the frequency and duration of contact (Granovetter, 1973; Lin et al., 1981; Marsden and Campbell, 1984). Many prior studies have suggested that, the higher interaction between two persons, the stronger sentiments of friendship (kind of strong tie) those persons feel (Granovetter, 1973; Krackhardt, 1992; Marsden and Campbell, 2012).

Emotional intensity is more related to the absolute strength of the emotions between two entities rather than to any specific direction that is being positive or negative. People with high intensive relationships will spend more time together and produce longer duration than people with less intensive relationships and hence have a higher tie strength.(Granovetter, 1973; Mathews et al., 1998)

Intimacy is defined as the deep affection between two entities providing a sense of reliance and security (Marsden and Campbell, 1984; Petróczi et al., 2007). Intimacy relationships have the willingness to talk all the time with open mind in order to get or provide recognition and support(Pin Luarn and Yu-Ping Chiu, 2015). This requires significantly more commitment and presumably higher level of positive affect toward alter (Lewis and West, 2009; Lewis et al., 2008).

Reciprocal services refer to the various forms of interaction or specific services or related to communication. Some of the prominent studies related to tie strength had suggested that strong ties are motivated to share what information, knowledge or resource they have, and thus provide a ready access to information circulating in their network.(Granovetter, 1983; Krackhardt, 1992; Levin and Cross, 2004) Hence, strong tie includes more reciprocity services in exchanges (Granovetter, 1983).

Social distance refers to the variation in socioeconomic status, education level, political affiliation, and race and gender between people(Lin et al., 1981, 1978).Some of the previous studies have shown that people with similar social distance have a higher probability of developing a strong tie.(Feld, 1981; Gilbert and Karahalios, 2009)

Emotional support refers to conveying messages that involve emotional concerns, like caring, understanding, or empathy to another person and reassuring the individual is a valuable one to care about. (Taylor et al., 2004) Providing emotional support such as advice on family problems indicates strong tie.(Wellman and Wortley, 1990) Some previous studies have also indicated that strong tie provides a powerful emotional support that not only improves personal mental health, but also unites individuals to overcome crisis (Kendler et al., 2005).

Structural variables can such as social homogeneity, shared affiliation, overlap of social circles, network topology and informal social circles all contribute to the tie strength. (Alba and Kadushin, 1976; Boyd and Ellison, 2007; Burt, 2004; Xiang et al., 2010) Some of the previous studies suggest that strong ties tend to bond similar people together, and these similar people tend to cluster together such that they are all mutually connected. (Burt, 2004; Gilbert and Karahalios, 2009; Lin et al., 1978)

Thus, this section provides a brief overview of the various dimensions of tie strength. Many authors have suggested even more dimensions or a variation of the above mentioned dimensions (see example (Petróczi et al., 2007)). However, the dimensions of tie strength discussed in this section have been limited to the most commonly accepted dimensions found in the existing literature.

2.6 Various indicators and predictors of tie strength

In the previous the various dimensions of tie strength were discussed. This section provides some of the indicators and predictors that have been used to operationalize these different dimensions. This section helps to partially answer the research question Q3. The section provides an overview of the various predictors and measures of tie strength in general. Thus, this section provides an idea of the possible measures and predictors of tie strength which may or may not have been used to calculate tie strength in social media. Thus, partially answering to the research question Q3 which is related to the different measures and predictors of tie strength in social media.

One of the first studies to measure tie strength was done by Marsden and Campbell in their paper titled "Measuring Tie Strength"(Marsden and Campbell, 2012).In their study they provided a concept for the indicators and predictors. According to this study indicator were actual components of tie strength while predictors were related to, but not components of tie strength. However, even in this study both indicators and predictors were used as measures for calculating the tie strength.(Marsden and Campbell, 1984) Thus, there could not any clear demarcation between indicators and predictors while calculating the tie strength. Hence, the measures for tie strength calculation are a mix of indicators and predictors which may not be easily attributed individually to either being an indicator or a predictor. Based on this lack of practical differentiation between indicator and predictor, a table is provided below which gives a list of some of the most commonly used measures of tie strength that have been used in general and not specifically in social media.

Table 3. Commonly used offline measures of tie strength

Measure	**References**
Closeness	(Blumstein and Kollock, 1988; Daly and Haahr, 2009; Echebarria and Barrutia, 2013; Levin and Cross, 2004; Marsden and Campbell, 2012, 1984; Mathews et al., 1998; McGuire and Bielby, 2016; Nitzan and Libai, 2011; Perlman and Fehr, 1987; Verlegh et al., 2013)
Frequency	(Blumstein and Kollock, 1988; Dahlander and McFarland, 2013; Daly and Haahr, 2009; Echebarria and Barrutia, 2013; Granovetter, 1973; Levin and Cross, 2004; Lin et al., 1978; Marsden and Campbell, 2012, 1984; McGuire and Bielby, 2016;

	Nitzan and Libai, 2011; Onnela et al., 2007; Villanueva-Felez et al., 2015; Wang, 2016)
Breadth of discussion	(Daly and Haahr, 2009; Granovetter, 1973; Marsden and Campbell, 2012, 1984; McGuire and Bielby, 2016)
Duration/ longevity	(Daly and Haahr, 2009; McGuire and Bielby, 2016; Petersen, 2015; Villanueva-Felez et al., 2015)
Confiding/trust	(Daly and Haahr, 2009; Granovetter, 1973; Levin and Cross, 2004; Marsden and Campbell, 2012, 1984; Mathews et al., 1998; Villanueva-Felez et al., 2015)
Degree of friendship	(Echebarria and Barrutia, 2013; Villanueva-Felez et al., 2015)
Degree of reciprocity	(Blumstein and Kollock, 1988; Daly and Haahr, 2009; Friedkin, 1980; Granovetter, 1973; Mathews et al., 1998; McGuire and Bielby, 2016; Perlman and Fehr, 1987; Villanueva-Felez et al., 2015; Wellman, 1982)
Recency	(Daly and Haahr, 2009; Lin et al., 1978)
Sociability	(McGuire and Bielby, 2016; Mitchell, 1987)
Provide support	(Blumstein and Kollock, 1988; Echebarria and Barrutia, 2013; McGuire and Bielby, 2016; Mitchell, 1987; Perlman and Fehr, 1987; Wellman, 1982; Wellman and Wortley, 1990)
Voluntary investment in a tie	(Blumstein and Kollock, 1988; Perlman and Fehr, 1987)
Co-worker	(Lin et al., 1981; Marsden and Campbell, 2012, 1984)

Overlapping kinship	(Lin et al., 1981; Marsden and Campbell, 2012, 1984)
Prestige difference	(Lin et al., 1981, 1978, Marsden and Campbell, 2012, 1984)
Educational difference	(Lin et al., 1981, 1978, Marsden and Campbell, 2012, 1984)

The above table provides some of the most common measures of tie strength. The above table includes different indicators and indicators which have been used in different studies to evaluate and calculate the tie strength. It can be seen from the table that frequency of communication is one of the most commonly used measure for evaluating tie strength. Various studies have adopted different scales for measuring this frequency ranging from time interval of several years to a few minutes (see Onnela et al., 2007; Villanueva-Felez et al., 2015).

Thus, this section provides a brief overview of the different measures of tie strength that have been used in the tie strength evaluation and calculation. This section helps to answer the research question related to the different measures of tie strength in social media by providing a list of some of the most commonly used in general. Hence, providing an idea about the potential measures of tie strength which may be useful when evaluating tie strength using social media data.

3. EVALUATION OF TIE STRENGTH FROM SOCIAL MEDIA

3.1 What is social media?

This section helps to provide a background answer which would be useful in answering the research questions Q3, Q4 and Q6. The section provides the definition of the social media which is used in this study and also provides a brief description about the different kind of social media channels. Thus, this section enables the required understanding about the social media which is essential for answering the research Q3, Q4 and Q6.

The concept of Web 2.0 and social media are to some extent interrelated and are used interchangeably. However, it is beneficial to differentiate these from each other.(Kaplan and Haenlein, 2010) Web 2.0 can be defined as technologies that facilitate and empower users to communicate, generate content and share it with one other by way of communities, social networks and virtual worlds far more easily than before. These kind of tools and technologies assert the power of users to select, filter, publish and edit information at the same time to participate in the content creation in social media (J. J. Jussila et al., 2014; Tredinnick, 2006). On the other hand, social media can be defined as ‘‘a group of Internet-based applications that build on the ideological and technological foundations of Web 2.0, and that allow the creation and exchange of user-generated content’’ (Kaplan and Haenlein, 2010).

According to Wollan et al. (2010), some of the characteristics which distinguish digital social media interaction from other social conversations are ability to have one to many, many to many or one to one conversations; it features content created and consumed by the consumers of that content; it is easy to use; and it is highly scalable, accessible and works in real time. It can be seen that social media are exactly not a unified and well-defined set of approaches, hence, this should be taken into account when studying the use and potential of social media in a selected context(J. J. Jussila et al., 2014). Many different researchers(see e.g. Boyd and Ellison, 2007; J. J. Jussila et al., 2014; Kaplan and Haenlein, 2010; Warr, 2008) have provided different classification of social media applications like wikis (e.g., Wikipedia), blogs (e.g., company newsrooms), microblogs (e.g., Twitter, and Yammer), social networking sites (e.g., LinkedIn, and Facebook), social content communities (e.g., YouTube, Dailymotion, SlideShare, and Instagram), intermediaries (e.g., InoCentive), and virtual social worlds (e.g., Second Life, Pokemon Go). However, in the context of this study, the social media refers to the social networking sites like Facebook and the microblogging sites like Twitter.

Thus, this section provides a brief overview of the different types of social media applications in general and also a formal definition of social media. This section also points to the kind of social media which are relevant to this study. Hence, this section helps to answer the research question Q3, Q4 and Q6 by providing a definition of social media and also the relevant kind of social media in the context of this study.

3.2 Motives of using social media and its usefulness for tie strength evaluation

This section helps to partially answer the research question Q4 and Q5. Since, this section provides the different motives of using the social media in general, it helps in identifying the different motives of social media which may also be relevant in case of an event. Thus, this section provides a part of the answer to research questions Q4 and Q5 related to the relevance of using social media data for tie strength evaluation in an event and also the different kinds of ties which can be identified in an event by understanding the different motives of the social media use in general.

Social networks in an offline life serve many different purposes like providing social and emotional support, information resources and ties to different people (Wellman, 1999). Similar kinds of social network have been identified in the online world as well where people go online to seek both social and emotional support, information resources and to seek ties with other people(Boyd and Ellison, 2007; Joinson, 2008).

Social media has been found to be used for surveillance purpose by the users i.e. to track the actions, beliefs and interests of the larger groups to which the users themselves belong to (Joinson, 2008; Lampe et al., 2006). At a more general level social media like Facebook has been found to be used for social searching and social browsing. Social searching is related to using the social media to look up details about someone whom the user knows offline. On the other hand social browsing is related to establishing a contact with someone online with an intention to meet offline at a later stage (Ellison et al., 2011; Joinson, 2008; Lampe et al., 2006). Some of these studies have shown that the social media users are likely to use sites like Facebook to maintain their existing ties than to establishing new ties (see Ellison et al., 2011, 2007; Lampe et al., 2006).

The differences in the design of the different social media channels also effect the purpose of their use. It has been found that the features of microblogging sites like Twitter which allow following anyone without being their friend makes it more useful for many purposes than the other social media channel like Facebook.(Hughes et al., 2012) Some studies have shown that the social media channel like Twitter has been used to establish new ties and also to maintain existing ties. The Twitter functions like retweet have been found to be useful way of maintaining ties with existing relationships by some studies.(Ahn and Park, 2015; Boyd et al., 2010)

Another important use of social media has been for seeking new information and also spreading new information. Many studies have suggested use of some of the social media channels for propagating information.(J. Zhao et al., 2011) These studies have also shown that many times the social media channels are used by the users to spread a specific political agenda, product, spread electronic word of mouth publicity and multiple other related issues.(Aral and Walker, 2014; Zhan Shi et al., 2014)

According to Smock et al. (2011), it has been found that the users of social media may have very different motives for using the social media and may use the different functions of the social media channels differently. There is not necessarily homogeneity in the use of the same function of a social media channel for same purpose by users as has been suggested in many previous studies. The Figure 8. Different reasons for using social mediabelow provides the some of the most prominent motives for using social media channels as found in literature, however, it does not in any way specify how these specific motives are achieved by the different social media users. From the perspective of the current study, the use of social media for networking and maintaining existing relationship are the most important and are highlighted in green color in figure below.

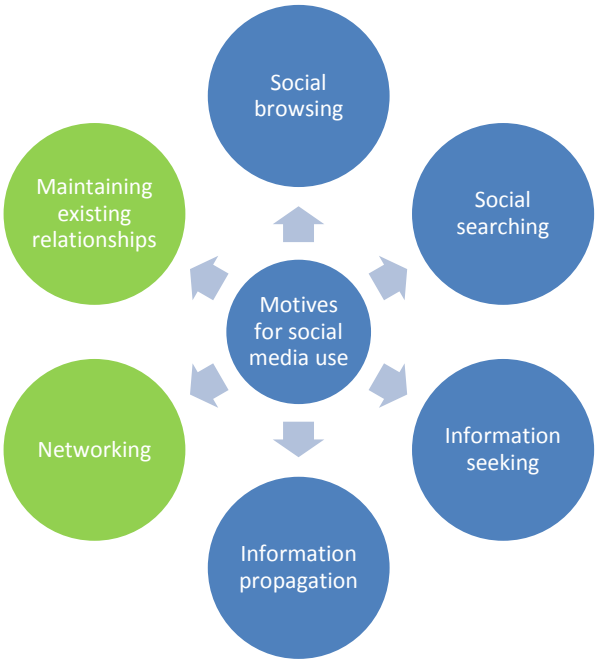

Figure 8. Different reasons for using social media

Thus, it can be seen that the current section provides some of the most prominent and common motives for using the social media. The need to maintain existing relationships and establish new relationships (or networking) are some of the most common reasons for social media use in the current literature. Hence, this section helps to answer the research question Q4 and Q5 related to the relevance of social media data in tie strength evaluation by highlighting that the social media in general is also used for networking

and maintaining existing ties; therefore, it would logically make sense to use social media data for evaluating tie strength.

3.3 Characteristics of different social media channels and their helpfulness in tie strength evaluation

This section addresses the research question Q4 and Q6. This section provides a brief overview of some of the limitations of some major social media channels. This overview helps in understanding the suitability of different social media channels in case of tie strength evaluation in an event. These characteristics and limitations of the different social media channels also help in understanding the possibility of the use already known measures and predictors of social media in case of an event.

The different social media channels have certain characteristics and limitations which allow their use for specific purposes. Some studies have analyzed these differences in the characteristics of the social media channels specifically for Twitter and Facebook to understand the narcissism character of the social media users (see e.g. Davenport et al., 2014; Panek et al., 2013). However, these differences in the social media channels can also be useful and relevant to while deciding on a specific social media channel for tie strength evaluation. Some these differences which may be relevant for the tie strength evaluation are shown below in the table.

Table 4. Differences in Facebook and Twitter which may be relevant for tie strength evaluation

Criteria	**Facebook**	**Twitter**
Reciprocal Relationship	Only allows reciprocal relationship.	Allows one way as well as reciprocal relationship.
Control over self-presentation	High degree of control as it is possible to create a detailed user profile.	Low degree of control over self-presentation as it is possible to create only very minimal user profile.
Tool for self-promotion / relationship maintenance and building	Possible to use exclusively for self-promotion. No limitation on the character limit of Facebook post or comments. Allows ability to share pictures	Cannot be used exclusively for self-promotion. One reason is due to 140-character word limit. Needs to be used for maintaining or establishing new relationships.
Data Access (openness)	Default terms of use of Facebook do not allow access to Facebook posts , comments and user profile data.	Default terms of use allow easy access to Tweet and user profile data. Thus more open in terms of data access.

According to Granovetter's (1973) definition of tie strength, reciprocal services is one of the dimensions of tie strength. Thus, the ability to see this in an online relationship for a social media channel would be helpful in tie strength evaluation. In case of Facebook, all the relationships are reciprocal in nature i.e. if A is friend with B then B is also friend with A; on the other hand, in case of Twitter if A is a follower of B then it does not imply B is a follower of A(Davenport et al., 2014; Panek et al., 2013). Therefore, it can be seen that Facebook and Twitter behave differently in terms of what constitutes as an online relationship.

Some of the studies suggest that in case of Facebook, it's possible to have a high degree of control over the online self-presentation. This is due to the Facebook's functionality to offer a detailed user profile. In case of Twitter, there is a very minimal user profile and the users' tweets are the main source of self-presentation.(Hughes et al., 2012; Panek et al., 2013) These differences in self-presentation make Twitter users to show their actual self rather than their perceived self-image(Hughes et al., 2012; Marwick and Boyd, 2011; Panek et al., 2013). This difference might be helpful in trying to identifying a more relevant source of online data for tie strength evaluation.

Twitter has a 140-character limit for a single tweet and also does not allow direct sharing of photos. This limits the use of Twitter only as a tool for self-promotion, it is more related to the notion of "what you say", rather than "who you are". Also, studies have shown that use of Twitter is more related to the daily activities and self-promotion is not commonly accepted. The use of Tweets has been attributed to establishing and maintaining relationships in many cases.(Ahn and Park, 2015; Chen, 2011; Hughes et al., 2012; Marwick and Boyd, 2011; Panek et al., 2013) On the other hand, Facebook allows direct sharing of photos and also does not have any character limit on the posts and comments. These features allow Facebook to be used exclusively as a tool for self-promotion.(Hughes et al., 2012; Panek et al., 2013) Hence, this difference in the possibility to use a social media only for self-promotion will be relevant to identify the useful source for tie strength evaluation especially in the context of an event where multiple social media channels may be used.

