

Conceptualisation of Digital Traces for the Identification of Informal Networks in Enterprise Social Networks

Research in Progress

Sebastian Behrendt
Bundeswehr University, Munich
Email: s.behrendt@unibw.de

Alexander Richter
University of Zurich
Email: arichter@ifi.uzh.ch

Kai Riemer
The University of Sydney
Email: kai.riemer@sydney.edu.au

Abstract

Organisations can be understood as organisms exhibiting a formal structure formalised by the “org chart”, and informal structures of emerging networks between employees. The increasing use of Enterprise Social Networks (ESN) provides managers and researchers with new opportunities to uncover formal and informal structures. Yet, it remains underexplored what exactly constitutes relationship structures in ESN. We employ the notion of ‘digital traces’, stored as user-generated data on the ESN and set out to explore ways for conceptualising relations as the basis for network constitution and visualisation. We illustrate our approach with a case study of an ESN and demonstrate how resulting networks vary significantly depending on the digital traces employed.

Keywords

informal networks, digital traces, enterprise social network, enterprise 2.0, social network analysis

INTRODUCTION

Over the past few years, the use of Enterprise Social Networks (ESN) is constantly increasing (Zhang et al. 2010). ESN play an increasingly important role in changing communication practices (Aral et al. 2013; Bharadwaj et al. 2013; Krogh 2012). Besides facilitating organisational collaboration, ESN usage incidentally produces an enormous amount of user-generated data. This data can be used in two ways: Firstly, it allows the identification of informal organizational structures, since almost every interaction in the system leaves a persistent digital trace (Aral et al. 2013). Secondly, ESN provide new ways for employees to create informal relations. These informal structures can generally be seen as the result of unplanned relations and interactions between employees (Chandler 1962). They often build on emergent procedures created by employees and are reflected in informal groups, communication, standards and leaders (Zell 2011). Whereas a formal structure can be thought of as the skeleton of an organisation, the informal structure might represent its nervous system (Krackhardt and Hanson 1993).

The existence of informal structures in organisations has already been demonstrated in the 1930ies by the so called Hawthorne experiments (Roethlisberger 1976). Since then, various studies showed that such informal structures have a network character (Bryan et al. 2007; Cross et al. 2002; Krackhardt and Hanson 1993) and that they have a significant impact on employee satisfaction and performance (Cross et al. 2002). Moreover, for executives, they offer the possibility to identify and understand the true nature of collaboration in their organisation, and hence to better support it (Allen et al. 2007). Yet, informal networks are often hard to uncover and manipulate (Krackhardt and Hanson 1993).

ESN mimic the functionality of public Social Networking Services (SNS), such as Facebook or Twitter; SNS are platforms for connecting users by creating relationships (e.g. through ‘following’ other users) and facilitate interactions between them through the exchange of short messages (boyd and Ellison 2007). Accordingly, ESN can be described as web-based platforms, available internally to employees, that support users in contributing content to a shared pool, which enables public responses to these objects, allows profile information to be presented, and subsequently connects users (Behrendt et al. 2014; McLure Wasko and Faraj 2005). Relationships can emerge through features like ‘friend requests’ and ‘following’ or through group membership or content creation (McLure Wasko and Faraj 2005; Richter and Koch 2008) which similarly leads to a high degree of interconnectedness (Agarwal et al. 2008; Riemer and Richter 2010b).

Consequently, the use of ESN produces a considerable amount of data, since almost every interaction in the system leaves a persistent digital trace (Aral et al. 2013). This data provides researchers and managerial decision-makers with unprecedented opportunities leading to a “revolution in the measurement of collective human behaviour” (Kleinberg 2008 p.66). Consequently, ESN data is already used for research in various ways, for example, in studies on patterns of knowledge exchange (Majchrzak et al. 2013) and their underlying network

structures (Chau and Xu 2012; Lerman and Ghosh 2010), or the distribution of ideas (Ciriello et al. 2013), rumours (Oh et al. 2013) or sentiments (Hillmann and Trier 2012).

However, there is not just one informal network. Due to the dynamic aspect of organisational collaboration, there are various possible perspectives on informal networking. Regarding ESN it remains unclear what exactly might best constitute informal networks between employees. One way of uncovering informal networks is by employing the various digital traces that people leave in the course of everyday collaboration within the space. Yet, digital traces are so far only rarely used to uncover informal networks. We argue that an important reason lies in the different nature of ESN digital traces compared to the data used traditionally for exploring informal social networks, such as interview data (Howison et al. 2011; Kane et al. 2014). Consequently, no comprehensive overview exists cataloguing the available digital traces (boyd and Crawford 2012). Therefore, in this paper we lay the basis to answer the question of how to derive informal networks from digital traces in ESN?