Data access is important especially in case of tie strength evaluation in a conference, as the access to data can be critical in being able to evaluate the tie strength. Based on the terms of use in case of Facebook and Twitter, it can be seen that it's easy to access the tweet data using Twitter API[3]. However, in case of Facebook[4], there are many permissions which have to be explicitly taken before being able to access any Facebook comment or post related data. This difference in the access to data may not have direct role

[3] https://dev.twitter.com/overview/terms/agreement-and-policy
[4] https://www.facebook.com/policies

in tie strength calculation, however, access to data is essential for doing any social media data based tie strength evaluation.

In the context of this study, it can be seen from the Table 4 above that Twitter is more suitable as a data source for carrying out SNA due to the possibility to observe direction of the online relationship and the easy availability of data. Also the fact the that Twitter has lower degree of control over self-presentation and cannot be used solely as a self-promotion tool but rather for maintaining relationships make it a good social media source for evaluating tie strength in this study.

This section highlights some of the important differences between two most popular social media channels Twitter and Facebook which may be relevant for tie strength evaluation. Hence, this section helps in answering the research question Q4 and Q6 which are related to the relevance of tie strength evaluation and the limitations of the presently known measures, predictors related to tie strength evaluation in conference setting by highlighting some of the important differences between the social media channels and how these could have an impact on the tie strength evaluation.

3.4 Measures of tie strength in social media

This section answers the research question Q3 and also provides the necessary background information needed to answer research question Q6. The section provides an overview of the various predictors and measures of tie strength which have been used in social media. Thus, this section provides an idea of the possible measures of tie strength which have been used to calculate tie strength in social media but may or may not be applicable in case of an event.

One of the earliest studies for measuring tie strength using social media was done by (Gilbert and Karahalios, 2009). In this study, they used personal Facebook data of study participants to calculate the tie strength of their online relationships. This study provided some measures for calculating the tie strength using Facebook friends network data along with other personal data of the study participants. In order to compare the tie strength calculated using social media data, the participants were asked to answer a set of five questions which pointed towards the actual tie strength between the participant and their friend. This data (questionnaire based tie strength) was then compared with the tie strength values calculated using social media data. This study used 74 different measures based on Facebook data to calculate tie strength.(Gilbert and Karahalios, 2009) Over the years many studies have used the same measures or similar measures to calculate the tie strength using Facebook data.(see (Fogués et al., 2013; Panovich et al., 2012) The table below provides some of the measures of Facebook which have been used for tie strength calculation.

Table 5. Measures of tie strength using Facebook

Dimension	Measure	References
Amount of Time	• Days since first communication	(Fogués et al., 2013; Gilbert and Karahalios, 2009)
Emotional Intensity	• Wall words exchanged • Participant-initiated wall posts • Friend-initiated wall posts • Inbox messages exchanged • Inbox thread depth • Participant's status updates • Friend's status updates • Friend's photo comments • Picture tagging	(Fogués et al., 2013; Gilbert and Karahalios, 2009; Xiang et al., 2010)
Intimacy	• Participant's number of friends • Friend's number of friends • Days since last communication • Wall intimacy words • Inbox intimacy words • Co-presence in photo • Distance between hometowns • Friend's relationship status • Current town	(Aral and Walker, 2014; Fogués et al., 2013; Gilbert and Karahalios, 2009; Xiang et al., 2010)
Reciprocal Services	• Links exchanged by wall post • Applications in common	(Fogués et al., 2013; Gilbert and Karahalios, 2009)
Social Distance	• Age difference • Number of occupations difference • Educational difference (degrees) • Overlapping words in religion	(Aral and Walker, 2014; Fogués et al., 2013; Gilbert and Karahalios, 2009)

	• Political difference (scale)	
Emotional Support	• Wall & inbox positive emotion words • Wall & inbox negative emotion words • Likes	(Fogués et al., 2013; Gilbert and Karahalios, 2009)
Structural Factors	• Number of mutual friends • Groups in common • Norm. TF-IDF of interests and about • Mean strength of mutual friends • Fans of same Facebook pages • Number of common affiliations	(Aral and Walker, 2014; Fogués et al., 2013; Gilbert and Karahalios, 2009)

The above table provides some of the measures which have been used to calculate tie strength using Facebook data. However, many of the features which have been used to carry out these studies may longer be available on Facebook. On the other hand, many new features have also been added since these studies were done (for example comment on a comment or post, different reactions instead of the Like button) and may provide better measures to calculate tie strength.

Another popular social media which has been studied for a long time for its effect and use in relationship building and forming new relationships is Twitter(see examples (Boyd et al., 2010; Boyd and Ellison, 2007; Hutto et al., 2013).However, limited number of studies have tried to evaluate tie strength using the Twitter data. One of the earliest study to calculate tie strength using Twitter data was done by (Gilbert, 2012) . In this study, the study participants were asked to log into an application on Twitter which would extract the participant's personal data including follower and followee data. This data was used to calculate the tie strength of the participants with their Twitter followers. Based on the calculated tie strength, the participants contacts were divided into different groups and were presented to the participant using the application. The participant could either keep the groups as shown or change the persons in the groups, thus providing a way to validate the Twitter data based tie strength calculation.(Gilbert, 2012) A table below provides some of the measures that have been used to calculate tie strength using Twitter data.

Table 6. Measures of tie strength using Twitter

Dimension	Measure	References
Amount of Time	• Days since first communication	(Gilbert, 2012)
Emotional Intensity	• @-reply words exchanged • Initiated @-replies measures the number of @-replies • Direct message headers	(Gilbert, 2012)
Intimacy	• Days since first communication • @-reply intimacy words	(Gilbert, 2012)
Reciprocal Services	• Link sharing via @-replies • Retweet • Mutual followers	(Ahn and Park, 2015; Gilbert, 2012; Zhan Shi et al., 2014)
Social Distance	• Follower difference • Following count	(Gilbert, 2012)
Structural Factors	• Mean tie strength of mutual friends • Network overlap	(Gilbert, 2012; Hutto et al., 2013)

The table above provides some of the common measures which have been used to calculate tie strength using Twitter data. However, many of the features which were used while doing these studies can no longer due to the changes in the way those Twitter features now work. For example, the retweet function of Twitter has changed since the first study done by Gilbert (2012). From the table, it can be seen that current studies have not been able to identify independent measures to evaluate the emotional support dimension of tie strength.

This section provides a brief summary of the currently known measures for calculating tie strength using social media. From this section, it can be observed that most of these

studies have used the personal social media data of the participants which may not be easily accessible in case of conference. Thus, these tie strength measures may not fully applicable while using publically available social media data in case of a conference. Hence, this section helps to answer the research question Q3 related to the different measures of tie strength in social media. This section also provides some possible limitations in using these measures and hence, also provides partial answer to the research question Q6 related to the extent to which the currently known measures of tie strength be used in case of conference.

4. WHY CONFERENCE SETTING MATTERS FOR TIE STRENGTH EVALUATION?

4.1 Motives for attending conferences

This section helps to answer the research question Q4 and Q5. The section provides the different motives which people have while attending a conference. The identification of the different motives of attending conference helps to address the part of the research question Q4 which is partly related to the relevance of tie strength evaluation in an event. The identification of different motives for attending the conference also provides part of the answer to research question Q5 which is related to the discovering of different kinds of ties in a conference as different motives for attending conferences may provide need to identify different kind of ties.

The conferences play an important role in the transfer of scientific, managerial and other type of information and knowledge among the conference attendees or participants. According to (Severt et al., 2007) there are different dimensions to the motivations of the conference participants in attending a conference or a convention. These dimensions are: activities and opportunities, networking, education benefits, products and deals and convenience of conference. The figure below provides these major factors where the most important factors which are relevant for the current study have been highlighted in green color.

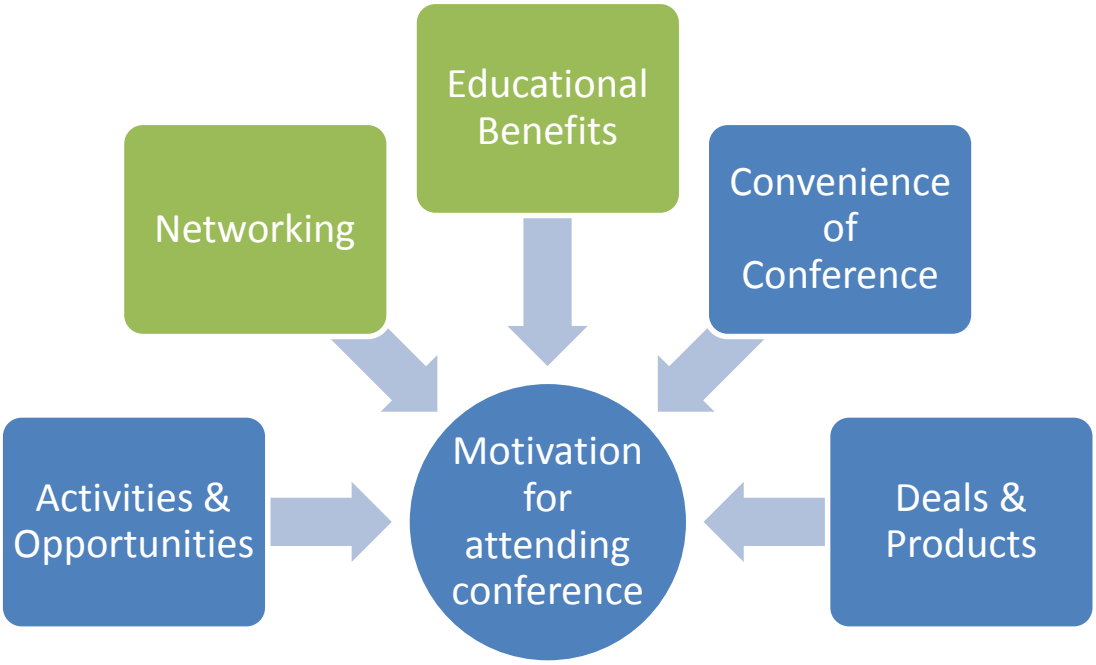

Figure 9. Major motivators for attending a conference

Activities and opportunities factor is related to business opportunities, association related activities, travelling opportunities, visiting friends or relatives, or attending a guest program.(Oppermann and Chon, 1997; Severt et al., 2007) The factors like travelling opportunities, visiting friends or relatives have been found to have very limited influence on the motivation for attending a conference.(PhD et al., 2001; Severt et al., 2007)

Networking factor is related to opportunities to meet new people who may share similar interests or may provide relevant information. The participants use these conferences to try to establish contacts with new participants who may be potentially useful in the future.(Oppermann and Chon, 1997; Severt et al., 2007; Zhang et al., 2016) Networking has been found to be one of the most important motivation for attending conferences in many different studies.(see example(Oppermann and Chon, 1997; Ross et al., 2011; Severt et al., 2007)

Educational benefits factor refers to the different opportunities which a participant may have access to by attending the conference. These opportunities include interesting conference programs, different educational information, career enhancement opportunities and educational information at exhibits.(Severt et al., 2007) The educational benefits have also been found to be one of the top motivators for attending a conference.(Ross et al., 2011; Severt et al., 2007)

Convenience of conference factor includes aspects like reasonable travel time to conference location, reasonable pricing of conference and chance to easily integrate the conference into the participant's work schedule. These factors related sometimes play a role in the overall motivation of a participant to attend a conference.(Severt et al., 2007) For

example, an educational conference organized during summer vacations may be opted out by many potential conference participants due to the inconvenience in the scheduling.

Product and deals factor may not be applicable to all kinds of conferences and is more relevant in case of conventions. This factor refers mainly to the products available for purchase at exhibits and also to the deals on conference packages.(Severt et al., 2007)

Out of these different motivators for attending a conference, it has been found that the opportunity for networking and the opportunity to gain educational benefits are the most important factors for attending a conference in general.(Oppermann and Chon, 1997; Ross et al., 2011; Severt et al., 2007; Zhang et al., 2016) Hence, this section helps to answer the research questions Q4 and Q5. As it can be seen from this section that networking is one of the most important motivator for attending a conference, thus it partially answers Q4 and Q5 which are about the relevance of tie strength in a conference setting and also the importance of discovering different kind of ties in a conference setting.

4.2 Current ways of identifying potentially useful contact in a conference

This section helps to answer the research question Q4. The section provides the different ways in which the participants meet potentially useful contacts. This helps to address the relevance of tie strength evaluation in case of conference as this section points to the fact that the present methods do not take the tie strength perspective into account while identifying potentially useful contacts.

In general, there are three different broadways of identifying and networking with potentially useful contact in case of conferences. These methods are based on: the structure or the manner in which the conference is organized by the conference organizers; through the use of technology based interventions like conference recommendation systems; and lastly due to chance encounter with a relevant person.

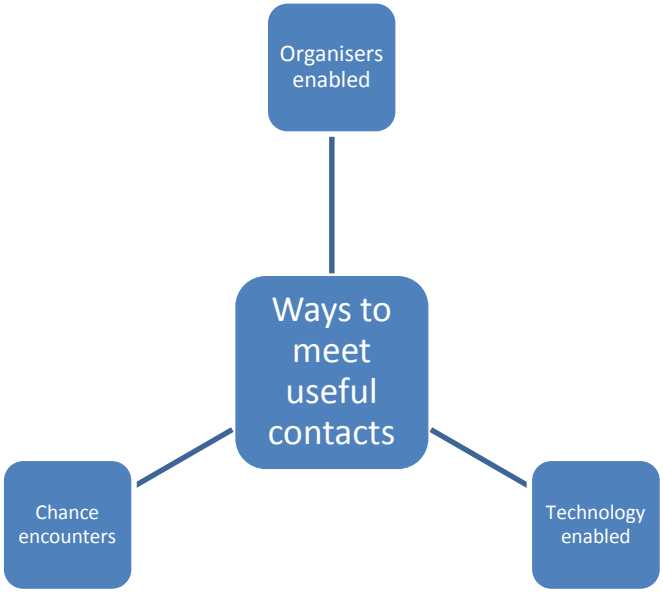

Figure 10. Different ways of networking with potentially useful people in a conference

The conference organizers in many conferences use the past participant feedback and the analysis of the previous conferences data to design the layout for subsequent conferences which promotes networking among conference participants. This includes organizing common transportation to conference venue and physical spaces and seating order based on the common themes which the conference participants are interested in or are relevant to their learning objectives. For example, the seating arrangements around the lunch tables and coffee tables can be based around the identified topics of interest.(Aramo-Immonen et al., 2016, 2015) Thus, different kinds of layout arrangements by the conference organizers in many cases improve the possibility of the conference participants to find potentially useful contacts.

Over the years, the need for meeting relevant people in a conference has given rise to the development of many different technology based interventions like conference recommendation systems (eg. brella.io, confer). These conference recommendation systems can be used to provide suggestions to meet certain other participants that may be potentially useful.(Hornick and Tamayo, 2012) Generally these systems have relied on giving recommendation based on certain keywords which are usually extracted from the conference participants registration form or some other information which had been provided by the participant at the time of conference registration(Hornick and Tamayo, 2012; Zhong et al., 2015). In recent years some studies have tried to incorporate other sources of data like bibliographic data, co-occurrence data, participant's mobile device data and also data from sites like epinions.com, flickr to provide more relevant recommendations(Gupte and Eliassi-Rad, 2012; Zhang et al., 2016; Zhong et al., 2015).

Hence, the technology based systems are also being used to provide ways to meet potentially useful contacts in a conference.

Finally, many times conference participants end meeting other relevant new participants by chance. In such meetings there are no structured interventions which were either based on the efforts of the organizers in organizing the conference or based on the conference recommendation systems. However, such serendipitous encounters are very limited and cannot be planned by the conference participants in advance.(Reinhardt et al., 2011; Ross et al., 2011; Zhang et al., 2016) Thus, this method of chance encounter is not very helpful in increasing the chances of a conference participant to meet another potentially useful contact.

In summary, it can be seen from this section that the current methods of finding potentially useful contacts do not take into account the possibility to use tie strength. Thus, this section partially answers the research question Q4 which is related to the relevance of tie strength evaluation in a conference setting by showing that the chances of networking may be enhanced if a tie strength based approach is used.

4.3 Current ways of social media use in conferences

This section helps to answer the research question Q4. The section gives a brief overview about the use of social media by the different stakeholders of a conference which includes the conference participants and also the conference organizers. Thus, this section helps in answering to the research question Q4 by providing the reason for using social media data (Twitter data in this study) in evaluation of tie strength in a conference.

The advent of social media has allowed the traditionally passive role of conference participants and delegates to be transformed into more active role. Social media has provided novel ways for integrating participants in the preconference planning, during-conference participation and after conference activities for example sharing conference related information. This has also allowed creation of tailored conference content and more useful networking opportunities.(Jussila et al., 2013; Reinhardt et al., 2009) In recent years blogging, microblogging has become popular and pervading in daily life including their use in conferences. Twitter is one of the most popular social media which is used in this regard.(Reinhardt et al., 2009; Ross et al., 2011)

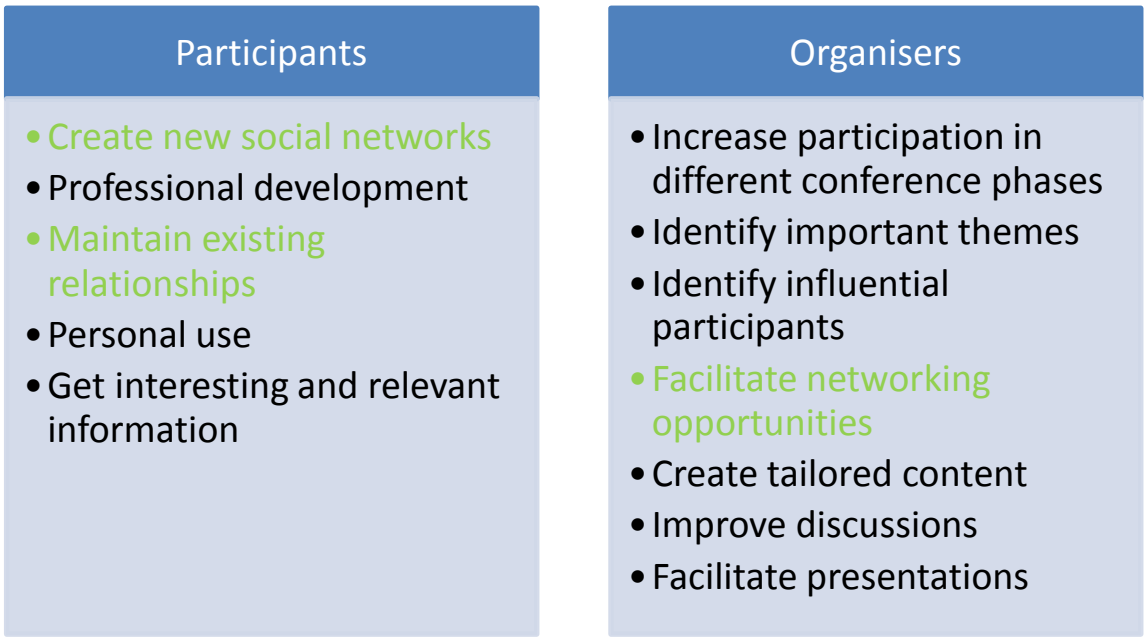

Figure 11. Common uses of social media by different conference stakeholders

Based on the different studies which have analyzed the use of social media especially Twitter in a conference, it can be stated that there several distinct ways in which Twitter is used: (a) for communication amongst participants; (b) for communication amongst organizers/ presenters and audience; and (c) for reporting to non-participants about the conference. It has also been found that these social media channels are used before, during and after the conference.(Aramo-Immonen et al., 2015; Ebner et al., 2010; Jussila et al., 2013; Reinhardt et al., 2009; Ross et al., 2011) The figure above provides some of the most common uses of social media by the two most important conference stakeholders. The most important which are relevant in the context of this study are highlighted in green in the figure above.