We address this issue by presenting an approach to identify and conceptualise the digital traces relevant for analysing informal networks in ESN. We aim at indicating the wide array of possible digitally enabled networks and give some first orientation with this emerging domain. Our contributions are thus as follows. Firstly, we distinguish and categorise different digital traces, and contribute to the conceptual foundations that enable informal social network analysis in ESN. Secondly, we show how digital traces can be employed for deducing informal networks from ESN. Thirdly, by applying our framework to a case data set, we demonstrate the application of digital traces in ESN for social network analysis in general and the analysis of informal networks in particular. Fourthly, we demonstrate that the resulting networks vary greatly depending on which digital traces are employed.

The remainder of this paper is structured as follows. We begin with providing more background on the concept of informal networks and benefits derived from their analysis. We then provide a conceptualisation of digital traces in existing research. Following from that, we develop our approach for identifying digital traces in a structured way for the discovery of informal ESN structures. As we specifically intend to combine a theory-based framework development and an empirical proof of concept, we apply this framework to a data set taken from a social network of medical officers for illustration purposes. We conclude with a discussion of the presented approach and indicate possible next steps.

BACKGROUND: INFORMAL NETWORKS

Informal networks are unsanctioned and ungoverned organic structures which connect a potentially unbounded group of individuals internally but also across organisational boundaries (Chandler 1962). They are not defined by organisational structures or executives but are the result of informal relations between employees (Cross et al. 2002; Krackhardt and Hanson 1993; Toni and Nonino 2010). Employees can establish different types of informal relations (Borgatti et al. 2009), such as *Similarities*, *Social Relations*, *Interactions* and *Flows* which build on each other. *Similarities* describe spatial and temporal proximity, co-membership in groups and events and socially significant attributes. They lead to *Social Relations* which can be a kind of kinship, affection (Likes, Hates), cognition (knows, knows about) or certain kind of roles like “Friend of” or “Boss of”. These relations enable *interactions*, which are single events over a period of time like “talking to” or “helping out”. These interactions create a flow of tangible and intangible things like information or knowledge, which are transmitted through interactions. When these interactions and flows do not follow the organizational chart and are more personal, they can be described as informal communication (Johnson et al. 1994).

This informal communication can form different types of informal networks (Krackhardt and Hanson 1993), which can for example describe networks of work and non-work related communication, problem-solving networks or knowledge networks (Cross et al. 2002). These networks can vary in size (Bryan et al. 2007) and complexity, are highly adaptive but solidify over time (Krackhardt and Hanson 1993). Furthermore, by using tools for digitally supported communication like smartphones or networking websites, they can skip entire organisational functions or entities and can even cross organisational and geographical boundaries (Bryan et al. 2007; Cross and Parker 2004).

Today, especially in knowledge-intensive industries, ever more tasks are accomplished collaboratively through such informal networks (Cross et al. 2002) because they can reduce possible search and coordination costs (Bryan et al. 2007) and often come to fruition when unexpected problems occur (Krackhardt and Hanson 1993). Hence they have a significant impact on employee satisfaction and performance (Cross et al. 2002).

At the same time, informal networks are hard to detect, they furthermore elude managerial control and hence can lead to dysfunctional organisations by adding complexity, muddling roles, or aggravating the intensity of corporate politics (Krackhardt and Hanson 1993). The majority of the internal overload of emails, instant messages or meetings is produced by informal communication as everybody is searching for certain information

or contact person, which also increases complexity and inefficiency. It can furthermore lead to parallel or “shadow” networks, especially in large organisations (Bryan et al. 2007). The effectiveness of different networks also varies significantly, as they essentially rely on serendipity or because people with valuable knowledge or skills may not know about or join the most appropriate network. Furthermore, members holding key positions in a network can hinder or even undermine the collaboration if they become overloaded, act as gatekeepers, leave the company or pursue personal interests and accumulate and appropriate knowledge to gain power (Bryan et al. 2007; Cross and Parker 2004; Krackhardt and Hanson 1993).

These aspects above point to the need for organisations to gain an understanding of their informal networks, as formal structures fail to reflect accurately the true nature of social relationships, dynamics and dependencies between employees and often differ significantly from these informal structures (Cross et al. 2002).

A good understanding of how informal networks are formed, structured and evolve is thus vital for organisational success (Cross et al. 2002) and their ability to innovate (Cross and Parker 2004) as it enables executives to understand the true nature of collaboration and hence better support and facilitate effective collaboration (Allen et al. 2007). Studying informal network can reveal critical disconnections between employees or business units. They can help to identify personnel failing in their formal task (Allen et al. 2007), or they can show the often unexpected location of key employees (Tushman and Scanlan 1981). These informal key roles often have a great impact on collaboration and knowledge sharing processes (Toni and Nonino 2010) because their informal influence can be stronger than influence derived from formal positions (Stieglitz et al. 2014). Analysing informal networks can furthermore reveal irregular or unwanted communication patterns or fragile network structures, especially holes in the network or unfavourable centralisation of resources (Krackhardt and Hanson 1993).

DIGITAL TRACES IN ENTERPRISE SOCIAL NETWORKS

Enterprise social networks offer employees new ways for informal networking through communicating and collaborating in both public enterprise-wide communication streams and private groups with restricted membership (Riemer and Richter 2010a). Examples of ESN platforms are Yammer, IBM Connections, Tibbr, Sitrion or Jive. An important reason for organisations to adopt dedicated workplace ESN services is to mitigate the risk related to confidentiality and information security of using public SNS such as Facebook for workplace communication e.g. (DiMicco et al. 2008).

We argue that ESN provide new ways to uncover and analyse informal networks. Every activity performed by a user leaves a trace, which is stored by the ESN itself. This produces a considerable amount of data offering unprecedented opportunities for qualitative and quantitative analysis to researchers and managerial decision makers (Kleinberg 2008). However, these so called digital traces are of different nature than data traditionally used for exploring informal networks so far (Howison et al. 2011; Kane et al. 2014).

Digital traces in ESN are records of activity (Howison et al. 2011). They are digitally stored evidence of human and human-like activity that occurred at a defined point in time in the past (Freelon 2014). These traces can vary in terms of data formats i.e., textual, tabular, images, videos, channels, ‘likes’, ‘tweets’, etc. produced by various platforms and services (Freelon 2014; Milolidakis et al. 2014) and often include the content of interpersonal communication (Agarwal et al. 2008). Some traces can be seen as indirect evidence for a social relationship, rather than a direct measure of it (Howison et al. 2011).

Digital traces comprise a plethora of diverse data types (Freelon 2014) and allow the discovery of hidden knowledge in a timely and purposeful manner (Milolidakis et al. 2014). They are also said to constitute a new research area; “one that analyses and builds theories of large social systems by using their reflections in massive datasets” (Kleinberg 2008 p.68). For that reason, digital traces are already widely used for a variety of research questions. Furthermore, a number of tools have emerged that use several types of digital traces and allow various types of network analysis. For example, Lin et al. (2012) apply the tool SmallBlue to analyse enterprise communication (email and phone logs), outlining the various challenges that occur when performing such an analysis, such as system issues, privacy laws or the economic value of social networks. Another tool for analysing enterprise communication data is SaNDVis (e.g. Perer et al. 2013). The authors demonstrate its use to reflect on existing relationships by visually analysing longitudinal usage patterns.

A number of aspects have to be considered for a scientific analysis of this data. Digital traces are a by-product of user activities and are not directly produced for the purposes of research. Thus, they require careful and contextual interpretation. Additionally, they consist of single events and provide no ready-to-use aggregation. Moreover, digital traces are constantly produced over time and can be seen as temporal or chronological data (Agarwal et al. 2008; Howison et al. 2011). Scholars have called for particular care in dealing with large sets of digital data, especially in terms of accuracy of the data, possible bias, missing context or different ethical issues (boyd and Crawford 2012). In organisational settings data privacy and the monitoring of employees are

particularly pertinent issues, because they involve different regulation and boundaries than public settings (Lin et al. 2012). Hence, it is important for researchers to take more responsibility towards their “research object” as these data allow analysing a person without their knowledge (boyd and Crawford 2012). However, the employees’ knowledge about an ongoing analysis might also influence the result as they might alter their behaviours or choose to communicate through other channels to preserve their anonymity (Leonardi et al. 2013).

Accordingly, digital trace data need to be pre-processed to serve any particular research purpose (Howison et al. 2011), which requires the identification of relevant data sets and the appropriate level of aggregation (Milolidakis et al. 2014). This in turn requires not only an understanding of their general characteristics (as given above), but also of their individual structure. The next section will address this issue and present our conceptualisation of digital traces and our approach to structuring the variety of digital traces.

A FRAMEWORK FOR CONCEPTUALISING DIGITAL TRACES

Following the characteristics of digital traces as described above, and for the purpose of our research in progress we conceptualise digital traces as follows:

Digital traces are digitally stored, event-based, chronological records of activities of actors, which result in direct or indirect actor relations or content in different data formats.

The goal of our research is to uncover and derive informal networks from ESN using the digital traces produced via ESN usage. Therefore it is necessary to structure these digital traces accordingly. Hence, we develop a corresponding approach, which we describe in the following. In essence, we use an argumentative deductive approach, as we deduce a combined framework based on given models and definitions.

To identify informal networks, Cross et al. ask: “Who talks to whom about what?” (Cross et al. 2002). As seen above, this question does not cover all aspects of informal networks. Therefore, to fully assess informal networks, we suggest extending this question and asking instead:

“Who is talking to whom, when, where and how, and about what?”

We see this question as a guiding structure that allows for identifying informal networks. It contains six sub-questions which we use in the following to structure digital traces. We assign the relevant properties of each of the phenomena described above and group the sub-questions accordingly (see Table 1). The resulting framework allows describing the data that are required to answer the respective sub-questions and thereby identifying informal networks. The sub-questions and the according digital traces are described below.