According to (Ross et al., 2011), Twitter provides an effective backchannel for interacting with other conference participants. It provides an informal way to interact with other conference participants and acts as a secondary route of communication. Some of the previous studies have found that Twitter in general is used to maintain existing relationships and to establish new relationships (Ahn and Park, 2015; Boyd et al., 2010). This has also been found to be true in case of conferences. The need to establish new social relationships and to maintain existing relationships were found to be amongst the top reasons for using social media (especially Twitter) in a conference setting(Reinhardt et al., 2009; Ross et al., 2011). Other reasons for using social media include professional development, to get update information and to learn about new topics (Ross et al., 2011).

Various studies have also explored the use of social media by conference organizers. Conference organizers have used the social media to crowdsource certain conference

activities like conference marketing and other co-creational activities to both organizers and participants alike (e.g. Jussila et al., 2013; Ritala and Hurmelinna-Laukkanen, 2009; Ross et al., 2011). The social media has been used by the organizers and presenters to facilitate instant discussions during presentations.(Aramo-Immonen et al., 2015; Jussila et al., 2013) The visualization of the social media discussion data related to the conference has been used to identify the most influential participants and also identify the common important themes in the conference (Aramo-Immonen et al., 2015; J. Jussila et al., 2014). These kind of visualizations can help the organizers to design better layouts which can be helpful in effective networking for the event participants (Aramo-Immonen et al., 2016, 2015).

The use of different social media channels allows different degree of information which is visible to the non-participants. However, in general and specifically in case of Twitter it has been found that the social media data from a conference is not very useful source of information as it is not easy to understand the conference social media discussion without the context (Ebner et al., 2010).

In summary, this section provides some of the different ways in which the social media is currently used by both the conference organizers and the conference participants. It is evident from this section that networking is an important motivator for the participants in using the social media. Hence, this section helps to answer the research question Q4 which is related to the importance of tie strength evaluation using social media data in the context of a conference. Since, this section highlights that social media is an important medium for establishing and maintaining ties in case of conference.

4.4 Relevance of a tie strength based approach for enhancing networking in conferences

This section helps to answer the research question Q4 and Q6. This section discusses some of the characteristics which are common in case of conference and how these characteristics might limit the use of existing methods of tie strength calculation from social media. As the previous sections have already established that networking is one of the most important reason for attending a conference and also using the social media. Hence, this section helps to answer the research question Q4 which is related to the significance of using tie strength in a conference setting by discussing the common denominator between attending a conference and using social media which is networking. This section also provides answer to research question Q6 which is related to the extent of currently known measures of social media can be used in case of conference setting by providing the limitations of existing methods of tie strength calculation using social media data.

One of the primary aims of the conference participants in a conference is to meet new potentially useful other participants. However, there is a very limited time in such

events for such opportunities.(Oppermann and Chon, 1997; Severt et al., 2007; Zhang et al., 2016) This lack of time acts as potential challenge and limits the chance of meeting potentially useful contacts. In order to avoid this challenge, some studies have shown that participants use social media as a channel for networking (Ross et al., 2011).

Use of social media for networking and information seeking has been shown to be one of the most important reasons for social media use in a conference setting (Ebner et al., 2010; Reinhardt et al., 2009; Ross et al., 2011). Thus, intuitively it would make sense to use social media data for measuring tie strength even in case of conference setting. In the past there have been many studies which have used social media data for tie strength calculation. However, all these studies have relied on using the online personal data from the social media sites of the participants (see examples (Fogués et al., 2013; Gilbert, 2012; Gilbert and Karahalios, 2009; Xiang et al., 2010). This can be a potential challenge in case of conference as such an approach would require access to the personal social media data of the conference participants which may be difficult to get and access in most cases. Hence, the already established methods for tie strength calculation using social media data may not be directly useful in the context of conference setting. On the other hand, it may be more easy to use the publically available social media data about a conference to calculate the tie strength.

The use of social media for networking in such co-located professional events (Zhang et al., 2016) has resulted in a desire to build event recommendation systems which may provide relevant recommendations for the event participants. However, currently such conference recommendation systems give recommendations based on certain keywords which may be extracted from the conference participant's registration form or some other information participant information provided at the time of conference registration(Hornick and Tamayo, 2012; Zhang et al., 2016). In recent years some studies have tried to incorporate other sources of data like bibliographic data, co-occurrence data, participant's mobile device data and also data from sites like epinions.com, Flickr to provide more relevant recommendations(Gupte and Eliassi-Rad, 2012; Zhang et al., 2016; Zhong et al., 2015). However, these systems don't yet incorporate online social media based tie strength evaluation while giving recommendations in events. The development and incorporation of such an approach may result in better and relevant recommendations and provide a more efficient way for networking and meeting useful people in an event like conference. This idea is illustrated by the figure below.

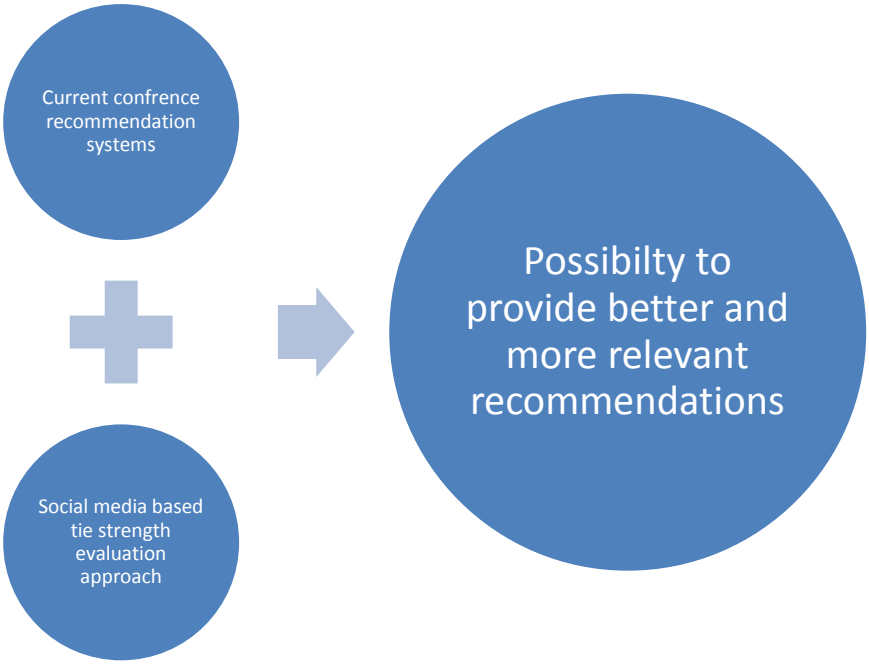

Figure 12. Potential benefits of incorporating a tie strength based approach in present conference recommendation systems.

Thus, this section highlighted the use of the personal social media data for tie strength evaluation and prediction by the current studies and the potential challenge in using these methods for tie strength evaluation in case of an event due to the lack of access of personal social media data in most events. This section also pointed out the use of social media for networking in co-located events like conferences and the resulting desire to build the conference recommendation systems. It also highlighted the current status of such conference recommendation systems and how these systems could benefit from incorporating the social media based tie strength functionality while giving recommendations. Hence, this section helped in answering the research question Q4 which is related to the relevance of tie strength evaluation using Twitter data in the context of an event. The section also partially addressed the research question Q6 which is related to the limitations of the currently used measures of tie strength evaluation by highlighting some of the challenges related to access to personal social media data in case of events.

5. RESEARCH: METHODS AND DATA COLLECTION

5.1 Case study approach

The term ‘case study’ is suggested to be definitional morass where different researchers have many different things in mind when they talk about case study research (Gerring, 2006, 2004). One of the most prominent advocate of case study research, Robert Yin defines it “as an empirical enquiry that investigates a contemporary phenomenon in depth and within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident”(Yin, 2013). The aim of a case study is to investigate the case thoroughly by using multiple methods and data sources which all aptly reflect the research problem (Ghauri and Grønhaug, 2005; Yin, 2013).

According to Yin (2013), there are approximately four categories of case study design: a single-case and a multiple-case designs with both having either holistic or embedded units of analysis. Single-case design is relevant when the case represents a critical, extreme or unique case worth documenting; a typical or a revelatory case with unique opportunity to observe previously inaccessible or common situation; or a longitudinal case, where the same case is studied at various points in time. Multiple-case study design is generally considered more applicable when researcher seeks exemplary outcomes (i.e. literal reproduction or generalization) or contrasting results for predictive reasons (i.e. theoretical reproduction) in relation to a specific theory.(Saunders et al., 2009; Yin, 2013)

Any case study can have single or multiple units of analysis depending on the research objectives and research settings. Holistic approach is useful when the studied case consists of rather simple entities, such as one department or organization i.e. when the simple entity is considered as a whole without any further segregation. On the other hand, embedded approach is often considered when the chosen case or cases are examined extensively with subunits of analysis.(Saunders et al., 2009, pp. 145–147; Yin, 2013) The use of either holistic or embedded design approach should satisfy the overall goal of the research and should be explicitly justified. The case study design in this thesis consists of a single-case design with an embedded design approach. Multiple data sources (survey and Twitter data) and multiple methods related to social network analysis are used to study the chosen case comprehensively and in accordance with research questions. Case selection criteria and further implications of the research methods are described in section 5.3.1 of this chapter.

5.2 Social Network Analysis

Social network analysis is not a formal sociological theory on the contrary it's a strategy to investigate social structure using network and graph theories. (Otte and Rousseau, 2002) In this, the network structure is characterized in terms of nodes (individual actors, people or things within the network) and edges or ties (interactions or relationships) that connect them. Social network analysis has been used to visualize a variety of social structures like social network sites, friendship and acquaintance networks, collaboration graphs, co-citation networks and disease transmission.(D'Andrea et al., 2010; Pinheiro, 2011) In the present case study, the unit of analysis is based on the relationships between conference participants (actors) and their interaction on Twitter (edges) ,which makes the use of social network analysis well suited for the purpose.

In this study the network visualization and analysis was done using the open source tool Gephi. Gephi, is an interactive visualization and exploration platform available in open source (Bastian et al., 2009). Gephi was used to layout the networks, calculate metrics for network nodes, analyze networks for possible sub-networks (e.g. egocentric networks of individual nodes) or clusters (Modularity Class metric) calculated with Gephi's implementation of community detection algorithm (Blondel et al., 2008) and adjust the visual properties of the visualized network according to the analysis. The layout in this study was based on the user mentions in tweets. In this particular study, the weighted degree (sum of weighted indegree and outdegree) and modularity class (clustering) were the metrics that were of interest in the analysis. The weighed value takes into account multiple incoming connections, i.e. connections in which a person has mentioned another are more important than individual mentions.

The layout of the networks in this study is the result of a force driven layout algorithm in which nodes repel each other and the edges connecting the nodes act as springs pulling the nodes back together (Bastian et al., 2009). Hence the nodes that are interconnected will be placed close to each other.

5.3 Conducting the research

5.3.1 Case selection strategy

According to Yin (2013), single-case design is relevant when the case represents a critical, extreme or unique case worth documenting; a typical or a revelatory case with unique opportunity to observe previously inaccessible or common situation; or a longitudinal case, where the same case is studied at various points in time.

In this study the main objective was to evaluate tie strength using publically available social media data in the context of a conference. The selection of case CMAD was done

because it satisfied most of the conditions suggested by Yin (2013) while selecting a single-case design based case study.

Case CMAD is an extreme or a unique case which is relevant for the overall goal of this study which is to evaluate tie strength using social media data in a conference. Firstly, CMAD is a conference which has a majority of the conference participants belonging to the community of community managers who can be considered as advanced lead users of social media and online community management approaches, with most of them being highly active in Twitter. Secondly, these conference participants are not only active on the social media in general but also use the social media in the conference CMAD for various purposes like networking and maintaining relationships. Thirdly, the social media data related to conference CMAD is publically available which is very important to the main research problem which this study tries to address. Fourth, the social media data from CMAD conference is available for multiple years which enables the possibility to carry out this study from a longitudinal perspective as well. Another, important aspect of case CMAD is that its relatively focused around some particular themes and most of the conference participants have interest around these themes which is not the case in many other conferences that have a wide range of themes and topics.

Thus, based on the above discussed features in case of case CMAD, it can be seen that case CMAD is an extreme or unique case which provides a possibility to gain a large amount of learning relevant for the addressing the research objectives of this study. This may not be possible if some other case was selected. Hence, all the above mentioned factors make the selection of case CMAD appropriate to carry out the empirical part of this study.

5.3.2 Case description

In this study, the case study environment is community managers' online discussions in social media (specifically Twitter) in connection to yearly-organized Community Manager Appreciation Day (CMAD) event in Finland. The most recent event took place on January 25, 2016 at Jyväskylä, Finland. While the previous CMAD event took place on January 26,2015 at Lahti, Finland. CMAD events have been organized globally since 2010 and they originate from Jeremiah Owyang's blog to recognize and celebrate the efforts of community managers around the world using social media to improve customer experiences (Aramo-Immonen et al., 2015). The organizing committee of the fifth CMAD event (CMAD 2016) in Finland included 17 people participating in the planning meetings with a supporting online community of 238 members. The fourth CMAD event (CMAD 2015) included a total of 220 event participants. The fifth CMAD event (CMAD 2016) had a total of 270 participants of which 238 participants had provided their personal details on the CMAD 2016 webpage.

In general, it can be argued that discussions in social media represent only a very limited part of the overall communication between community members in professional communities, because many professionals are not in social media (e.g. Twitter or Facebook) or are not actively using social media in professional context. Thus, as a consequence, data-driven approaches can be seen as very constrained in their utility for studying professional communities. In this case, however, majority of the community members belonging to the community of community managers can be considered as advanced lead users of social media and online community management approaches, with most of them being highly active in Twitter.

Moreover, related to learning events and conferences, it has been noticed that most of the activity take place during the learning event or conference, with limited communication before and after(Reinhardt et al., 2009), making it debatable to draw any reasonable conclusions from data collected before and after the conference. However, based on previous studies of community managers in Finland (Aramo-Immonen et al., 2016, 2015, 2014), it can be argued that community managers communicate with each other also between events, and have also participated actively in planning the event, and assume that by collecting data based on these community member's discussions from Twitter it is possible to capture sufficient and representative amount of data to draw conclusions. However, in this study the data from during the event has been used to carry out the analysis.

5.3.3 Assumptions that this study makes for carrying out the empirical analysis

In order to carry out the analysis for this study certain assumptions or necessary conditions have been assumed. The assumptions presented in this section are based on a currently unpublished study which has been done as a part of the Academy of Finland project, COBWEB (see Gupta et al., 2017). These assumptions are important in order to make the study relevant and to enable other researchers to carry out similar studies for other events Though it is not possible to extensively test and generalize these assumptions using a single case study, it may still be possible to test these assumptions to some extent in this study. These assumptions are provided below:

I. Considerably great extent of event participants is present and active in social media (in this study it refers to Twitter) in an event like conference.
II. People use social media to establish new ties or strengthen existing ties even in co-located events like conferences.
III. Motives of discussion in social media are not limited to information sharing but also include maintaining existing ties and establishing new ties.
IV. Interactions in social media reflect actual social networks and relationships to an acceptable and useful level.

V. Social media data related to various dimensions, measures and predictors of tie strength can be extracted to a reasonable degree from publically available non personal social media data of an event like conference.

Many of the above mentioned assumptions are based on the evidence provided in the currently available literature. Assumption II has support from some of the studies which have used analyzed social media especially Twitter in case of a conference. Twitter has been used as a back channel to establish new ties and also strengthen existing ties in academic conferences (Ross et al., 2011) This would most likely be the scenario even in other types of professional conferences like CMAD, thus would support the assumption II. Assumption III and IV also has been found to be true from many of the previous studies. People tweet not only to convey information but also to maintain and establish new ties, hence, analyzing their Twitter data points towards possible actual social relationships and networks.(Ahn and Park, 2015; Boyd et al., 2010; Boyd and Ellison, 2007) Assumption I and V are more intuitive and do not have any direct evidence from the current literature due to the lack of research in this area. However, from the previous studies which have tried to use the personal social media data (Fogués et al., 2013; Gilbert, 2012; Gilbert and Karahalios, 2009; Hutto et al., 2013), it is possible to see preliminarily the availability of the same measures and predictors of tie strength in publically available social media data of an event like conference. Thus, the need for Assumption I. It is true that the single case study is not sufficient to extensively test and generalize these assumptions, however, the collected data for this event has been used to show that it was possible to satisfy these assumptions in the present study.

5.4 Data collection

The data collection was done using two different sources. The first data source was one of the social media channel used during CMAD 2015 and CMAD 2016 that is Twitter. The second data source was the data collected through the survey questionnaire from the CMAD 2016 participants. The collection process of both these data sources is explained in brief in this section.

5.4.1 Twitter data collection and processing for SNA

Twitter data was collected in two phases. First, the tweets for the different years of the CMAD event were collected by running a python batch script that queries the Twitter REST Application Programming Interface (API) for tweets using the official hashtag (like #cmadfi2014) or mentioning the official CMAD Twitter. Twitter REST API was sufficient for collecting the tweets because it allows implementing 180 queries per 15-min window with each of the queries potentially resulting into maximum of 100 tweets. The analysis of more high-volume Twitter streams insists applying Twitter Streaming API instead of the REST API.

Secondly, this was supplemented by using accessed Flockler, a social media-driven content management system that is used to run the CMADFI website. Flockler provides a web application programming interface (API) that allowed us to collect all tweets related to CMADFI. Additionally, in order to collect a full set of Twitter data including the full set of metadata that Twitter provides for each tweet, we distilled tweet ids from Flockler data and implemented a tailored batch script that uses Twitter REST API to access full tweet data including tweet sender, Twitter users mentioned in each tweet as well as hashtags related to tweets. The batch script exports tweet data in JSON for further processing. The detailed statistics for the Twitter corpus are shown in the table below.

Table 7. Twitter data corpus

Content Attribute	**Value**	**Actor Attribute**	**Value**
Time period	Start: 2013-01-21 End: 2016-04-18	Total Users	12454
Total Tweets	12454	Total Unique Users	1651
Original Tweets	7568	Unique Original Tweet Users	858
Retweets	4886	Unique Retweet Users	1262

Twitter Rest API arranges the tweet data in a format that is easy to process programmatically. This means that the users (e.g. @jyshgupta) and hashtags (e.g. #cmadfi) are represented with an explicit syntax and structure. This allowed creating a tailored Python script to identify the above mentioned entities in Twitter. data. The script further transformed the refined data into network. The network represents interconnections between people communicating over Twitter. More specifically, with interconnections, it refers to users mentioning each other in tweets through comments and discussions.

The tailored Python script uses NetworkX library (version 1.11) to construct the network and serialize it in Graph Exchange XML Format or GEXF (version 1.2). The same Python script was also used to calculate the shortest path length for every pair of nodes in the entire network. Shortest path length points towards the minimum number of steps required for one node to connect with the other node. Thus, the collected data from Twitter was cleaned, processed and transformed into network for carrying out the network analysis.

5.4.2 Survey data

Survey is a commonly used approach in business and management studies and is frequently used to ask the who, what, how much and how many type of questions. It is usually useful in descriptive and exploratory research.(Saunders et al., 2009) Since, this study is also exploratory, survey was used as one of the method for collecting the data.

Data collection using survey was necessary means of data for this study to interpret the social media data against the theoretical framing. The survey was operationalized based on the theoretical descriptions of Granovetter (Granovetter, 1983, 1973) and further theoretical definition of Philos by Krackhardt (Krackhardt, 1992) and adapting operationalized scale used in some of the previous relevant studies(Gilbert and Karahalios, 2009; Petróczi et al., 2007). One of the main aim of the survey was specially to capture the perceptions of professionals on their strong ties from the conference participants. The survey excluded asking direct questions about weak ties as those are higher in numbers (Granovetter, 1973) and are therefore, hard to recall by self-reported means. As strong ties constitute a base of trust and build on existing interaction accomplished over time, affection and reciprocal services (Krackhardt, 1992), the following survey items (shown in the table below) were used to operationalize the survey.

Table 8. Questions asked in the survey

S. No.	Survey Question
1	Which 3-5 CMAD 2016 participants do you interact most frequently with?
2	Which 3-5 CMAD 2016 participants would you most likely ask a personal favor from or return personal favor?
3	Which 3-5 CMAD 2016 participants have you known the longest in professional context?
4	Which 3-5 CMAD 2016 participants do you consider as your closest friend?
5	How novel (on an average) was the information you received from the CMAD 2016 participants amongst the following groups?
6	Which 3-5 CMAD 2016 participants do you consider as source of most novel information or ideas?

Questions 1 to 4 were framed to identify the strong ties of the survey respondents. Due to practical problem of recalling names of survey participants, the number of participant names were limited to five. Question 5 asked the participants to rate novelty of the information from three separate groups of participants on scale of 1-7. These three groups were: participants who survey respondent knew well; participants who survey respondent met face to face but did not know well; and participants who survey respondent have not had face to face interaction with. Question 5 was used to identify the different sources and quality of information in general. On the other hand, question 6 focused on identifying novel information sources for individual survey respondent.

An online survey link was shared to all the CMAD 2016 participants through the CMAD Facebook group wall and also by the official twitter handle of CMAD. 25 survey responses were received from a total of 270 participants. The survey was limited to CMAD 2016 participants due to practical limitation of recalling the participant names from previous years CMAD events. The survey was available in English and Finnish and was based on the CMAD 2016 event only.

6. RESULTS AND FINDINGS

This chapter focuses on the results and findings of the single-case case CMAD. The Twitter data for the descriptive analysis and the correlational analysis uses the during period data of the conferences CMAD 2015 and CMAD 2016. This selection of data was done firstly to make the analysis focused to a specific and well defined time period and phase of the event. In case of both CMAD 2015 and CMAD 2016 the during phase of the conference was fixed and specific i.e. the day when the conference was held. However, the before and after phase were not clearly defined in the case of CMAD. Secondly, the approach of using only the during period data of the conference is consistent with other similar studies which have used Twitter data from multiple conferences (see Ross et al., 2011).

Section 6.1 provides some of the descriptive analysis related to both the survey and the Twitter data. Section 6.2 provides the temporal pattern of the Twitter by the CMAD participants during the different phases of the conference. Section 6.3 provides some correlational analysis using the survey data and the two years longitudinal Twitter data of CMAD 2015 and 2016.

6.1 Descriptive analysis

The Table 9 below provide the user activity for the event participants during the CMAD 2015 held on 26, January, 2015 based on the weighted degree of their tweets on Twitter. Weighted degree refers to the online conversations which the CMAD 2015 participants had during the event via Twitter. During the CMAD 2015, a total of 220 participated in the event. From these 208 participants had publically shared their twitter handle on the CMAD 2015 page. The table below provides a detailed analysis of the user activity of the CMAD 2015 participants during the conference.

Table 9. Twitter based user activity of CMAD 2015 participants based on the weighted degree of Tweets.

Weighted degree range	Number of participants
Between 1 and 5	70
Between 5 and 10	22
Between 10 and 20	8
20 and above	6

From the table above, it can be seen that a total of 106 CMAD 2015 participants conversed at least once on Twitter during the CMAD 2015. It can be seen that 92 partici-

pants were at least relatively active (weighted degree between 1 and 10) while 14 participants were active (weighted degree above 10).

The Table 10 below provide the user activity for the event participants during the CMAD 2016 held on 25, January, 2016 based on the weighted degree of their tweets on Twitter. Weighted degree refers to the online conversations which the CMAD 2016 participants had during the event via Twitter. During the CMAD 2016, a total of 270 participated in the event. From these 214 participants had publically shared their twitter handle on the CMAD 2016 page. The table below provides a detailed analysis of the user activity of the CMAD 2016 participants during the conference.

Table 10. Twitter based user activity of CMAD 2016 participants based on the weighted degree of Tweets.

Weighted degree range	Number of participants
Between 1 and 5	27
Between 5 and 10	20
Between 10 and 20	25
20 and above	90

From the Table 10 above, it can be seen that a total of 162 CMAD 2015 participants conversed at least once on Twitter during the CMAD 2015. It can be seen that 47 participants were at least relatively active (weighted degree between 1 and 10) while 115 participants were active (weighted degree above 10).

Based on the Question 5 in the survey, it was observed that most novel information (on an average) was received from the participants whom the respondents had not met face to face (avg. rating on a scale of 1to 7 was 5.13), when compared to participants that respondents knew well (avg. rating on a scale of 1to 7 was 4.00), or had met face to face but did not know well (avg. rating on a scale of 1 to 7 was 4.65).

6.2 Temporal analysis

The Twitter activity of the conference CMAD 2015 was available from 1st September, 2014 to 30th April, 2015. However, the temporal activity based on the daily Twitter activity is given in the figure below. This shows the daily Twitter activity in terms of the number of tweets from 1st January,2015 to 28th February,2015 which includes the day of the actual CMAD 2015 event on 26 January 2015.

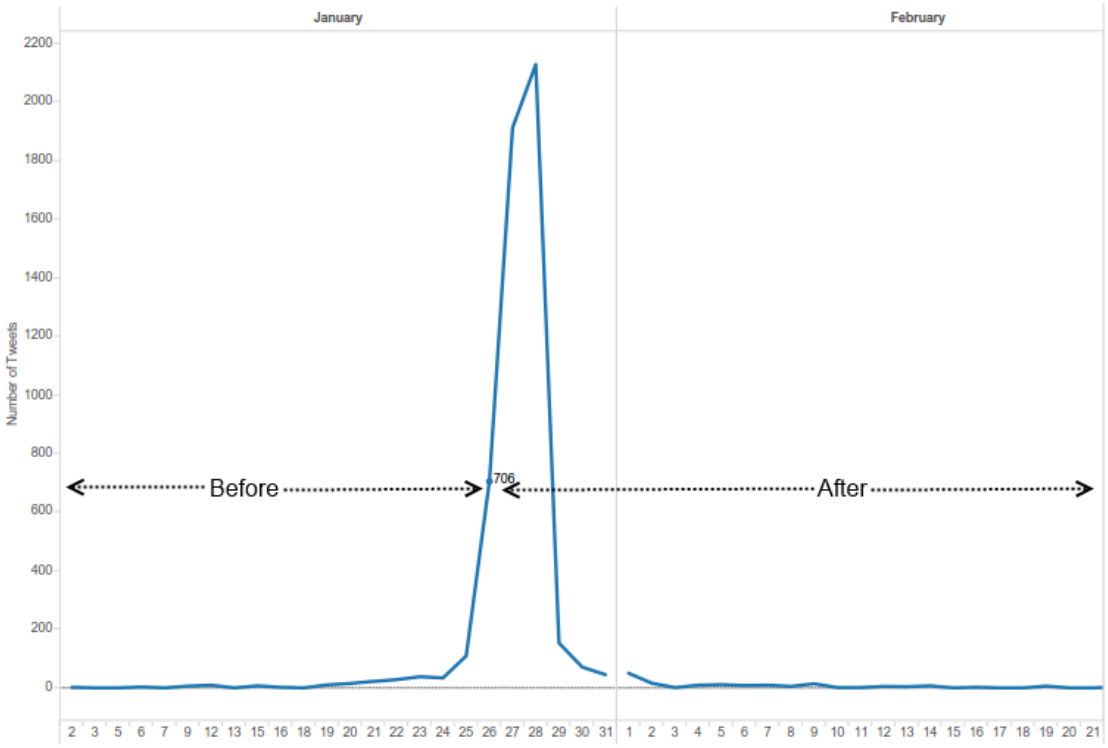

Figure 13. Temporal daily activity data about number of Tweets for CMAD 2015 for January and February 2015.

From the above figure, it can be seen that there is a spike in the Twitter activity which increases from the day on the CMAD 2015 event on 26 January 2015 and continues for the next three days. It can be observed that the peak in the Twitter activity occurs after the event day of CMAD 2015. From the figure, it can be seen that on the day of the event approximately 700 twitter interactions took place between the CMAD 2015 participants.

The Twitter activity of the conference CMAD 2016 was available from 1st September, 2015 to 30th April, 2016. However, the temporal activity based on the daily Twitter activity is given in the figure below. This shows the daily Twitter activity in terms of the number of tweets from 1st January,2016 to 28th February,2016 which includes the day of the actual CMAD 2015 event on 25th January 2016.

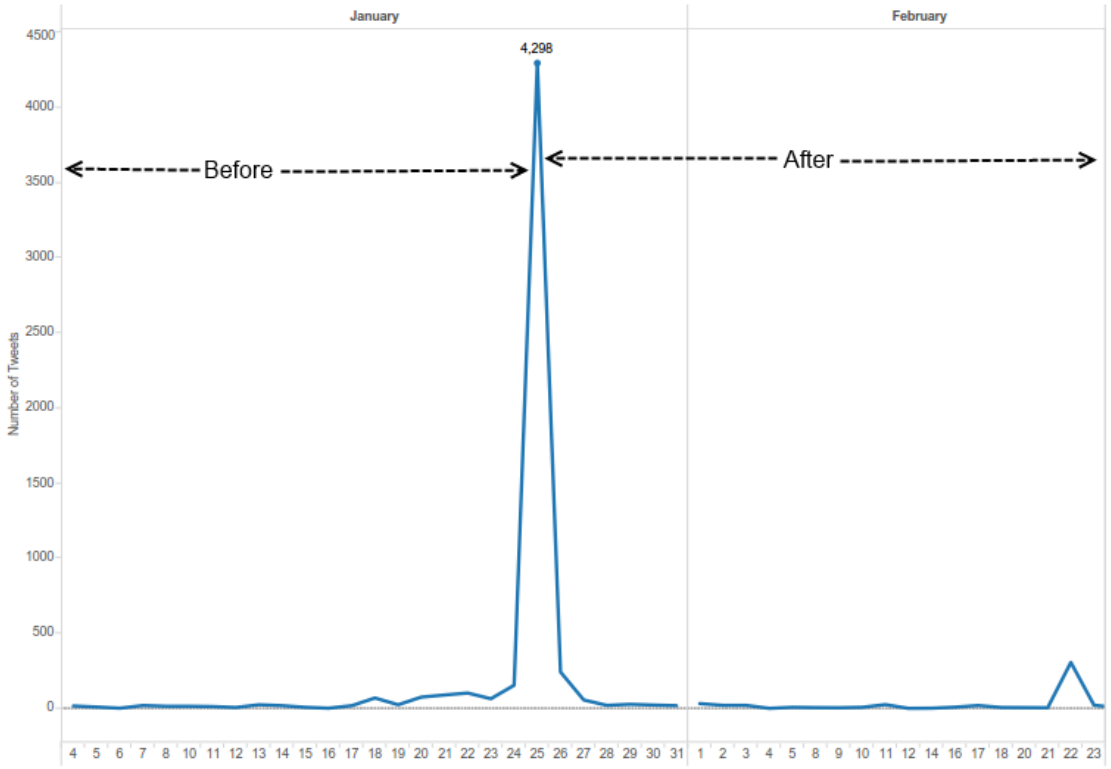

Figure 14. Temporal daily activity data about number of Tweets for CMAD 2015 for January and February 2016.

From the above figure, it can be seen that there is a spike in the Twitter activity which increases from a day before the CMAD 2016 and rapidly decreases a day after the CMAD 2016 event day. It can be observed that the peak in the Twitter activity occurs during the event day of CMAD 2016 i.e. 25 January 2016. From the figure, it can be seen that on the day of the event approximately 4300 twitter interactions took place between the CMAD 2016 participants.

6.3 Correlation analysis

The visualization of the CMAD participants' conversation on Twitter during the conference of CMAD 2016 is shown in Figure 15. The nodes in the visualization represent the CMAD participants. While their interests are made visible by connections to other participants, the greater the interest the larger the size of the connection (line width in Figure 15). The color of node represents the cluster of nodes in the network, which is based on a community-detection algorithm that analyzes the network to find group of nodes that are particularly tightly interconnected.

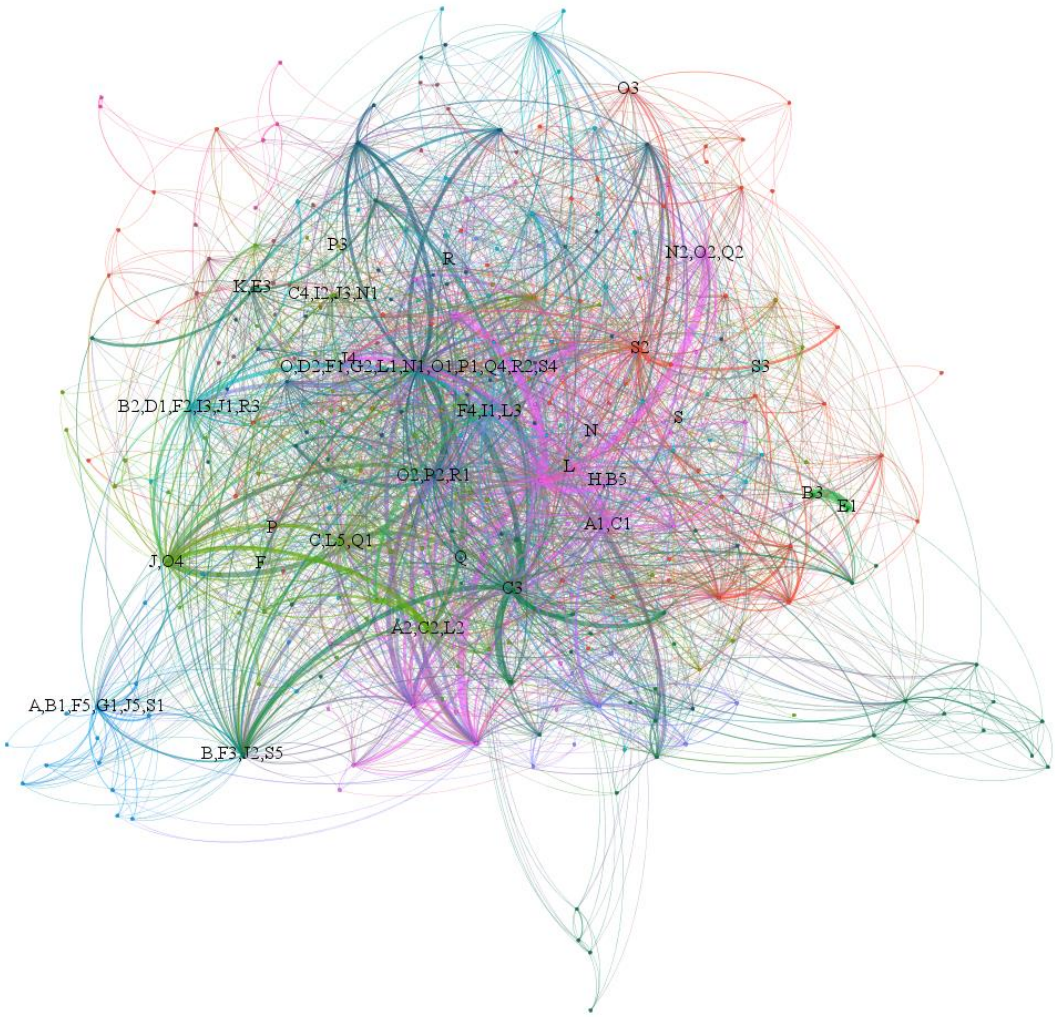

Figure 15. Force driven network of people based on Twitter conversations for CMAD 2016 with labeled nodes for the survey respondents and their novel information sources.