Table 1: Guiding questions for structuring ESN digital traces

Dimen sions	Informal Relations	Digital traces	References covering one dimension	References covering all dimensions
Who	Similarity	ESN User	(Toni and Nonino 2010)	(Agarwal et al. 2008; Borgatti et al. 2009; Chandler 1962; boyd and Crawford 2012; Freelon 2014; Howison et al. 2011; Kleinberg 2008; Milolidakis et al. 2014; Schulte-Zurhausen 2002; Roethlisberger 1976; Zell 2011)
How	Interactions	Records of an activity	(Bryan et al. 2007)	
When		Event based	(Krackhardt and Hanson 1993)	
Where		chronological data	(Cross and Parker 2004)	
What	Flow	Content in different formats	(Allen et al. 2007)	
Whom	Social Relations	Direct and indirect relations	(Cross et al. 2002)	

Who?

“Who?” refers to the communicating actor or the source of an activity and its properties. Therefore it is necessary to identify each actor in a way that allows describing possible similarities to other actors. This requires not only the distinct identification of the actor, but also additional details like age, gender, role, department, possible group memberships in the ESN, interests or expertise. These data can be accessed directly e.g. via a person’s profile page or derived indirectly via a qualitative analysis. E.g. a membership in several groups related to a certain topic might indicate the users’ interest in this topic. In this case, the necessary context is vital for a correct interpretation of the qualitative results.

How/ When/ Where?

“How?” refers to the type of activity which was performed. Such activities can be detected for example via the name of the ESN functionality that was used (e.g. “created an article”, or via a qualitative analysis of the result of the interaction. In any case, the interaction is performed at a certain date and time (“When?”), which can also be identified via the timestamp of the corresponding object. Furthermore, the place of the interaction is of interest (“Where?”). This can be a group, a blog or a wiki page, depending on the features of the ESN. Besides the type and name of the place, additional information like visibility or access rights, date and time of creation and other properties should be identified.

What?

“What” refers to the type of exchanged information. This can be assessed easily when the ESN provides different content types (e.g. blog post, status update, idea, question, PDF-file etc.). It can furthermore be assessed by analysing the content qualitatively, which in turn can be performed on various levels of detail depending on the goal of the analysis (e.g. genre analysis, keyword extraction, summarization, etc.).

To Whom?

The aspect of “To Whom?” refers to the target of the initial activity. This can be another human or human-like actor or a content object. In this case, the “To Whom?” can be described in every detail similar to the “Who?” aspect. Based on these properties, additional social relations between the source and the target can be created e.g. in terms of kinship, affection, roles or cognition. As stated earlier, activities can also be rather indirect evidence for a relationship. This can be the case when the activity is undirected and has no clear target. This can be for example a public status update or a discussion where it is not automatically detectable to which person a commenter is referring.

A CASE APPLICATION FOR ILLUSTRATION PURPOSES

In order to not limit our contribution to the conceptual framework development we apply and systematically evaluate our framework in a case study, using digital traces of an ESN for military medical personnel, for illustration purposes.

The case organisation is the medical service unit of the German Armed Forces (Deutsche Bundeswehr). It employs, amongst others, 2,700 medical officers and 1,600 trainee medical officers assigned to military medicine, military pharmacy, veterinary medicine, or dental medicine. The workforce and the students are distributed across five hospitals, 37 universities, and 200 other facilities.

In 2009, the department responsible for the training of medical officers identified a need for a means to support knowledge transfer and collaborative learning. It was recognised that trainee medical officers in particular expected state-of-the art communication tools. The department decided to implement an ESN, which we refer to as Med-Net in this paper. After a test phase in 2010, Med-Net was opened for potential users at the end of 2011. Even though the German Army is heavily regulated and has a very complex formal structure, Med-Net does not incorporate any pre-defined structure. The use is voluntary and the user guidelines allow a self-regulated communication and usage of all features. Hence, the users are not obliged to follow a certain process, e.g. when creating content or groups. Furthermore, at the time of the study, there were no military personnel supervising Med-Net, only two civil employees working as community managers. At the time of data extraction, 2,122 users were registered in Med-Net; they produced about 7,500 content elements of various types (e.g. blog post, wiki articles, comments, private messages, events, polls, status updates). In the context of a comprehensive evaluation, 13 semi-structured interviews with users from different military ranks and roles were carried out. While we do not intend to report on the interview results in detail here, they were necessary to comprehend the system and organisational context.

In the following we first demonstrate how the Med-Net data can be interpreted as digital traces using our framework and how such digital traces can be used to conceptualised user relations. We then demonstrate briefly how this allows us to derive different types of informal networks based on different kinds of relations.

Identifying digital traces for the conceptualisation of informal relations

To facilitate data analysis, all accessible data were exported from Med-Net into Microsoft Excel files (.xls), containing anonymized user ID and attributes like military rank or location, event metadata and the content itself. We then applied our framework and corresponding questions to conceptualise digital traces contained in the data set. We would like to note that we did not perform nor do we report on a comprehensive analysis of data

here. Rather, we highlight certain examples of digital traces to illustrate the application of our framework, as summarised in the following Table 2.