The labeled nodes in the network graphs represent the survey respondents and also their novel source of information as provided in the survey response for Question 6 (for example survey respondent is labeled as F while his/her novel information sources are labeled as F1, F2, F3, F4 and F5). From the above network, using the community detection algorithm of Gephi, a total of 21 different clusters were identified in case of CMAD 2016.

Out of the total of 25 survey participants, 15 responses were received for the Question 6 related to the participants who were the most novel source of information for the survey respondent. Based on these responses the Table 11 was created. This table shows the calculated modularity class (from CMAD 2016 Twitter data) of the survey respondent and the most novel information sources identified by each respondent. In Table 11, column “Survey respondents” refers to the 15 individual survey participants, coded by al-

phabetical letters; columns I-V refer to the clusters of novel information sources identified by survey respondents. The "Modularity class number" refers to the different modularity class-based clusters of survey respondents which were identified during the analysis. The green color in Table 11 was used to show the novel sources which had different modularity class than the survey respondent.

Table 11. Correlating modularity class of the novel information sources with survey respondents using CMAD 2016 Twitter data.

Survey Respondent	Survey Respondent's Modularity Class	I	II	III	IV	V
F	9	2	3	18	3	11
L	6	2	9	3	8	9
C	9	6	9	18	9	-
O	2	9	6	19	9	-
J	9	3	18	9	1	6
S	19	11	19	3	2	18
B	18	11	3	13	--	6
D	8	3	2	3	-	-
P	19	2	2	8	-	-
Q	2	9	6	3	2	-
N	6	2	6	-	-	-
I	9	3	9	3	-	-
A	11	6	9	--	-	-
R	2	2	2	3	-	-
G	--	11	2	-	-	-
E	--	--	--	--	-	-

Legend:

	Different modularity class than the respondent
-	Did not respond to the question
--	Not present on Twitter Data

From the Table 11, it can be seen that in total the 15 survey respondents provided a total of 58 individual novel information sources which correspond to the individual cells of the Table 11. It can be observed from the table that 49 from a total of 58 individual novel information sources (approximately 85%) belong to a different modularity class than the respondent. Also, it can be seen that from a total of 58 individual responses in 5 cases the data was not present in Twitter data.

From a total of 25 survey respondents 15 respondents replied to the survey Question 6 related to the naming at most 5 CMAD participants who were respondents novel source of information. The shortest path length between the survey respondent and their individual novel source of information was then calculated. This step was repeated for every response of the survey respondent to find the individual shortest path length between survey respondent and their novel source of information. This is shown in Table 12 below.

Table 12. Correlating shortest path length with novel source of information using CMAD 2016 Twitter data.

Survey Respondent	I	II	III	IV	V
J	1	1	2	1	1
C	2	1	1	1	-
O	1	1	2	1	-
B	1	2	2	--	1
F	2	3	1	3	2
N	2	1	-	-	-
P	2	1	3	-	-
R	2	2	3	-	-
D	2	2	3	-	-
A	2	2	--	-	-
Q	3	4	5	3	-
S	4	4	4	4	4
E	--	--	--	-	-
G	--	--	-	-	-
I	--	--	--	-	-
L	--	--	--	--	--

Legend:	
	Shortest Path Length - 1
	Shortest Path Length - 1
	Shortest Path Length - 1
	Shortest Path Length - 1
	Shortest Path Length - 1
-	Did not respond to the question
--	Not present on Twitter Data

From the Table 12, it can be seen that in total the 15 survey respondents provided a total of 58 individual novel information sources which correspond to the individual cells of the Table 12. It can be observed from the table that in 15 cases from a total of 58 novel information sources the shortest path length was 1. Also, it was observed that from a total of 58 individual responses in 15 cases the data was not present in Twitter data.

A list of Top 5 and Top 10 participants based on highest weighted degree using the ego-centric network of each survey respondent was created for every survey respondent. In addition to the Top 5 list another list of Top 10 was also created. The reason for creating an additional Top 10 list was to accommodate for the noise in the data while creating the conversation based weighted degree based list. This noise in our case is related to the conversations about general event announcements, logistics queries, and queries to the organizers which may not be related to strengthening of ties. Two separate egocentric networks were created using the Twitter data for CMAD 2016 and for CMAD 2015. These two Top 5 and Top 10 name lists based on the Twitter data were then compared with the survey responses.

The percentage match was then calculated for survey questions 1 to 4. For example, if respondent A answered survey question 1 with three participants name, then these name were compared with the names from Top 5 and Top 10 list from Twitter data. If one out of three of the survey response names appeared on the Top 5 lists from Twitter data, then the match percentage was 33%. At the same time if two out of three of the survey responses names appeared on the Top 10 list then the match percentage was 66%. This process was done for every survey response and was done for both the CMAD 2015 and CMAD 2016 Twitter data.

Table 13. Correlation between strong ties based on self-reported survey and CMAD 2015 Twitter data.

Survey	Q1		Q2		Q3		Q4	
Participant	Top 5	Top 10	Top 5	Top 10	Top 5	Top 10	Top 5	Top 10
T	66%	66%	66%	66%	66%	66%	66%	66%
O	60%	60%	60%	60%	60%	60%	60%	60%
V	33%	33%	33%	33%	33%	33%	33%	33%
L	25%	25%	33%	33%	50%	50%	33%	33%
I	25%	25%	25%	25%	0%	0%	0%	0%
J	20%	20%	20%	20%	0%	0%	--	--
B	0%	0%	20%	20%	0%	0%	20%	20%
R	0%	0%	0%	0%	33%	33%	0%	0%
C	0%	0%	0%	0%	20%	20%	0%	0%
D	0%	0%	0%	0%	0%	0%	0%	0%
P	0%	0%	0%	0%	0%	0%	0%	0%
X	0%	0%	0%	0%	0%	0%	0%	0%
Y	0%	0%	0%	0%	0%	0%	--	--
A	-	-	-	-	-	-	-	-
E	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-
G	-	-	-	-	-	-	-	-
H	-	-	-	-	-	-	--	--
K	-	-	--	--	--	--	-	-
M	-	-	-	-	-	-	-	-
N	-	-	-	-	-	-	-	-
Q	-	-	-	-	-	-	-	-
S	-	-	-	-	-	-	-	-
U	-	-	-	-	-	-	-	-

Legend:

	>60% Match between Survey responses and Social Media Top 10/ Top 5 Interactions
	30%-59% Match between Survey responses and Social Media Top 10 or Top 5 Interactions
	1%-29% Match between Survey responses and Social Media Top 10 Interactions
-	Not present in Twitter data
--	Did not respond to the question

From the Table 13 above, it can be seen that it was possible to identify at least one strong tie in 24 out of the total 90 cases in both the Top 5 and Top 10 list. It can also be observed that in 9 out of the total 90 cases, it was possible to find a 50% or more match between survey responses and the CMAD 2015 Twitter data for both the Top 5 and Top 10 list. From the 24 survey responses, it was not possible to find any CMAD 2015 Twitter data for 11 survey responses. It can also be observed that survey Question 2 was most accurate being able to identify at least one strong tie in 7 out of a total of 24 cases in both the Top 5 and the Top 10 list. From the table above, it can also be observed that the percentage match for the survey responses and the CMAD 2015 Twitter data was the same in both the Top 5 and the Top 10 list.

Table 14. Correlation between strong ties based on self-reported survey and CMAD 2016 Twitter data.

Survey	Q1		Q2		Q3		Q4	
Participant	Top 5	Top 10	Top 5	Top 10	Top 5	Top 10	Top 5	Top 10
T	33%	66%	33%	66%	33%	66%	33%	66%
L	50%	50%	33%	33%	50%	50%	33%	33%
X	33%	33%	33%	33%	33%	33%	33%	33%
H	66%	66%	66%	66%	66%	66%	--	--
J	40%	40%	40%	40%	33%	33%	--	--
Q	50%	50%	25%	25%	20%	20%	0%	0%
B	20%	20%	40%	40%	0%	0%	40%	40%
C	0%	20%	20%	40%	20%	60%	0%	20%
P	20%	20%	20%	20%	33%	33%	0%	0%
D	20%	40%	0%	20%	40%	40%	0%	20%
A	0%	40%	0%	33%	40%	60%	0%	33%
F	40%	40%	25%	25%	0%	33%	--	--
K	100%	100%	--	--	--	--	100%	100%
N	40%	60%	0%	0%	0%	0%	0%	0%
R	0%	0%	0%	0%	33%	33%	0%	0%
O	0%	0%	0%	0%	20%	20%	0%	0%
Y	0%	0%	0%	0%	0%	33%	--	--
I	0%	0%	0%	0%	0%	0%	0%	0%
S	0%	0%	0%	0%	0%	0%	0%	0%
V	0%	0%	0%	0%	0%	0%	0%	0%
E	-	-	-	-	-	-	-	-
G	-	-	-	-	-	-	-	-
M	-	-	-	-	-	-	-	-
U	-	-	-	-	-	-	-	-

Legend:

	>60% Match between Survey responses and Social Media Top 10/ Top 5 Interactions
	30%-59% Match between Survey responses and Social Media Top 10 or Top 5 Interactions
	1%-29% Match between Survey responses and Social Media Top 10 Interactions
-	Not present in Twitter data
--	Did not respond to the question

From the Table 14 above, it can be seen that it was possible to identify at least one strong tie in 39 out of the total 90 cases in the Top 5 list. On the other hand, it was possible to identify at least one strong tie in 48 out of the total 90 cases in the Top 10 list. It can also be observed that in 8 out of the total 90 cases, it was possible to find a 50% or more match between survey responses and the CMAD 2016 Twitter data for the Top 5 list and it was possible to find a 50% or more match in 15 of the total 90 cases in the Top 10 list. From the 24 survey responses, it was not possible to find any CMAD 2016 Twitter data for 4 survey responses. It can also be observed that survey Questions 1 and 3 were most accurate being able to identify at least one strong tie in 12 out of a total of 24 cases in the Top 5 list and 14 out of a total of 24 cases in the Top 10 list. From the table above, it can also be observed that the percentage match for the survey responses and the CMAD 2016 Twitter data was the higher case of the Top 10 list than the Top 5 list with 9 cases out of the total of 90 cases where percentage match was higher in case of Top 10 list than the Top 5 list.

Based on the correlation table for strong ties related to CMAD 2015 and CMAD 2016, it was found that there were six survey respondents whose survey responses were found to be present in the Top 5 or Top 10 list for both CMAD 2015 and CMAD 2016 for at least one of the survey questions (Question 1 to 4). The survey responses which were present in the Top 5 list were not mentioned again in the Top 10 list. The survey responses related to the strong tie survey questions for each survey respondent were labeled done using the following format. For example, the survey responses of survey participant O were labeled as OS1, OS2, OS3 and OS4. This was done for each of the six survey respondent and is shown in the Table 15 below.

Table 15. Comparison of the strong tie based on the survey response and its appearance in the Top 5 or Top 10 list based on the Twitter data for CMAD 2015 and CMAD 2016

Survey Participant	Year 2015		Year 2016	
	Top 5	Top 10	Top 5	Top 10
B	BS1	-	BS1,BS2	-
C	CS1	-	CS2	CS1,CS3
J	JS1	-	JS2,JS3	-
L	LS1	-	LS1,LS2	-
O	OS1,OS2,OS3	-	OS4	-
T	TS1,TS2	-	TS1	TS2

From the Table 15 above, it can be seen that in case of survey respondent C and T, there strong tie based on survey answer moved from Top 5 list of CMAD 2015 to Top 10 list of CMAD 2016 (see survey responses BS1 and TS2). On the other hand, in case of survey respondent B, L and T there was no change and their strong tie based on survey answer remained in Top 5 list for both CMAD 2015 and CMAD 2016 (see survey responses BS1, LS1 and TS1). In case of survey respondent J and O, it was observed that

different strong tie based on survey answers were present in the Top 5 list of CMAD 2015 and CMAD 2016.

The visualization of the CMAD participants' conversation on Twitter during the conference of CMAD 2015 and CMAD 2016 are shown in Figure 16 and Figure 17. The nodes in the visualization represent the CMAD participants. While their interests are made visible by connections to other participants, the greater the interest the larger the size of the connection (line width in Figure 16 and Figure 17). The color of node represents the cluster of nodes in the network, which is based on a community-detection algorithm that analyzes the network to find group of nodes that are particularly tightly interconnected.

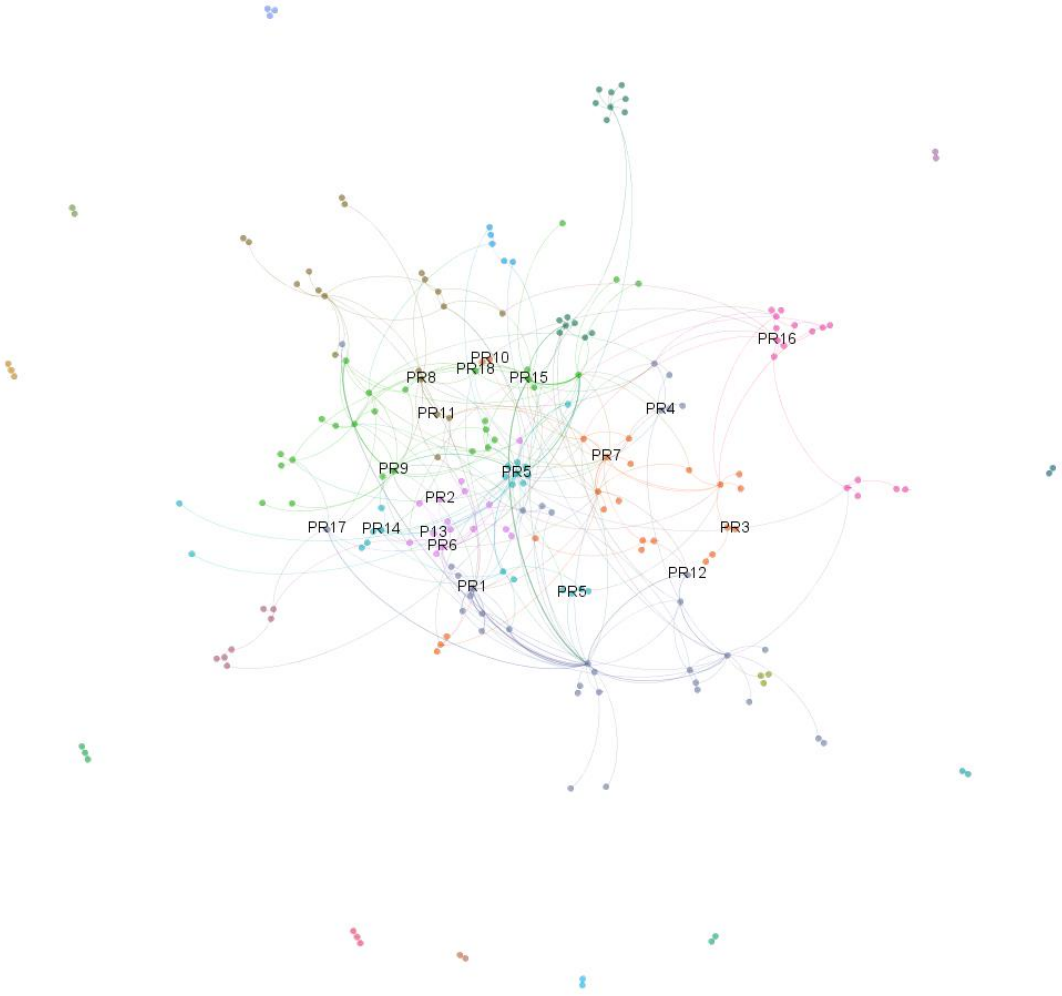

Figure 16. Force driven network of people based on Twitter conversations for CMAD 2015 with labeled nodes for the CMAD 2015 presenters.

The above network figure shows the network of people based on their Twitter conversations on the day of the CMAD 2015 conference. The different presenters who gave a

presentation during the CMAD 2015 are labeled as PR1, PR2 up to PR19. From the above network, using the community detection algorithm of Gephi, a total of 22 different clusters were identified in case of CMAD 2015. It was observed that 19 different presenters of CMAD 2015 belonged to 7 different clusters. Thus, in case of CMAD 2015 from a total of 22 identified clusters the presenters were present in 7 of these clusters.

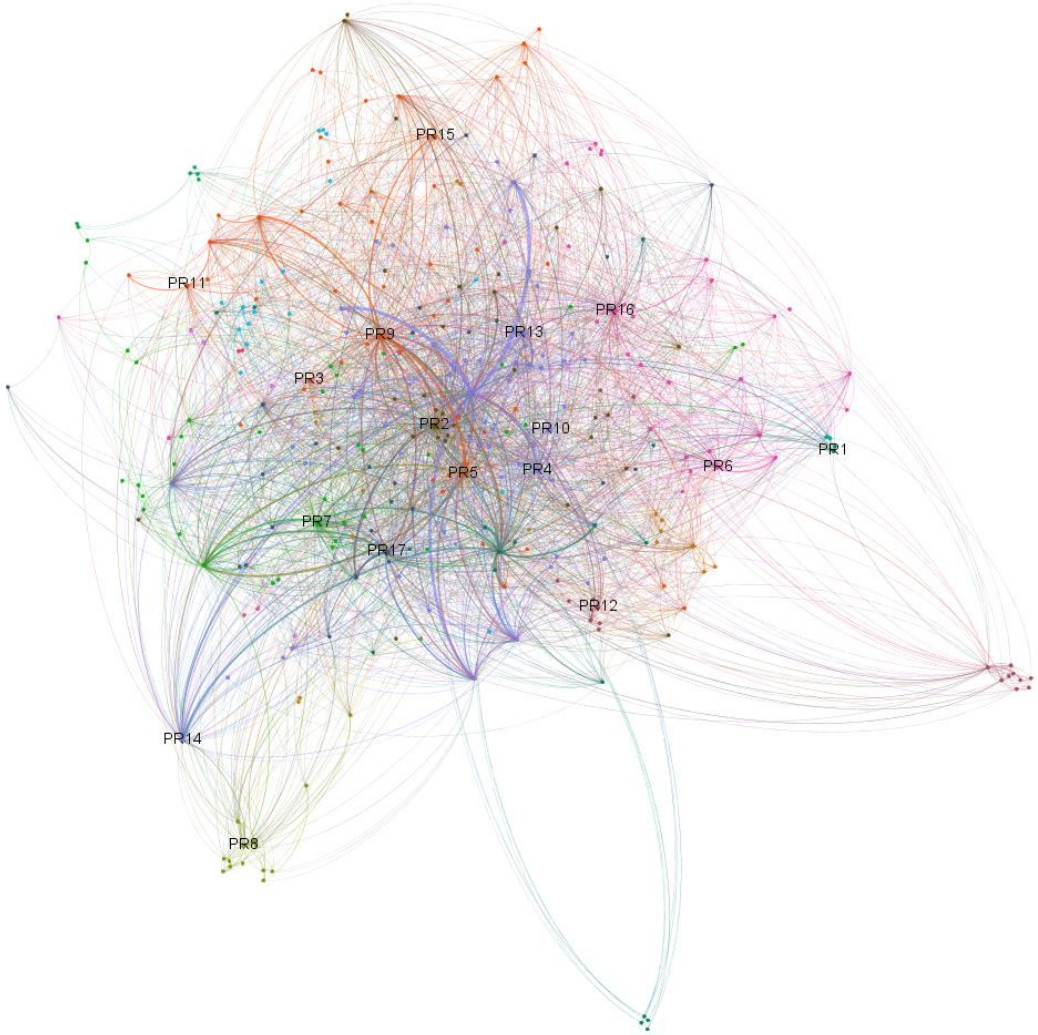

Figure 17. Force driven network of people based on Twitter conversations for CMAD 2016 with labeled nodes for the CMAD 2016 presenters.

The above network figure shows the network of people based on their Twitter conversations on the day of the CMAD 2016 conference. The different presenters who gave a presentation during the CMAD 2016 are labeled as PR1, PR2 up to PR17. From the above network, using the community detection algorithm of Gephi, a total of 21 different clusters were identified in case of CMAD 2015. It was observed that 17 different presenters of CMAD 2016 belonged to 8 different clusters. Thus, in case of CMAD

2016 from a total of 21 identified clusters the presenters were present in 8 of these clusters.

The survey responses of for survey Question 6 related to novel information source were compared with the presenter of the CMAD 2016. An analysis was done to compare the answers of the survey respondent for survey Question 6 with the names of the presenter of CMAD 2016. It was found out whether a presenter was also a novel information source for the survey respondent. This is shown in the Table 16 below where the presenter who are also novel information source are highlighted in green.

Table 16. Identifying CMAD 2016 presenters who were also novel information source for survey respondents.

Presenter CMAD 2016	**Novel information source for survey respondent**
PR1	No
PR2	Yes
PR3	No
PR4	Yes
PR5	Yes
PR6	No
PR7	Yes
PR8	Yes
PR9	Yes
PR10	No
PR11	Yes
PR12	No
PR13	No
PR14	Yes
PR15	No
PR16	No
PR17	Yes

From the Table 16, it can be seen that 9 presenters of CMAD 2016 are also novel information source of the survey respondents. It can be observed from the table above that all the presenters are not novel information source for the survey respondents.

7. DISCUSSION AND CONCLUSIONS

After analyzing the case data and finding the results in the previous chapter, we can now move to the relevance of these results in the context of this study. In this chapter, the key findings arising from the results of the theory and the empiric part of the study will be outlined, and discuss the meaning of them in relation to the supporting research questions which were formulated in the chapter 1. The research questions are highlighted as they appear during the discussion phase. After that a summarized answer to the main research problem is presented, along with the academic contributions and the managerial implications of this study. Finally, the limitations of this study and the future research areas are discussed in brief.

7.1 Discussion

In the first chapter of this thesis the research gap for this study was identified; based on which the main research problem statement and the subsequent support questions were formulated. The chapter 2, 3 and 4 provided the literature based part of the study while chapter 5 and 6 provided the empirical part of this study. In this section we discuss the results of both the literature and empirical part of the study towards answering the support question formulated in chapter 1.2.

Q1. What is tie strength and what are the different kind of ties?

This question was of great relevance for this study as the entire study is focused on the evaluation of tie strength using Twitter data in the context of the conference. The chapter 2.1 provided the two commonly accepted definitions of tie strength given by Granovetter (1973) and Krackhardt (1992). The existing literature showed that the definition of tie strength given by Granovetter was widely used across many studies. Based on these definitions of tie strength two main kind of ties – strong ties and weak ties were characterized. The strong ties are more easily accessible and have a great overlapping social circle. On the other hand, weak ties were people with whom you had acquaintance with. The weak ties have been found to a source of novel information in many scenarios. The Table 1 in chapter 2.2 provided a brief summary about the characteristics and importance of the weak and strong ties. The two major theories related to the tie strength and different kind of ties were also explained in the chapter 2.4.

In the literature a lot of other different kind of ties like dormant ties (Levin et al., 2011), latent ties (Haythornthwaite, 2002), intermediate ties (Retzer et al., 2010) were also found. However, at a broader level these ties still fall under the broader spectrum of

weak tie or a strong tie. In the context of this study, the different kind of ties were thus limited to a strong tie or a weak tie and the definition of tie strength that was used in this study was based on the original definition of tie strength provided by Granovetter in his seminal study "The Strength of Weak Ties" (see chapter 2.1 and 2.2).

Q2. What are the different dimensions of tie strength presently known?

The original definition of tie strength had defined four different dimensions of tie strength which were amount of time, emotional intensity, intimacy and reciprocal services (see chapter 2.1). However, over the decades some more dimensions of tie strength have been found and are commonly accepted as dimensions of tie strength. In chapter 2.5 a brief description of all these different dimensions of tie strength was provided. It can be seen from this chapter that presently tie strength has seven different dimensions. The three additional dimensions of tie strength other than the original four dimensions are emotional support, social distance and the structural factors. Hence, a total of seven different dimensions of tie strength are presently known.

In the context of this study the understanding of the presently known dimensions of tie strength helped in operationalizing some of these dimensions of tie strength. It was possible to operationalize the tie strength dimensions of amount of time, reciprocal services and also the structural factor dimension to some extent in the present study. The other known dimensions of tie strength were not operationalized in this study due to the non-availability of personal social media data in context of the conference CMAD.

Q3. Which are the presently known different measures and predictors of tie strength in social media?

In order to operationalize the different dimensions of tie strength, certain measures and predictors are needed to actually evaluate or calculate the tie strength. In chapter 2.6 a detailed list of the most commonly used offline measures of tie strength were presented. From the Table 3 in chapter 2.6, it was observed that communication frequency was the most widely used measure of tie strength. Chapter 3.1 provided the definition of social media which was relevant in the context of this study. Based on this definition the different measures of tie strength were provided in chapter 3.4. From the Table 5 and Table 6 in chapter 3.4, it was observed that many of these predictors may not be relevant in the context of this study as they would require personal social media data. Also due to changes in the functionality of these social media channels some of the predictors which were presented in the tables of chapter 3.4 may no longer be useful. For example, the working of retweet functionality of Twitter has changed since the studies related to tie strength were done. Also, it was observed that in case of Twitter presently there are no measures to operationalize the emotional support dimension of tie strength. Certain new functionality like the react functionality (which is an extension of the like button) or the comment to comment feature of Facebook and other new functionality in Twitter

may be useful in developing new measures of tie strength in social media for future studies.

In the context of this study, a common approach which had been followed by many studies (see chapter 2.6 and chapter 3.4) was used and communication frequency was used for operationalizing the tie strength. In this study, the tie strength dimensions of amount of time, reciprocal services and the structural factors were operationalized using the measures of weighted degree, shortest path, modularity class and the force driven network diagrams.

Q4. Why does the event setting like conference matter for tie strength evaluation using publically available social media data (especially Twitter)?

In chapter 3.2 the different motives for social media use were presented. From this it was found that need for maintaining relationships and networking were some of the most important motives for using the social media. One of the major reason for attending a conference was networking (see chapter 4.1). In such conferences one of the main reason for using social media was found to be similar to motive for social media use in general i.e. for networking and maintaining (see chapter 3.2 and chapter 4.3). Chapter 4.2 provided some of the commonly used methods for networking in a conference. It was evident from this that the current methods do not use any tie strength based approach. The relevance of such a tie strength based approach in case of a conference was made evident in chapter 4.4. Thus, it can be seen from this discussion that tie strength evaluation in case of an event setting like conference would be useful as it may provide a new novel approach for enhancing networking during a conference.

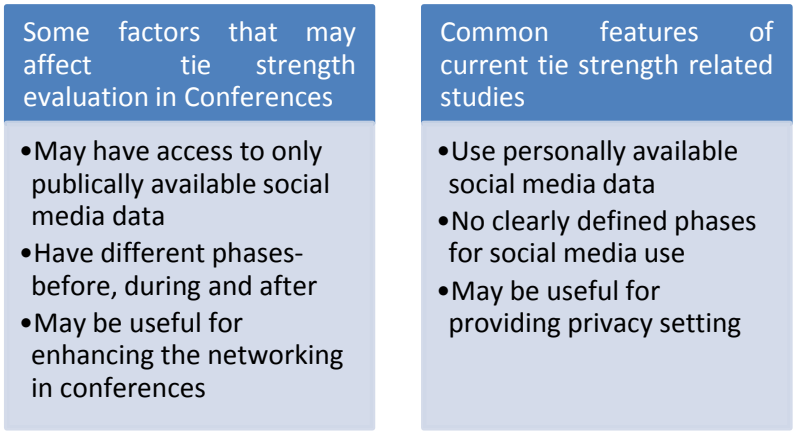

Figure 18. Some of the major differences between the social media based tie strength evaluation in conference from the current social media based tie strength evaluation studies

The present research question also refers to the need for using the publically available data especially Twitter in tie strength evaluation. In conferences and similar events there is very limited amount of time and also its difficult to get access to personal data of eve-

ry participant as highlighted in chapter 4.4. Such limitations make it more relevant to use publically available social media data. In chapter 3.3 certain characteristics of the popular social media channels Facebook and Twitter which were relevant for tie strength evaluation were briefly presented. It was found that the use of Twitter as a source of social media data was more suitable in the context of events like conference in general. As Twitter had certain characteristics like directionality of relationship, easy access to data, its use for relationship building and also low control over self-representation (which would mean more reliance on the actual tweets rather than profile details) made Twitter a suitable source of social media data for this study.

In the context of this study, the assumptions which were presented in chapter 5.3.3 are to a large extent satisfied in the results presented in chapter 6. The user activity tables and the temporal graphs about the number of tweets presented in chapter 6.1 and 6.2 show the use of Twitter by the CMAD 2015 and CMAD 2016 participants during the conference. The results and findings shown in chapter 6 also help in highlighting the relevance of tie strength evaluation using publically available Twitter data in the context of event setting like conference. These results and findings are discussed in detail in the discussion to the subsequent research questions.

Q5. Can and how the different kind of ties be identified using the publically available Twitter data about the conference?

The central question of this study was to evaluate tie strength and identify different kind of ties using social media data. The design of the survey questions was also done keeping this objective into consideration (see chapter 5.4.2) The different correlational analysis done in chapter 6.3 based on SNA (see chapter 5.4.1) and survey help in identifying the different kind of ties. The Figure 15 below shows in a nutshell, how the different kinds of ties were identified in this study.

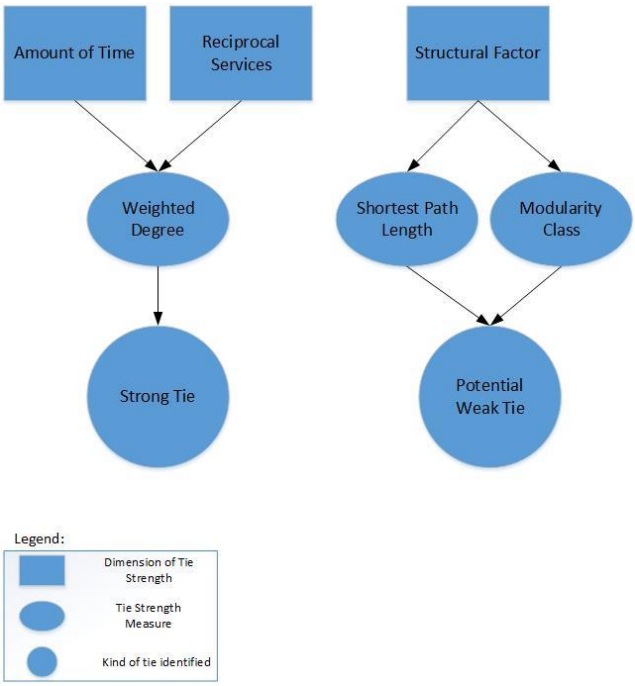

Figure 19. The identification of different kind of ties in this study.

From the findings in Table 13 and Table 14 it was seen that weighted degree was a useful measure for identifying the strong ties. The findings from these two tables showed that there was a higher degree of percentage match in the Top 10 list when compared to the Top 5 list for CMAD 2016. Though it may be difficult to make any conclusion based on this finding, it may be highly possible that these results may be due to the fact that the organizers tweets related to conference related information might have increased the weighted degree with the event participants. Thus, making the real strong ties appear lower in the weighted degree based list.

Also, it was observed that the overall accuracy in detecting strong tie was higher in case of CMAD 2016 than CMAD 2015. This could be possibly attributed to the fact that at time of conducting survey, the survey respondents were asked to take only CMAD 2016 into context. However, these responses were also used for analyzing the CMAD 2015. One of the primary reason why this was done in case of survey questions related to strong ties was due to the fact that strong ties have a long and frequent history of interactions (see chapter 2.2 and 2.4.1). In this study Table 15 was created to demonstrate the possibility of using the longitudinal data to find any relevant patterns. It was not possible to use this table to observe any kind of results in the context of this study.

The combination of network-based measures of shortest path length (shown in Table 12) between two participants combined with modularity class (shown in Table 11) was useful in identifying the novel information sources which could be potential weak ties. In this study, it was found that clustering of people network alone may help in identifying the different interest groups which may point to different ties.

From the conversation based people network of both CMAD 2015 and CMAD 2016 (shown in Figure 15,16 and 17), it was observed that the presenters were not present in all the different clusters. In case of CMAD 2015 a total of 22 identified clusters the 19 different presenters were present in 7 different clusters while the 17 different presenters of CMAD 2016 were present in 8 out of a total of 21 identified clusters. These findings suggest that the presenters were not the main drivers of conversation in all the different clusters, if that would have been the case then all the different presenters would have appeared in different clusters. This was also shown to some extent from Table 16 which showed that not all the presenters were found to be the novel information source.

Based on the structure of the different conversation based network figures (shown in Figure 15,16 and 17) it can be observed that most of the identified novel information sources appear to be the non-redundant bridging ties filling the structural hole (see chapter 2.4.2). However, since the identified clusters were not further investigated, there is no way to know if these clusters are any kind of sub-communities. Hence, these preliminary results are not of use in this study but may provide a possible way to identify potential weak ties in case it's possible to identify and classify these clusters into different sub-communities.

Thus, in a nutshell it can be said yes it was possible to identify the strong ties and potential weak ties using the Twitter data by using the measures of weighted degree, shortest path length and modularity class. Also the analysis related to presenters also presented a potential method to identify weak ties using the concept of structural holes.

Q6. To what extent can presently known dimensions, measures and predictors of tie strength in social media be used in a conference setting to identify different kind of ties using publically available data?

In this study it was possible to operationalize the dimensions of amount of time, reciprocal services and also the structural factor to some extent using the measures and predictors of weighted degree, shortest path length and modularity class. This can also be seen from Figure 15 which shows how the different kind of ties were identified in this study. The lack of personal data and also the process of data collection (see chapter 5.4.1) limited the operationalization of the other dimensions of tie strength.

Many of the measures and predictors which were used in the previous studies related to the tie strength evaluation from social media data (see chapter 3.4) were not useful in the context of this study. There were at least two prominent reasons for it. Firstly, many of these measures relied on the use of personal social media data (for example direct Twitter message headers). Secondly, many of the functionalities at the time of those studies have either changed or are no longer available now making the use of those measures redundant (for example change in the functionality of retweet function).

Thus, based on this study it can be observed that there may be need to develop some new measures to improve the overall accuracy of tie strength evaluation which may be relevant specifically in case of a conference setting. For example, it might be useful to develop measures which can differentiate between information sharing messages (eg. conference related message) from other kind of messages.

Hence, based on this study it would not be possible to give any specific percentage or number regarding the extent to which the present dimensions, measures and predictors of tie strength in social media are applicable in a conference setting using publically available data. However, it could be concluded even based on this study that not all the available measures and predictors of tie strength from social media can be used directly in the context of a conference setting and there is a need to either adapt these measures or to develop new measures which can be directly used in this context.