Table 2: Application of the digital traces framework to the case data for purpose of illustration

Aspect	Data which allow	Example Med-Net Data
Who?	Identification of individual users Description of a user (via meta data)	User id (anonymised) Military rank; Military Unit; Location
How?	Identification of type of interaction	Write (an article); Edit (an article); Comment (any content object); Publish (a blog post)
When?	Identification of time of interaction	Automatically generated timestamps
Where?	Identification of place of interaction (in a group, wiki page etc) Description of a place (via meta data)	group id; wiki chapter; blog ID group type (public, private); visibility
What?	Identification of objects of interaction Description of content object (via meta data) Qualitative content analysis	Content ID Content type; Create date, Access rights Content itself
To Whom?	Identification of counterpart/recipient Description of counterpart/recipient (via meta data)	User id (anonymized); content ID Military rank; content type

Based on these data, we established two types of relations: a “person to person” relation, and a “person to object” relation. Table 3 illustrates these two types and a notation for representing relations, based on a graph database query language “Cypher¹”, as well as an example.

Table 3: Illustration of two types of relations, and representation via notation

Relation	Example	Notation
Person to person	Paul sends a contact request to John	(User A) – [type of interaction] → (User B)
Person to object	Paul comments on article “My Project”	(User A) – [type of interaction] → (Content A)

Consequently, when trying to deduce a network from these relations, a graph with two types of nodes (person, object) would be created, a so-called bipartite graph (Wasserman and Faust 1994). However, as informal networks are relations between persons only, there is a need to “eliminate” the objects by transforming the relation of “person to object” into “person to person” relations. This can be done by interpreting the object as a ‘meeting point’ of two persons, whereby the interest in the common object is interpreted as constituting a relation between the two actors. We therefore created a connection between two users based on the content elements they both interacted with, as represented in Table 4.

Table 4: Conversion of person-to-object relations into person-to-person relation

	Notation	Example
Before	(User A) – [type of interaction] → (Content A)	Paul – writes – article “My Project”
	(User B) – [type of interaction] → (Content A)	John – comments on – article “My Project”
After	(User A) – [type of interaction with Content A] → (User B)	John – comments on article “My Project” of → Paul

Identification of informal networks based on different kinds of relations

The resulting relations allow the creation and visualization of different network graphs. Figure 1, by way of example, shows networks created using relations derived from “Content and comments” (graph A), “Direct Messages” (graph B) and “Contact Requests” (graph C). Table 5 summarizes the aspects of each graph. According to (Trier and Richter 2014), these graphs represent an analytical network model, but on other levels

¹ <http://www.neo4j.org/learn/cypher>

they also illustrate different transactions and a meaning structure, as we utilized the military rank of each user, represented by the colors of the nodes.

Table 5: Description of network graphs

Graph	Notation
Graph A – Content & Comments	(User A) - [commented on content of] → (User B)
Graph B – Direct Messages	(User A) - [sent direct message to] → (User B)
Graph C – Contact Requests	(User A) - [has contacted] → (User B)

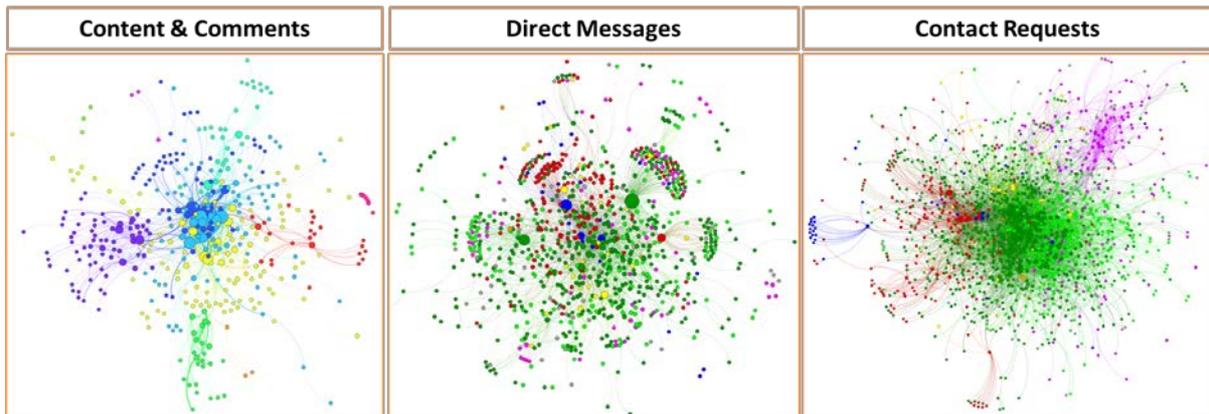


Figure 1: Network graphs derived from digital traces in Med-Net

It has to be acknowledged, that these relations could also have emerged without the use of Med-Net, e.g. by using other communication channels. Yet, the digital traces of Med-Net allow to make these structures visible. As such, the graphs exemplarily show the applicability of using digital traces to analyse different forms of informal networks. The examples furthermore show that there is not the one and only informal network. Digital traces allow taking different perspectives on the network structure, depending on the research aim and the data used. We conclude that it is worthwhile further investigating the conceptualisation of digital traces as the basis for informal network identification and visualisation in ESN. This will offer the opportunity to derive different types of networks that will serve different managerial and research purposes.