7.2 Conclusions

First and foremost, the main purpose of this research was to increase the understanding of the evaluation of tie strength using social media in the context of an event setting like conference. This objective was transformed into a problem statement that guided the whole research process along with the supporting research questions (see chapter 1.2). In the previous section, the supporting questions were answered by discussing the key results of this study. These questions ultimately deliver an answer for the main research problem. The problem statement of this research was: *How can Twitter data be used to evaluate tie strength and identify different types of ties in the context of a conference?*

This study began by reviewing the existing literature related to the topics of this research that is tie strength, social media and conference setting. From the literature review, it was evident that there are mainly two kinds of ties – strong and weak. It was also observed that the definition of tie strength has not changed much since it was given by Granovetter (1973). However, the dimensions of the tie strength have increased from the original four dimensions to about seven dimensions. The tie strength was operationalized using different measures and communication frequency was observed to be one of the most commonly used measure. The need to establish and maintain relationship was found to be one of the most important motivators for using social media. The different characteristics of social media (see chapter 3.3) also showed that Twitter was a suitable data source for tie strength evaluation. As discussed in answer to support question Q4, a common link which connected these three different research areas was the fact that social media like Twitter were used for networking in events like conferences. Hence, the literature review based section of this study was able to show that the existing theory provided evidence about the use of social media for networking in conferences; so, it would logically make sense to try to evaluate tie strength using publically available Twitter data.

The empiric part of the study was based on the single case of conference CMAD. Based on the discussion in answer to support question Q4, it was already observed that the presently known measures of tie strength (see chapter 3.4) could not be directly used in the present case. As discussed in the answer to support question Q5, that the general assumption related to this case (see chapter 5.3.3) were satisfied to a useful extent. It was possible to identify different kind of ties - strong and weak ties to some extent using the Twitter conversation data. The identification of strong ties was done for both the years while the identification of potential weak based on the novel information sources was restricted to CMAD 2016 and the reasons for this were also discussed in answer to support question Q5. The correlation of the number of different clusters in which the presenters were present with the total number of identified clusters for both the years also showed that the presenters were not the sole drivers of the different identified clusters. The answer to support question Q6 pointed out that in this empiric study it was possible to use the tie strength dimensions of amount of time, reciprocal services and structural factors to some extent. These dimensions were operationalized using the measures of weighted degree, shortest path and modularity class.

Even though, this study was limited to a single case, it can be said that this study was successful in answering the main problem statement. The combination of the literature study and the empiric study was successful in firstly showing that it's possible to identify different kind of ties using publically available Twitter conversation data in the context of a conference. Secondly, the 'how' part of the main problem was addressed by the different analysis done in the empiric part of this study which identified the different kind of ties. This is also shown in Figure 15.

7.2.1 Academic contributions and managerial implications

This thesis was focused on addressing the research gap identified in chapter 1.1. This thesis highlighted several important themes under the broad topics of tie strength, social media and conference setting and thus contributes on the topic area in many ways from the academic research perspective. The study also has some managerial implications, though the objective of the study was more towards stronger academic perspective.

To the best of our knowledge this is one of the first studies to evaluate tie strength using publically available social media data in the context of an event. More specifically to the best of our knowledge, this is the first study to evaluate tie strength in a longitudinal manner from merely publically available Twitter data in a conference setting. The longitudinal nature of this study provides a chance to analyze the communication pattern of the same event over two different years and adds to the existing knowledge about this stream of research. Such an analysis of communication pattern could be helpful in developing algorithms to develop automated conference recommendation systems that use social media data from previous years to give better recommendations.

The Table 15 presented in chapter 6.3, provides a demonstration for a method which can be used by future studies that try to analyze longitudinal event data to observe the communication pattern of strong ties in a specific social media channel. Hence, Table 15 contributes towards developing an academic methodology in the context of tie strength evaluation in an event using longitudinal social media data. Such methodologies for analyzing the communication pattern could help to create systems which can rely on the earlier patterns and help in automating the process of tie recommendation in conferences.

This study also provides an understanding of which tie strength dimensions and measures can be used with publically available event related Twitter data and also about the preliminary accuracy of the used proxies. This would be useful in identifying the measures which can be used from the earlier studies(e.g. Fogués et al., 2013; Gilbert, 2012; Gilbert and Karahalios, 2009) in case of an event setting like conferences.

The study also provides understanding about the use of new social media data sources like Twitter for tie strength measurement in the event context. This academic understanding may be used in the future to automate the process (e.g. Kahanda and Neville, 2009) of identifying different ties to connect professional in events (see chapter 4.4).

At a more general level, this study also contributes to the tie strength measurement from social media. Using network level measures like shortest path, modularity class in addition to the previously used interpersonal level measures (e.g. Fogués et al., 2013; Gilbert, 2012; Marsden and Campbell, 1984), this study also adds to the understanding of the tie strength measurement from network perspective as suggested by Marsden and Campbell (2012).

The present study also has some managerial implication. As defined by Granovetter (1973), weak ties are in general the novel source of information. This has been found to be true in various subsequent studies across different social contexts. Thus, in the context of an event as well, it would intuitively make sense to identify weak ties as these ties may be a novel source of information for the event participant. Since, one of the motives of attending such events is to meet and establish ties with potentially useful contacts, the identification of weak ties may be helpful in achieving this goal (see chapter 4.4). However, the usefulness of the novel information or in a more general sense, the usefulness of the identified weak tie may vary a lot based on the kind of event it is. For example, in case of a focused conference which has a clearly defined theme and is very narrow in the range of topics that are addressed in it, the identification of weak ties itself may be sufficient to establish a potentially useful contact. As the participants in such an event are very well aware of the topic and theme of the event, suggesting an identified weak tie may be useful as both the participant and their weak tie would likely share the same common interests which are addressed in such a focused event. On the other hand, in case of large events with a wide range of themes, there may be large

number of weak ties which could be identified. However, in this case most of the identified weak tie using the social media data may not be useful. As the range of topics and themes addressed in such event is very large, it would be more useful to narrow down the list of identified weak ties further to potentially useful weak ties. This would require further analysis and use of other data sources. For example, in case of a large academic conference (like HICSS), the bibliographic data of the event participants may be combined with their social media data to suggest potentially useful ties weak ties. The combination of different data sources can vary based on the type of event and its context but in such large events it may help in identification of potentially useful weak ties than just any weak tie. Thus, it would be important for the businesses which would try to build such conference recommendation system to also take into consideration the range of themes and the context of the conferences in order to provide relevant and useful recommendations.

Thus, it can be seen that this study provides a snapshot of the current status of some of the themes relevant to this study (see Table 2 and Table 3) and also adds new knowledge to the current academic understanding. At the same time, this study also highlights some possible scenarios which have certain managerial implications that should also be considered.

7.2.2 Limitations

After discussing the results and describing the general academic contributions and managerial implications of this study, some of the limitations of this exploratory study are discussed in this section. Limitations are part of every research and also important for identifying topics for the future.

Firstly, this exploratory study is based on a single-case based case study; thus, the results in general cannot be directly generalized to apply to all other conferences. The results from this study should be treated as preliminary and should be confirmed in other further studies and in other types of conferences, such as scientific conferences, to allow further generalization.

Secondly, in this study, only some potential approaches related to the analyses of conversation based networks or clusters for identifying different kind of ties were studied with more emphasis towards identification of strong ties. However, in the future these approaches should be used to identify different kind of ties.

Thirdly, due to the limited amount of respondents in our survey, we cannot yet draw any statistically significant results, but the results should be considered as preliminary. We will extend the survey in further event studies to increase the accuracy and generalizability of results.

Fourth, in this study only the data from the during phase of the conference was used for carrying out the analysis which may have had an impact on the overall. In the future studies could use the data from all or specific phases to see impact it has on the tie strength evaluation.

Finally, the full data corpus for Twitter was collected after the event using the REST API of Twitter. While now focusing on social media conversational data, the above omission restricted the use of Twitter follower/followee network data in our study as we did not have any timestamp data about when a particular CMAD participant became Twitter follower of another participant. The use of this data could have enabled the operationalization of another approach for identifying the weak ties in an event setting, and we will make use of this approach in our further studies.

Though, the above limitations hinder the generalizability of the results from this study to some extent. However, many of the methods (for example Table 15) and measures (for example weighted degree, clustering) used in this study can also be used in future studies. Thus, it can be said that though the above limitations may limit the generalization of all the results of this study. However, many of the aspects of this study are not limited to only this study (like the used tie strength measures) and can be generalized and be used in other studies.

7.2.3 Future research

This study leaves a lot of space for the future studies. Firstly, as can be seen from Table 2 (see chapter 2.3), the context of event has not been studied at any level of analysis. Since, professional events like conferences are important at many different levels. Thus, it provides a research gap which the future studies can try to address.

Secondly, there are many dimensions and measures for tie strength (see chapter 2.5, 3.4 and Table 2 in chapter 2.3) and only a very limited amount of these have been used in this study. In future studies, more dimensions and measures should be combined to evaluate tie strength in an event context.

Thirdly, this studies uses data from a single social media channel (like Twitter), the future studies can try to incorporate data from other sources like bibliographic data of scientific publications, location data and various other data sources along with the data from multiple social media channels.

Finally, incorporating big social data in the form of large collection of Twitter data and public Facebook walls of events may enable developing automated tie strength evaluation methods in case of events.

REFERENCES

Ahn, H., Park, J.-H., 2015. The structural effects of sharing function on Twitter networks: Focusing on the retweet function. Journal of Information Science 41, 354–365. doi:10.1177/0165551515574974

Alba, R.D., Kadushin, C., 1976. The Intersection of Social Circles A New Measure of Social Proximity in Networks. Sociological Methods & Research 5, 77–102. doi:10.1177/004912417600500103

Aral, S., Walker, D., 2014. Tie strength, embeddedness, and social influence: A large-scale networked experiment. Management Science 60, 1352–1370.

Aramo-Immonen, H., Jussila, J., Huhtamäki, J., 2015. Exploring co-learning behavior of conference participants with visual network analysis of Twitter data. Computers in Human Behavior, Computing for Human Learning, Behaviour and Collaboration in the Social and Mobile Networks Era 51, Part B, 1154–1162. doi:10.1016/j.chb.2015.02.033

Aramo-Immonen, H., Jussila, J., Huhtamäki, J., 2014. Visualizing informal learning behavior from conference participants Twitter data, in: Proceedings of the Second International Conference on Technological Ecosystems for Enhancing Multiculturality. ACM, pp. 603–610.

Aramo-Immonen, H., Kärkkäinen, H., Jussila, J.J., Joel-Edgar, S., Huhtamäki, J., 2016. Visualizing informal learning behavior from conference participants' Twitter data with the Ostinato Model. Computers in Human Behavior 55, Part A, 584–595. doi:10.1016/j.chb.2015.09.043

Bastian, M., Heymann, S., Jacomy, M., others, 2009. Gephi: an open source software for exploring and manipulating networks. ICWSM 8, 361–362.

Blondel, V.D., Guillaume, J.-L., Lambiotte, R., Lefebvre, E., 2008. Fast unfolding of communities in large networks. Journal of statistical mechanics: theory and experiment 2008, P10008.

Blumstein, P., Kollock, P., 1988. Personal relationships. Annual Review of Sociology 467–490.

Borgatti, S.P., Halgin, D.S., 2011. On network theory. Organization Science 22, 1168–1181.

Boyd, D., Golder, S., Lotan, G., 2010. Tweet, tweet, retweet: Conversational aspects of retweeting on twitter, in: System Sciences (HICSS), 2010 43rd Hawaii International Conference on. IEEE, pp. 1–10.

Boyd, D.M., Ellison, N.B., 2007. Social Network Sites: Definition, History, and Scholarship. Journal of Computer-Mediated Communication 13, 210–230. doi:10.1111/j.1083-6101.2007.00393.x

Brown, J., Broderick, A.J., Lee, N., 2007. Word of mouth communication within online communities: Conceptualizing the online social network. Journal of interactive marketing 21, 2–20.

Burt, R.S., 2004. Structural Holes and Good Ideas. American Journal of Sociology 110, 349–399. doi:10.1086/421787

Burt, R.S., 2000. The network structure of social capital. Research in organizational behavior 22, 345–423.

Burt, R.S., 1995. Structural Holes: The Social Structure of Competition. Harvard University Press.

Burt, R.S., 1992. Structural hole. Harvard Business School Press, Cambridge, MA.

Chen, G.M., 2011. Tweet this: A uses and gratifications perspective on how active Twitter use gratifies a need to connect with others. Computers in Human Behavior, Web 2.0 in Travel and Tourism: Empowering and Changing the Role of Travelers 27, 755–762. doi:10.1016/j.chb.2010.10.023

Chen, J., Liu, Y., Zou, M., 2016. Home location profiling for users in social media. Information & Management 53, 135–143. doi:10.1016/j.im.2015.09.008

Cheng, D.X., Lee, F.L.F., 2015. Journalist–Source Relations. Journalism Studies 16, 850–867. doi:10.1080/1461670X.2014.947146

Coleman, J.S., 1997. Family, school, and social capital. International encyclopedia of the sociology of education 623–625.

Coleman, J.S., 1988. Social capital in the creation of human capital. American journal of sociology S95–S120.

Creswell, J.W., 2002. Educational research: Planning, conducting, and evaluating quantitative. New Jersey: Upper Saddle River.

Dahlander, L., McFarland, D.A., 2013. Ties That Last: Tie Formation and Persistence in Research Collaborations over Time. Administrative Science Quarterly 58, 69–110. doi:10.1177/0001839212474272

Daly, E.M., Haahr, M., 2009. Social Network Analysis for Information Flow in Disconnected Delay-Tolerant MANETs. IEEE Transactions on Mobile Computing 8, 606–621. doi:10.1109/TMC.2008.161

D'Andrea, A., Ferri, F., Grifoni, P., 2010. An overview of methods for virtual social networks analysis, in: Computational Social Network Analysis. Springer, pp. 3–25.

Davenport, S.W., Bergman, S.M., Bergman, J.Z., Fearrington, M.E., 2014. Twitter versus Facebook: Exploring the role of narcissism in the motives and usage of different social media platforms. Computers in Human Behavior 32, 212–220. doi:10.1016/j.chb.2013.12.011

Dávid, B., Huszti, E., Barna, I., Fu, Y., 2016. Egocentric contact networks in comparison: Taiwan and Hungary. Social Networks 44, 253–265. doi:10.1016/j.socnet.2015.10.001

Demirkan, I., Deeds, D.L., Demirkan, S., 2013. Exploring the Role of Network Characteristics, Knowledge Quality, and Inertia on the Evolution of Scientific Networks. Journal of Management 39, 1462–1489. doi:10.1177/0149206312453739

Dul, J., Hak, T., 2008. Case Study Methodology in Business Research. Butterworth-Heinemann/Elsevier.

Easley, D., Kleinberg, J., 2010. Networks, crowds, and markets: Reasoning about a highly connected world. Cambridge University Press.

Ebner, M., Mühlburger, H., Schaffert, S., Schiefner, M., Reinhardt, W., Wheeler, S., 2010. Getting Granular on Twitter: Tweets from a Conference and Their Limited Usefulness for Non-participants, in: Reynolds, N., Turcsányi-Szabó, M. (Eds.), Key Competencies in the Knowledge Society, IFIP Advances in Information and Communication Technology. Springer Berlin Heidelberg, pp. 102–113.

Echebarria, C., Barrutia, J.M., 2013. Limits of Social Capital as a Driver of Innovation: An Empirical Analysis in the Context of European Regions. Regional Studies 47, 1001–1017. doi:10.1080/00343404.2011.603720

Ellison, N.B., Steinfield, C., Lampe, C., 2011. Connection strategies: Social capital implications of Facebook-enabled communication practices. New Media Society 13, 873–892. doi:10.1177/1461444810385389

Ellison, N.B., Steinfield, C., Lampe, C., 2007. The Benefits of Facebook "Friends:" Social Capital and College Students' Use of Online Social Network Sites. Journal of Computer-Mediated Communication 12, 1143–1168. doi:10.1111/j.1083-6101.2007.00367.x

Farrow, H., Yuan, Y.C., 2011. Building Stronger Ties With Alumni Through Facebook to Increase Volunteerism and Charitable Giving. Journal of Computer-Mediated Communication 16, 445–464. doi:10.1111/j.1083-6101.2011.01550.x

Feld, S.L., 1981. The Focused Organization of Social Ties. American Journal of Sociology 86, 1015–1035.

Figueiredo, C., Chen, W., Azevedo, J., 2015. Central nodes and surprise in content selection in social networks. Computers in Human Behavior 51, Part A, 382–392. doi:10.1016/j.chb.2015.04.070

Fogués, R.L., Such, J.M., Espinosa, A., Garcia-Fornes, A., 2013. BFF: A tool for eliciting tie strength and user communities in social networking services. Inf Syst Front 16, 225–237. doi:10.1007/s10796-013-9453-6

Friedkin, N., 1980. A test of structural features of granovetter's strength of weak ties theory. Social Networks 2, 411–422. doi:10.1016/0378-8733(80)90006-4

Gerring, J., 2006. Case study research: Principles and practices. Cambridge University Press.

Gerring, J., 2004. What Is a Case Study and What Is It Good for? American Political Science Review null, 341–354. doi:10.1017/S0003055404001182

Ghauri, P.N., Grønhaug, K., 2005. Research methods in business studies: A practical guide. Pearson Education.

Gilbert, E., 2012. Predicting Tie Strength in a New Medium, in: Proceedings of the ACM 2012 Conference on Computer Supported Cooperative Work, CSCW '12. ACM, New York, NY, USA, pp. 1047–1056. doi:10.1145/2145204.2145360

Gilbert, E., Karahalios, K., 2009. Predicting Tie Strength with Social Media, in: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, CHI '09. ACM, New York, NY, USA, pp. 211–220. doi:10.1145/1518701.1518736

Granovetter, M., 1983. The strength of weak ties: A network theory revisited. Sociological theory 1, 201–233.

Granovetter, M.S., 1973. The Strength of Weak Ties. American Journal of Sociology 78, 1360–1380.