INTENDED CONTRIBUTION AND FUTURE WORK

We have reported on research in progress. While we have provided a comprehensive list of conceptualisations of digital traces in ESN, we have only employed some of these to derive relations from our Med-Net case data. Our main aim was to show that such a conceptualisation is important and needs further investigation. So far, we have used the data structured by our framework only partially and focused on the aspects of “Who”, “How” and “Whom”. Figure 2 provides a summary of our research approach reported on in this paper.

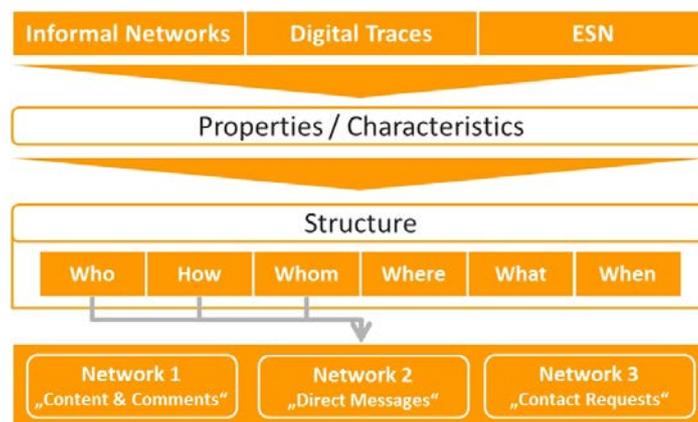


Figure 2: Approach for developing the framework and its application as presented in this paper

Further research needs to be done and is planned as part of our project. As far as our framework and the various aspects (questions) to conceptualising digital traces are concerned, the evolutionary aspect and hence the question of “When?” has not yet been addressed. We also did not analyse the aspect of “Where?” the relations are created in Med-Net. The latter for example would allow insights into privacy aspects within these networks (public or private communication). Furthermore, we did not group or cluster the users based on their individual properties such as military rank or their location, which could generate another network view. We plan to incorporate and scrutinise these aspects in future analyses.

We further plan to use content-focused data processing like text mining in order to classify and cluster text elements which can further be used to generate links between users (Ben-Dov and Feldman 2005; Diesner 2010). Correspondingly, the aspect of “What?” was not analysed qualitatively in our study. Doing so would either require labour-intensive manual data coding or automated content analysis to deduce relevant information such as knowledge exchange or trust building or sentiment dissemination (Pang et al. 2008; Staples and Webster 2008). Another future research avenue is to find meaningful levels of aggregation of digital traces, which are always event-based data.

Finally, communication in an ESN is not the only communication in an organisation. Therefore it needs to be analysed to what extent these networks match, replace or extend the informal communication outside of ESN. Hence, in the near future we specifically plan to compare ESN digital traces with other traces of activity for the identification of informal networks (e.g. gathered via interviews), which can be a basis for an even better understanding of informal networks in organisations as it reveals important context information and therefore allows developing a more suitable method for identifying informal networks in ESN.

CONCLUSION

Informal networks are an essential part of any organisation as they can heavily affect how employees work together. Moreover, they have proven to impact employee satisfaction and performance. The increased use of Enterprise Social Networks (ESN) allows the creation of informal networks on a whole new level as employees have found new ways to interact. Simultaneously, ESN usage constantly creates various data that can be used to uncover informal networks. Detailed knowledge about an organisation’s informal networks can help to improve collaboration processes as they can aid in the identification of key employees.

Digital traces have not been widely employed for the identification of ESN informal networks. Therefore, we have introduced an approach to identify and conceptualise the digital traces relevant for identifying informal networks in ESN. In this study, we have described the phenomenon of informal network and digital traces in Enterprise Social Networks, and put their properties into perspective by creating a multi-aspect framework via an argumentative deductive approach based on a literature review. We evaluated the framework by applying it to the case of a social network of military medical staff called Med-Net. As a consequence, we were able to reveal informal networks of different types, which clearly showed the applicability of our framework, but also revealed that the resulting informal networks vary greatly with the digital traces employed for conceptualising the underlying relations. We conclude that it is important to be aware of the assumptions that go into the visualisation of networks and that it is necessary to investigate further the conceptualisation of digital traces as the basis for informal network constitution in ESN.

Our framework presents a starting point for such future research; it can be used as groundwork to establishing a consistent approach for uncovering informal networks from ESN. The application of our approach in the case of Med-Net indicates the potential of digital traces for analysing informal networks. The results emphasize the potential of analysing informal networks for organisations, as critical network structures were made visible. In this context our framework indicated several other research questions, which will be addressed in the near future.