Gupta, J.P., Menon, K., Kärkkäinen, H., Huhtamäki, J., Mukkamala, R.R., Hussain, A., Vatrapu, R., Jussila, J., Pirkkalainen, H., Olsson, T., 2017. Evaluating tie strength and identifying different ties in an event setting using publicly available social media data, in: 2017 50th Hawaii International Conference on System Sciences (HICSS). Submitted to the 2017 50th Hawaii International Conference on System Sciences (HICSS).

Gupte, M., Eliassi-Rad, T., 2012. Measuring tie strength in implicit social networks, in: Proceedings of the 4th Annual ACM Web Science Conference. ACM, pp. 109–118.

Haythornthwaite, C., 2002. Strong, Weak, and Latent Ties and the Impact of New Media. Information Society 18, 385–401. doi:10.1080/01972240290108195

Heider, F., 1958. The Psychology of Interpersonal Relations. Psychology Press.

Heidl, R.A., Steensma, H.K., Phelps, C., 2014. Divisive Faultlines and the Unplanned Dissolutions of Multipartner Alliances. Organization Science 25, 1351–1371. doi:10.1287/orsc.2014.0898

Hemmert, M., Bstieler, L., Okamuro, H., 2014. Bridging the cultural divide: Trust formation in university–industry research collaborations in the US, Japan, and South Korea. Technovation 34, 605–616. doi:10.1016/j.technovation.2014.04.006

Hirai, Y., Watanabe, T., Inuzuka, A., 2013. Empirical analysis of the effect of Japanese university spinoffs' social networks on their performance. Technological Forecasting and Social Change 80, 1119–1128. doi:10.1016/j.techfore.2012.10.027

Hornick, M., Tamayo, P., 2012. Extending Recommender Systems for Disjoint User/Item Sets: The Conference Recommendation Problem. IEEE Transactions on Knowledge and Data Engineering 24, 1478–1490. doi:10.1109/TKDE.2011.90

Hughes, D.J., Rowe, M., Batey, M., Lee, A., 2012. A tale of two sites: Twitter vs. Facebook and the personality predictors of social media usage. Computers in Human Behavior 28, 561–569. doi:10.1016/j.chb.2011.11.001

Hutto, C.J., Yardi, S., Gilbert, E., 2013. A Longitudinal Study of Follow Predictors on Twitter, in: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, CHI '13. ACM, New York, NY, USA, pp. 821–830. doi:10.1145/2470654.2470771

Joinson, A.N., 2008. Looking at, Looking Up or Keeping Up with People?: Motives and Use of Facebook, in: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, CHI '08. ACM, New York, NY, USA, pp. 1027–1036. doi:10.1145/1357054.1357213

Jussila, J., Huhtamäki, J., Henttonen, K., Kärkkäinen, H., Still, K., 2014. Visual Network Analysis of Twitter Data for Co-organizing Conferences: Case CMAD 2013, in: 2014 47th Hawaii International Conference on System Sciences. Presented at the 2014 47th Hawaii International Conference on System Sciences, pp. 1474–1483. doi:10.1109/HICSS.2014.190

Jussila, J., Huhtamäki, J., Kärkkäinen, H., Still, K., 2013. Information Visualization of Twitter Data for Co-organizing Conferences, in: Proceedings of International Conference on Making Sense of Converging Media, AcademicMindTrek '13. ACM, New York, NY, USA, p. 139:139–139:145. doi:10.1145/2523429.2523482

Jussila, J.J., Kärkkäinen, H., Aramo-Immonen, H., 2014. Social media utilization in business-to-business relationships of technology industry firms. Computers in Human Behavior 30, 606–613. doi:10.1016/j.chb.2013.07.047

Kahanda, I., Neville, J., 2009. Using Transactional Information to Predict Link Strength in Online Social Networks. ICWSM 9, 74–81.

Kang, J.-Y.M., Johnson, K.K.P., 2015. F-Commerce platform for apparel online social shopping: Testing a Mowen's 3M model. International Journal of Information Management 35, 691–701. doi:10.1016/j.ijinfomgt.2015.07.004

Kaplan, A.M., Haenlein, M., 2010. Users of the world, unite! The challenges and opportunities of Social Media. Business Horizons 53, 59–68. doi:10.1016/j.bushor.2009.09.003

Kendler, K.S., Myers, J., Prescott, C.A., 2005. Sex Differences in the Relationship Between Social Support and Risk for Major Depression: A Longitudinal Study of Opposite-Sex Twin Pairs. AJP 162, 250–256. doi:10.1176/appi.ajp.162.2.250

Kowald, M., van den Berg, P., Frei, A., Carrasco, J.-A., Arentze, T., Axhausen, K., Mok, D., Timmermans, H., Wellman, B., 2013. Distance patterns of personal networks in four countries: a comparative study. Journal of Transport Geography 31, 236–248. doi:10.1016/j.jtrangeo.2013.06.006

Krackhardt, D., 1992. The strength of strong ties: The importance of philos in organizations. Networks and organizations: Structure, form, and action 216, 239.

Krackhardt, D., Stern, R.N., 1988. Informal networks and organizational crises: An experimental simulation. Social psychology quarterly 123–140.

Kumar, S., Rohani, V.A., Ratnavelu, K., 2014. International research collaborations of ASEAN Nations in economics, 1979–2010. Scientometrics 101, 847–867. doi:10.1007/s11192-014-1363-y

Lampe, C., Ellison, N., Steinfield, C., 2006. A Face(Book) in the Crowd: Social Searching vs. Social Browsing, in: Proceedings of the 2006 20th Anniversary Conference on Computer Supported Cooperative Work, CSCW '06. ACM, New York, NY, USA, pp. 167–170. doi:10.1145/1180875.1180901

Levin, D.Z., Cross, R., 2004. The Strength of Weak Ties You Can Trust: The Mediating Role of Trust in Effective Knowledge Transfer. Management Science 50, 1477–1490. doi:10.1287/mnsc.1030.0136

Levin, D.Z., Walter, J., Murnighan, J.K., 2011. Dormant Ties: The Value of Reconnecting (SSRN Scholarly Paper No. ID 1625543). Social Science Research Network, Rochester, NY.

Lewis, J., West, A., 2009. "Friending": London-based undergraduates' experience of Facebook. New Media Society 11, 1209–1229. doi:10.1177/1461444809342058

Lewis, K., Kaufman, J., Gonzalez, M., Wimmer, A., Christakis, N., 2008. Tastes, ties, and time: A new social network dataset using Facebook.com. Social Networks 30, 330–342. doi:10.1016/j.socnet.2008.07.002

Li, Y., Wang, X., Huang, L., Bai, X., 2013. How does entrepreneurs' social capital hinder new business development? A relational embeddedness perspective. Journal of Business Research 66, 2418–2424. doi:10.1016/j.jbusres.2013.05.029

Lin, N., Dayton, P., Greenwald, P., 1978. Analyzing Instrumental Use of Relations in Context of Social-Structure. Sociol. Methods. Res. 7, 149–166.

Lin, N., Ensel, W.M., Vaughn, J.C., 1981. Social Resources and Strength of Ties: Structural Factors in Occupational Status Attainment. American Sociological Review 46, 393–405. doi:10.2307/2095260

Marsden, P.V., Campbell, K.E., 2012. Reflections on Conceptualizing and Measuring Tie Strength. Social Forces 91, 17–23.

Marsden, P.V., Campbell, K.E., 1984. Measuring Tie Strength. Social Forces 63, 482–501.

Marwick, A.E., Boyd, D., 2011. I tweet honestly, I tweet passionately: Twitter users, context collapse, and the imagined audience. New Media Society 13, 114–133. doi:10.1177/1461444810365313

Mathews, K.M., White, M.C., Long, R.G., Soper, B., von Bergen, C.W., 1998. Association of indicators and predictors of tie strength. Psychol. Rep. 83, 1459–1469. doi:10.2466/PR0.83.7.1459-1469

McCarty, C., Bernard, H.R., Killworth, P.D., Shelley, G.A., Johnsen, E.C., 1997. Eliciting representative samples of personal networks. Social Networks 19, 303–323. doi:10.1016/S0378-8733(96)00302-4

McGuire, G.M., Bielby, W.T., 2016. The Variable Effects of Tie Strength and Social Resources How Type of Support Matters. Work and Occupations 43, 38–74. doi:10.1177/0730888415596560

Mitchell, J.C., 1987. The components of strong ties among homeless women. Social Networks 9, 37–47. doi:10.1016/0378-8733(87)90016-5

Mizruchi, M.S., Stearns, L.B., Fleischer, A., 2011. Getting a Bonus: Social Networks, Performance, and Reward Among Commercial Bankers. Organization Science 22, 42–59. doi:10.1287/orsc.1090.0516

Nitzan, I., Libai, B., 2011. Social Effects on Customer Retention. Journal of Marketing 75, 24–38. doi:10.1509/jmkg.75.6.24

Onnela, J.-P., Saramäki, J., Hyvönen, J., Szabó, G., Lazer, D., Kaski, K., Kertész, J., Barabási, A.-L., 2007. Structure and tie strengths in mobile communication networks. PNAS 104, 7332–7336. doi:10.1073/pnas.0610245104

Oppermann, M., Chon, K.-S., 1997. Convention participation decision-making process. Annals of Tourism Research 24, 178–191. doi:10.1016/S0160-7383(96)00049-7

Otte, E., Rousseau, R., 2002. Social network analysis: a powerful strategy, also for the information sciences. Journal of Information Science 28, 441–453. doi:10.1177/016555150202800601

Panek, E.T., Nardis, Y., Konrath, S., 2013. Mirror or Megaphone?: How relationships between narcissism and social networking site use differ on Facebook and Twitter. Computers in Human Behavior 29, 2004–2012. doi:10.1016/j.chb.2013.04.012

Panovich, K., Miller, R., Karger, D., 2012. Tie Strength in Question & Answer on Social Network Sites, in: Proceedings of the ACM 2012 Conference on Computer Supported Cooperative Work, CSCW '12. ACM, New York, NY, USA, pp. 1057–1066. doi:10.1145/2145204.2145361

Perlman, D., Fehr, B., 1987. The development of intimate relationships.

Petersen, A.M., 2015. Quantifying the impact of weak, strong, and super ties in scientific careers. Proc Natl Acad Sci U S A 112, E4671–E4680. doi:10.1073/pnas.1501444112

Petróczi, A., Nepusz, T., Bazsó, F., 2007. Measuring tie-strength in virtual social networks. Connections 27, 39–52.

Phan, B., Engø-Monsen, K., Fjeldstad, Ø.D., 2013. Considering clustering measures: Third ties, means, and triplets. Social Networks 35, 300–308. doi:10.1016/j.socnet.2013.02.007

PhD, B.N.R., PhD, J.A.B., PhD, J.L., 2001. Understanding Motivations, Inhibitors, and Facilitators of Association Members in Attending International Conferences. Journal of Convention & Exhibition Management 3, 45–62. doi:10.1300/J143v03n03_04

Pin Luarn, Yu-Ping Chiu, 2015. Key variables to predict tie strength on social network sites. Internet Research 25, 218–238. doi:10.1108/IntR-11-2013-0231

Pinheiro, C.A.R., 2011. Social network analysis in telecommunications. John Wiley & Sons.

Rapoport, A., 1953. Spread of information through a population with socio-structural bias: I. Assumption of transitivity. Bulletin of Mathematical Biophysics 15, 523–533. doi:10.1007/BF02476440

Reagans, R., 2010. Close Encounters: Analyzing How Social Similarity and Propinquity Contribute to Strong Network Connections. Organization Science 22, 835–849. doi:10.1287/orsc.1100.0587

Reinhardt, W., Ebner, M., Beham, G., Costa, C., 2009. How people are using Twitter during conferences. Creativity and Innovation Competencies on the Web. Proceedings of the 5th EduMedia 145–156.

Reinhardt, W., Maicher, J., Drachsler, H., Sloep, P.B., 2011. Awareness support in scientific event management with ginkgo, in: Proceedings of the 11th International

Conference on Knowledge Management and Knowledge Technologies. ACM, p. 40.

Retzer, S., Yoong, P., Hooper, V., 2010. Inter-organisational knowledge transfer in social networks: A definition of intermediate ties. Inf Syst Front 14, 343–361. doi:10.1007/s10796-010-9250-4

Ritala, P., Hurmelinna-Laukkanen, P., 2009. What's in it for me? Creating and appropriating value in innovation-related coopetition. Technovation 29, 819–828.

Rogers Everett, M., 1995. Diffusion of innovations. New York 12.

Ross, C., Terras, M., Warwick, C., Welsh, A., 2011. Enabled backchannel: Conference Twitter use by digital humanists. Journal of Documentation 67, 214–237.

Saunders, M., Lewis, P., Thornhill, A., 2009. Research Methods for Business Students. Pearson Education.

Severt, D., Wang, Y., Chen, P.-J., Breiter, D., 2007. Examining the motivation, perceived performance, and behavioral intentions of convention attendees: Evidence from a regional conference. Tourism Management 28, 399–408. doi:10.1016/j.tourman.2006.04.003

Smock, A.D., Ellison, N.B., Lampe, C., Wohn, D.Y., 2011. Facebook as a toolkit: A uses and gratification approach to unbundling feature use. Computers in Human Behavior 27, 2322–2329. doi:10.1016/j.chb.2011.07.011

Sohn, D., 2009. Disentangling the Effects of Social Network Density on Electronic Word-of-Mouth (eWOM) Intention. Journal of Computer-Mediated Communication 14, 352–367. doi:10.1111/j.1083-6101.2009.01444.x

Tashakkori, A., Teddlie, C., 1998. Mixed Methodology: Combining Qualitative and Quantitative Approaches. SAGE Publications.

Taylor, S.E., Sherman, D.K., Kim, H.S., Jarcho, K., Takagi, K., Dunagan, M.S., 2004. Culture and social support: Who seeks it and why? J. Pers. Soc. Psychol. 87, 354–362. doi:10.1037/0022-3514.87.3.354

Tortoriello, M., Reagans, R., McEvily, B., 2011. Bridging the Knowledge Gap: The Influence of Strong Ties, Network Cohesion, and Network Range on the Transfer of Knowledge Between Organizational Units. Organization Science 23, 1024–1039. doi:10.1287/orsc.1110.0688

Tredinnick, L., 2006. Web 2.0 and Business A pointer to the intranets of the future? Business Information Review 23, 228–234. doi:10.1177/0266382106072239

Verlegh, P., Ryu, G., Tuk, M., Feick, L., 2013. Receiver responses to rewarded referrals: the motive inferences framework. Journal of the Academy of Marketing Science 41, 669–682. doi:10.1007/s11747-013-0327-8

Villanueva-Felez, A., Woolley, R., Cañibano, C., 2015. Nanotechnology researchers' collaboration relationships: A gender analysis of access to scientific information. Social Studies of Science 45, 100–129. doi:10.1177/0306312714552347

Wang, J., 2016. Knowledge creation in collaboration networks: Effects of tie configuration. Research Policy 45, 68–80. doi:10.1016/j.respol.2015.09.003

Warr, W.A., 2008. Social software: fun and games, or business tools? Journal of Information Science 34, 591–604. doi:10.1177/0165551508092259

Wellman, B., 1999. Networks in the Global Village: Life in Contemporary Communities. Westview Press.

Wellman, B., 1982. Studying personal communities in East York. Centre for Urban and Community Studies, University of Toronto.

Wellman, B., Wortley, S., 1990. Different Strokes from Different Folks: Community Ties and Social Support. American Journal of Sociology 96, 558–588. doi:10.1086/229572

Wollan, R., Smith, N., Zhou, C., 2010. The Social Media Management Handbook: Everything You Need To Know To Get Social Media Working In Your Business. John Wiley & Sons.

Wu, A., DiMicco, J.M., Millen, D.R., 2010. Detecting Professional Versus Personal Closeness Using an Enterprise Social Network Site, in: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, CHI '10. ACM, New York, NY, USA, pp. 1955–1964. doi:10.1145/1753326.1753622

Xiang, R., Neville, J., Rogati, M., 2010. Modeling Relationship Strength in Online Social Networks, in: Proceedings of the 19th International Conference on World Wide Web, WWW '10. ACM, New York, NY, USA, pp. 981–990. doi:10.1145/1772690.1772790

Yin, R.K., 2013. Case study research: Design and methods. Sage publications.

Zhan Shi, Huaxia Rui, Whinston, A.B., 2014. Content Sharing in a Social Broadcasting Environment: Evidence from Twitter. MIS Quarterly 38, 123-A6.

Zhang, A.X., Bhardwaj, A., Karger, D., 2016. Confer: A Conference Recommendation and Meetup Tool, in: Proceedings of the 19th ACM Conference on Computer Supported Cooperative Work and Social Computing Companion. ACM, pp. 118–121.

Zhao, J., Wu, J., Feng, X., Xiong, H., Xu, K., 2011. Information propagation in online social networks: a tie-strength perspective. Knowl Inf Syst 32, 589–608. doi:10.1007/s10115-011-0445-x

Zhao, K., Stehlé, J., Bianconi, G., Barrat, A., 2011. Social network dynamics of face-to-face interactions. Phys. Rev. E 83, 56109. doi:10.1103/PhysRevE.83.056109

Zhong, Y., Yang, J., Nugroho, R., 2015. Incorporating Tie Strength in Robust Social Recommendation, in: Big Data (BigData Congress), 2015 IEEE International Congress on. IEEE, pp. 63–70.

APPENDIX A: WEBLINK OF THE DIFFERENT CMAD CONFERENCES

As one of the important aspects of this study was the use of publically available data. In this appendix the web links that were used to find the Twitter ids of the CMAD conference participants and also the different presenters during the CMAD conferences are provided in the table below.

Presenters 2015 CMAD	http://2015.cmad.fi/esiintyjat-2015
Presenters 2016 CMAD	http://cmad.fi/esiintyjat
CMAD 2015 Participants	http://2015.cmad.fi/uutiset/cmadfi-osallistujat-2015
CMAD 2016 Participants	http://cmad.fi/uutiset/cmadfi-ilmoittautuneet-2016