References

- Agarwal, R., Gupta, A. K., and Kraut, R. 2008. “Editorial Overview—The Interplay Between Digital and Social Networks,” *Information Systems Research* (19:3), pp. 243–252.
- Allen, J., James, A. D., and Gamlen, P. 2007. “Formal versus informal knowledge networks in R&D: a case study using social network analysis,” *R&D Management* (37:3), pp. 179–196.
- Aral, S., Dellarocas, C., and Godes, D. 2013. “Introduction to the Special Issue —Social Media and Business Transformation: A Framework for Research,” *Information Systems Research* (24:1), pp. 3–13.
- Behrendt, S., Richter, A., and Trier, M. 2014. “Mixed methods research for enterprise social networks,” *Computer Networks* (2014:70).
- Ben-Dov, M., and Feldman, R. 2005. “Text Mining and Information Extraction,” in *Data Mining and Knowledge Discovery Handbook*, O. Maimon, and L. Rokach (eds.), New York: Springer-Verlag, pp. 801–831.

- Bharadwaj, A., El Sawy, Omar A., Pavlou, P. A., and Venkatraman, N. 2013. "Visions and voices on emerging challenges in digital business strategy," *MIS Quarterly* (37:2), pp. 633–634.
- Borgatti, S. P., Mehra, A., Brass, D. J., and Labianca, G. 2009. "Network Analysis in the Social Sciences," *Science* (323:5916), pp. 892–895.
- boyd, d., and Crawford, K. 2012. "Critical questions for big data: Provocations for a cultural, technological, and scholarly phenomenon," *Information, Communication & Society* (15:5), pp. 662–679.
- boyd, d. m., and Ellison, N. B. 2007. "Social Network Sites: Definition, History, and Scholarship," *Journal of Computer-Mediated Communication* (13:1), pp. 210–230.
- Bryan, L. L., Matson, E., and Weiss, L. M. 2007. "Harnessing the power of informal employee networks," *McKinsey Quarterly* (4), pp. 44–55.
- Chandler, A. D. 1962. *Strategy and Structure. Chapters in the History of the Industrial Enterprise*, Cambridge: MIT Press.
- Chau, M., and Xu, J. 2012. "Business intelligence in blogs: Understanding consumer interactions and communities," *MIS Quarterly* (36:4), pp. 1189–1216.
- Ciriello, R. F., Hu, D., and Schwabe, G. 2013. "Identifying patterns of idea diffusion in innovator networks," in *Proceedings of the International Conference on Information Systems*, Milan, Association for Information Systems.
- Cross, R., Borgatti, S. P., and Parker, A. 2002. "Making Invisible Work Visible: Using Social Network Analysis to support strategic collaboration," *California Management Review* (44:2), pp. 25–46.
- Cross, R. L., and Parker, A. 2004. *The hidden power of social networks: Understanding how work really gets done in organizations*: Harvard Business Press.
- Diesner, J. 2010. "Extraktion relationaler Daten aus Texten," in *Handbuch Netzwerkforschung*, C. Stegbauer, and R. Häußling (eds.), Wiesbaden: VS Verlag für Sozialwissenschaften.
- DiMicco, J., Millen, D. R., Geyer, W., Dugan, C., Brownholtz, B., and Muller, M. 2008. "Motivations for social networking at work," *CSCW '08 Proceedings of the 2008 ACM conference on Computer supported cooperative work* (3), pp. 711–720.
- Freelon, D. 2014. "On the Interpretation of Digital Trace Data in Communication and Social Computing Research," *Journal of Broadcasting & Electronic Media* (58:1), pp. 59–75.
- Hillmann, R., and Trier, M. 2012. "Dissemination Patterns and Associated Network Effects of Sentiments in Social Networks," in *2012 IEEE/ACM International Conference on Advances in Social Networks Analysis and Mining*.
- Howison, J., Wiggins, A., and Crowston, K. 2011. "Validity Issues in the Use of Social Network Analysis with Digital Trace Data," *Journal of the Association for Information Systems* (12:12), pp. 767–797.
- Johnson, D. J., Donohue, W. A., Atkin, C. K., and Johnson, S. 1994. "Differences Between Formal and Informal Communication Channels," *Journal of Business Communication* (31:2), pp. 111–122.
- Kane, G. C., Alavi, M., Labianca, G., and Borgatti, S. P. 2014. "What's Different About Social Media Networks?: A Framework and Research Agenda," *MIS Quarterly* (38:1), pp. 275–304.
- Kleinberg, J. 2008. "The Convergence of Social and Technological Networks," *Communications of the ACM* (51:11), pp. 66–72.
- Krackhardt, D., and Hanson, J. R. 1993. "Informal networks: the company behind the chart," *Harvard Business Review* (71:4), pp. 104–111.
- Krogh, G. von 2012. "How does social software change knowledge management? Toward a strategic research agenda," *The Journal of Strategic Information Systems* (21:2), pp. 154–164.
- Leonardi, P. M., Huysman, M., and Steinfield, C. 2013. "Enterprise Social Media: Definition, History, and Prospects for the Study of Social Technologies in Organizations," *J. Computer-Mediated Communication* (19:1), pp. 1–19.
- Lerman, K., and Ghosh, R. 2010. "Information Contagion: an Empirical Study of the Spread of News on Digg and Twitter Social Networks," in *Fourth International AAAI Conference on Weblogs and Social Media*, Washington, DC USA. May 2010, pp. 90–97.
- Lin, C.-Y., Wu, L., Wen, Z., Tong, H., Griffiths-Fisher, V., Shi, L., and Lubensky, D. 2012. "Social Network Analysis in Enterprise," *Proceedings of the IEEE* (100:9), pp. 2759–2776.
- Majchrzak, A., Wagner, C., and Yates, D. 2013. "The impact of shaping on knowledge reuse for organizational improvement with wikis," *MIS Quarterly* (37:2), pp. 455–A12.
- McLure Wasko, M., and Faraj, S. 2005. "Why should I share? Examining social capital and knowledge contribution in electronic networks of practice," *MIS Quarterly* (29:1), pp. 35–57.
- Milolidakis, G., Akoumianakis, D., and Kimble, C. 2014. "Digital traces for business intelligence: A case study of mobile telecoms service brands in Greece," *Journal of Enterprise Information Management* (27:1), pp. 66–98.
- Oh, O., Agrawal, M., and Rao, R. 2013. "Community Intelligence and Social Media Services: A Rumor Theoretic Analysis of Tweets During Social Crises," *MIS Quarterly* (37:2), pp. 407–426.

- Pang, B., Lee, L., Aggarwal, C. C., and Zhai, C. 2008. "Opinion Mining and Sentiment Analysis," *Foundations and Trends® in Information Retrieval* (2:2), pp. 1–135.
- Perer, A., Guy, I., Uziel, E., Ronen, I., and Jacovi, M. 2013. "The Longitudinal Use of SaNDVis: Visual Social Network Analytics in the Enterprise," *IEEE Transactions on Visualization and Computer Graphics* (19:7), pp. 1095–1108.
- Richter, A., and Koch, M. 2008. "Functions of Social Networking Services," in *Proc. Intl. Conf. on the Design of Cooperative Systems 2008*, P. Hassanaly, A. Ramrajsingh, D. Randall, P. Salembier, and M. Tixier (eds.), Carry-le-Rouet, France: Institut d'Etudes Politiques d'Aix-en-Provence, pp. 87–98.
- Riemer, K., and Richter, A. 2010a. "Social Software: Agents for Change or Platforms for Social Reproduction? A Case Study on Enterprise Microblogging," in *Proceedings of the 21th Australasian Conference on Information Systems*, Brisbane.
- Riemer, K., and Richter, A. 2010b. "Tweet Inside: Microblogging in a Corporate Context," in *Proceedings 23rd Bled eConference eTrust: Implications for the Individual, Enterprises and Society*.
- Roethlisberger, F. J. 1976. *Management and morale*, Cambridge, Mass.: Harvard University Press.
- Schulte-Zurhausen, M. 2002. *Organisation*, München: Vahlen.
- Staples, S., and Webster, J. 2008. "Exploring the effects of trust, task interdependence and virtualness on knowledge sharing in teams," *Information Systems Journal* (18:6), pp. 617–640.
- Stieglitz, S., Riemer, K., and Meske, C. 2014. "Hierarchy or Activity? The role of formal and informal influence in eliciting responses from enterprise social networks," in *Twenty Second European Conference on Information Systems*, Tel Aviv.
- Toni, A. de, and Nonino, F. 2010. "The Key Roles in the Informal Organization: A Network Analysis Perspective," *Learning Organization* (17:1), pp. 86–103.
- Trier, M., and Richter, A. 2014. "The Deep Structure of Corporate Social Network Sites: An Actor-oriented Case Study of Online Interaction," *Information Systems Journal* .
- Tushman, M. L., and Scanlan, T. J. 1981. "Boundary Spanning Individuals: Their Role in Information Transfer and Their Antecedents," *Academy of Management Journal* (24:2), pp. 289–305.
- Wasserman, S., and Faust, K. 1994. *Social network analysis: Methods and applications*: Cambridge university press.
- Zell, H. 2011. *Die Grundlagen der Organisation: Lernen und Lehren*, Norderstedt: Books on Demand.
- Zhang, J., Qu, Y., Cody, J., and Wu, Y. 2010. "A Case Study of Micro-blogging in the Enterprise: Use, Value, and Related Issues," in *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, New York, NY, USA: ACM, pp. 123–132.

COPYRIGHT

Sebastian Behrendt, Alexander Richter, Kai Riemer © 2014. The authors assign to ACIS and educational and non-profit institutions a non-exclusive licence to use this document for personal use and in courses of instruction provided that the article is used in full and this copyright statement is reproduced. The authors also grant a non-exclusive licence to ACIS to publish this document in full in the Conference Papers and Proceedings. Those documents may be published on the World Wide Web, CD-ROM, in printed form, and on mirror sites on the World Wide Web. Any other usage is prohibited without the express permission of the authors.